Handbook on Railway Construction
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NORTHERN RAILWAY
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MESSAGE

Indian Railways are rapidly modernizing and expanding its capacity to meet the transportation demands of the economy. Its quality of service has seen a paradigm shift during last few years which has brought all round appreciation to the Railway fraternity. Speedier and quality execution of network expansion and throughput enhancement projects of doubling, gauge construction, new line, electrification and signaling improvement are the key to a viable future for Indian Railways and also essential to meet requirements of country's economic development. With a view to enhance mobility on railway network, 'Super Critical' and 'Critical' projects are targeted for completion by Dec’2021 & Mar’2024, and the network capacity is to be substantially augmented on High Density and High Utilization routes. Speedy construction of Road Over / Under Bridges to eliminate level crossings is also essential for removing bottlenecks and improving safety in railway operation. These expectations pose an undoubting challenge to Railway's construction engineers.

I am happy to note that Northern Railway Construction organization has brought out an updated and comprehensive "Handbook on Railway Construction". The handbook covers the entire gamut of project planning, execution, monitoring and construction technology in the vast fields of railway projects. I am sure this will be a very useful tool for all railway engineers in proper planning and execution of railway projects. I congratulate the team of Engineers of Northern Railway Construction Organization for this effort and convey them my best wishes in their endeavour for speedier and quality construction of railway projects.

PIYUSH GOYAL
MESSAGE

Indian Railways are undergoing complete transformation of which, infrastructure development through doubling, gauge conversion, new lines, electrification, terminal facilities and station development is a singularly important aspect. The augmentation of infrastructure is eliminating the bottlenecks and capacity constraints in transportation throughout, and providing modern facilities to the passengers and freight business. Higher speeds and increase in throughput are being increasingly realised with sustained inputs to the infrastructure. The construction engineers play an important role in the infrastructure development.

Northern Railway Construction Organization has done excellent work by bringing out an updated and comprehensive “Handbook on Railway Construction”, incorporating latest policy circulars of Ministry of Railways, procedure of land acquisition under new Land Acquisition Act of 2013 and Railway (Amendment) Act 2008 and knowhow about various IT tools and web-based applications for scientific project planning and monitoring besides an extensive coverage on all aspects of construction technology for railway projects. Design and script of the book has been meticulously developed. It has an excellent narrative about construction of tracks, bridges, stations, signalling and electrification to provide a ready guide for dealing with any challenge related to construction processes.

I am sure, this book will be every useful to construction engineers, planners and project managers for railway projects.

I wish all the success to teams associated with construction work in Indian Railways.

(SURESH ANGADI)
MESSAGE

A well-developed transportation system particularly Railways plays a vital role in the economic development of a country. Inadequate transport infrastructure leads to bottlenecks both in the supply of raw materials as well as movement of finished goods to the market place. This places a huge responsibility on Railways to substantially augment capacity to support and drive growth of the economy.

With sustained focus on infrastructure creation, Indian Railways have commissioned 2,226 km of New Lines, Doubling and Gauge Conversion during 2019-20. Availability of funds for the projects has been substantially enhanced from an average of Rs. 11,527 crore per annum during 2009-2014 to Rs. 26,026 crore per annum during 2014-19 and Rs. 39,836 crore during 2019-20. For meeting the transportation demands in tandem with the growth of economy a quantum jump is required in construction of infrastructure. At the same time it is to be ensured that the infrastructure created is of high quality and reliability to cater to higher speeds and higher freight carrying capacity.

Project planning and preparation are crucial for timely and quality delivery of projects. Award of contracts without paper project preparation is counter productive. Construction engineers have to rise to the occasion and do thorough project planning and preparation to ensure that projects get completed in a time bound manner.

I am happy to note that Northern Railway Construction Organization has brought out updated and comprehensive "Handbook on Railway Construction" duly including important instructions related to survey, planning, estimation, land acquisition, project preparation, contracts /tenders, besides various technical guidelines on execution of projects. The Handbook covers Railway Construction in holistic perspective, and has been compiled by Northern Railway Officers having long experience in project implementation. I am sure that "Handbook on Railway Construction" will be of tremendous interest and use for all field engineers.

I convey my appreciation to officers of Northern Railway Construction Organization for successfully bringing out this Handbook.

VINOD KUMAR YADAV
MESSAGE

Indian Railways are rapidly modernizing and expanding its capacity to meet the transportation demands of the economy. Its quality of service has seen a paradigm shift during last few years which has brought all round appreciation to the Railway fraternity. Speedier and quality execution of network expansion and throughput enhancement projects of doubling, gauge construction, new line, electrification and signaling improvement are the key to a viable future for Indian Railways and also essential to meet requirements of country's economic development. With a view to enhance mobility on railway network, 'Super Critical' and 'Critical' projects are targeted for completion by Dec'2021 & Mar'2024, and the network capacity is to be substantially augmented on High Density and High Utilization routes. Speedy construction of Road Over / Under Bridges to eliminate level crossings is also essential for removing bottlenecks and improving safety in railway operation. These expectations pose an undoubtling challenge to Railway's construction engineers.

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New Delhi,
4th June, 2020

(Vishwesh Chaube)
Member Engineering
MESSAGE

The country has high expectations from Indian Railways in terms of network reach, availability and quality of train services and the quality of customer facilities. Saturated routes on IR network pose limitation in meeting demands for introducing new trains and in efficient operation of existing train services. Capacity enhancement new trains and in efficient operation of existing train services. Capacity enhancement through robust and adequate infrastructure is the foremost need for safe, efficient and reliable transportation network. Execution of construction projects of Doubling, gauge conversion, new lines, signalling improvement, road safety work, augmentation of rolling stock maintenance facilities, provision of modern passenger amenities are important and crucial to efficient Railway transportation system.

Several developments have taken place in construction technology in recent years. Railway Board and RDSO have also issued large number of instructions in recent past for expeditious and quality construction. Dissemination of knowledge of best practices in planning and execution of construction projects, as well as the relevant rules, processes and standards is absolutely essential for a fast paced, economical and quality construction.

To spread awareness and knowledge of the above, the Officers of Northern Railway Construction Organization have brought out a thoroughly revised and updated version of "Handbook on Railway Construction" during the period of lockdowns necessitated by covid-19. This will be an important tool in the hands of field engineers in planning and execution of Railway projects.

I Congratulate the team of Officers of Northern Railway Construction Organization for bringing out this edition of the handbook and convey my best wishes to them in their endeavour.

New Delhi.
31.05.2020

(rajiv chaudhry)
PREFACE TO THE SECOND EDITION

Last few years have seen a sea change in the execution of Construction projects on Indian Railways. Government of India has laid high thrust on expansion of IR's network capacity and fund availability for construction projects has been substantially augmented. Railway Board and RDSO have also issued a number of instructions for faster and qualitative execution of projects. At the same time several advancements in construction techniques and Information Technology are now being increasingly adopted in Railway projects.

In view of this backdrop, Member Engineering desired that Northern Railway's Handbook on Railway Construction needs updating and a thorough review. The task was taken up in right earnest and completed in a very short period. Pivotal role in this review was played by Sh. S. K. Jha, CAO(C)-II and Sh. Pramod Sharma, CE(C)/Planning who planned and coordinated the review on day to day basis. The review was carried out by the Chief Engineers, Chief Electrical Engineers and Chief Signaling & Telecom Engineers of Northern Railway Construction Organization, duly supported by their team of officers. Thus, came this updated second edition of the Handbook on Railway Construction.

Some of the significant features incorporated in this edition are:

1. The chapter on Survey has been amplified. Modern surveying techniques such as LiDAR (Light Detection and Ranging), Unmanned Aerial Vehicle (Drone) Survey, Development of Digital Elevation Model (DEM) and use of Satellite imagery etc. have been covered in greater details. Northern Railway's firsthand experience in the important survey work of Bilaspur-Manali-Leh new line has contributed to making this chapter more useful.

2. In Land Acquisition, besides other updating, procedure for land acquisition through Direct Negotiation including instances from actual works have been incorporated.

3. In Project Planning, RDSO references related to 'Design of Railway Formation' planning of bridges including important bridges, recent circulars on planning of New Lines and Doubling, modern web based tools for Project Monitoring and Quality Control and modern organization for field units with implementation of e-Office, e-DAS etc. have been covered.

4. Green Building concept has been detailed

5. In bridges, use of spherical bearings, latest loading criteria for superstructure, and latest developments in box pushing techniques have been covered. Guidance on depth of Drop Wall/ Curtain Wall has been included.

6. Amendments in IS-Codes (such as IS-456) have been updated.
7. Chapter on pile foundation has been augmented in greater details taking inputs from unified specifications, MORTH specifications, IS:2911 and field experience.

8. Chapter on track laying has been thoroughly updated to include various machinery, guidance for Cut & Connection, guidance on surveying and track laying with special reference to yard layouts, Improved SEJs and in-situ Glued Insulated Joints. Guidelines for NI work at 30 kmph have been included.

9. S&T chapter has been updated in line with latest instructions. Details on Electronic Interlocking installation have been incorporated. Important points related to CRS inspection while opening New Line/Doubling have also been covered.

10. Electrical TRD chapter has been thoroughly updated. Guidelines for provision of OHE mast for electrification at new and existing bridge pier as per BS-121 have been covered. Details on location of obligatory structures as per RDSO SMI and important parameters of high rise OHE are other important additions.

11. A new chapter on mechanized track laying has been added. This covers various technologies such as New Track Construction Machines, Crawler based Track Laying Portal Cranes, Point and Crossing Laying Machines (T-28), Continuous Track Lifter and Rail Threader. This will be very useful in adopting mechanized track laying techniques.

12. EPC (Engineering Procurement and Construction) contracts are now being gradually adopted in IR construction projects. The important aspects of EPC contracts have been covered and their nuances have been explained for the Railway engineers.

During the updating of this Handbook, valuable guidance was received from Sh. Vishvesh Chaube, Member Engineering, who has spearheaded several path breaking changes in the manner of execution of construction projects on Indian Railways. He was constantly monitoring and motivating us during the updating process. To our good fortune we also received the mentoring and guidance of Sh. Rajiv Chaudhary, General Manager, Northern Railway, himself a civil engineer with vast experience including that on Delhi Metro project. We are thankful for their valuable guidance and inputs.

This edition of the Handbook is first being released in a soft copy. This will make the book easy to carry for field engineers and it will always be in their reach while looking for answers to their queries or for their guidance during execution of projects.

It is hoped that this Second Edition of Handbook for Railway Construction will greatly help the field engineers in better planning and execution of construction projects. It will also be an important ready reference tool during their day to day work.

(ANIL KUMAR LAHOTI)
Chief Administrative Officer (Construction)
Northern Railway

New Delhi
31.05.2020
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CHAPTER-1

ALIGNMENT AND SURVEY

As per Indian Railways Code For the Engineering Department, Project Development Process consists of assessment of future needs, Project formulation (i.e. various options to meet the demand), Project investigation (i.e. to examine few selected alternatives as defined in terms of reference and preparation of Techno Economic Survey Reports or Feasibility Reports as the case may be), Project evaluation (Economic analysis or Social Profiatibility analysis, in addition to financial appraisal), Selection of a scheme based on such an appraisal, further detailed examination of selected proposal by conducting a Preliminary survey for accurate costing and preparation of project reports and investment decisions. Project formulation is an essential part of the planning process, requiring clear indications regarding objectives to be achieved and the alternatives to be investigated. Traffic surveys are conducted to make forecast of traffic prospects, to be undertaken in conjunction with Reconnaissance or Preliminary Engineering surveys. This chapter provides insight into various types of surveys for finalization of alignment of a Railway project, including modern survey techniques.

1.1 RECONNAISSANCE SURVEY:

1.1.1 Purpose

The main objective of reconnaissance survey is to examine the general characteristics of the area for the purpose of determining the most feasible route, or routes, for further more detailed investigations. The reconnaissance survey is a rough, quick investigation of an area with a view to determine the technical feasibility and approximate cost of one or more routes for a proposed Railway line with the help of contoured maps and other available material without very detailed investigations of the field. The field reconnaissance is done to get approximate distances and heights, using basic instruments such as prismatic compass, clinometer etc. Where suitable aerial photographs/ terrain models are available, field investigation by instruments can be considerably reduced with Stereoscopic studies of the photographs and fewer site visits may be required. Adequate data should however be collected, in order to examine feasibility of all possible routes in question, and also to furnish approximate estimates of quantities and costs, so as to decide on the most suitable alternative(s). The survey should also help in determining any deviation(s) required in basic geometric standards.

1.1.2 Survey method

The reconnaissance survey should be conducted in following sequence:

1.1.3 Study of Survey Sheets, Maps etc.

Reconnaissance begins with study of the project area through available maps. The details available from maps currently available in the country are as below:

(i) Survey of India (SOI) Maps.

a. The most useful maps are the topographical sheets available in the scale of 1:25,000, 1:50,000 and 1:250,000. Maps of 1:50,000 and 1:250,000 scale are available for the whole of India but map coverage of 1:25,000 is presently available for about half of country’s territory.
b. State maps on scale varying from 1:5,00,000 to 1:10,00,000 for different states.

These are useful as index maps or to indicate an overview of the project location and are available for most of the States.

c. Plastic Relief Maps on scale 1: 1,50,00,000.

Plastic relief maps are also available for few regions in the country. These three-dimensional maps delineating ridges, valleys, peaks, etc. with contour information, may be useful for alignment planning in very difficult areas.

d. SOI maps procurement

List of SOI offices (from where SOI maps can be procured) and unit price of different maps can be seen at http://www.surveyofindia.gov.in. The SOI maps can also be procured from SOI head office at Dehradun i.e. Map Archive and Dissemination Center (MADC), Survey of India, Hathibarkala, Dehradun.

The SOI topographical maps are divided into two types.

1. Restricted (area of strategic importance).

2. Unrestricted (rest of the country).

For procurement of SOI sheets, Indent on form No. O.57 (to be downloaded from SOI website http://www.surveyofindia.gov.in), is required to be submitted, with approval from Engineer-in-charge. After acceptance of Indent by SOI and communication from SOI about details of availability of maps, payment for available topographical maps is required to be ensured. After receiving the payment, SOI will supply the maps to Indenting officer.

SOI has now launched Open Series Map portal (http://spinakshe.uk.gov.in/). Unrestricted topographical maps of 1:50,000 can be downloaded from this portal after registration. Paid digital data in other formats (DGN, DEM, ARC, SHAPEFILE, GEOTIFF) can also be bought online through this website.

(ii) Apart from SOI maps, there are special purpose maps, like Forest Survey of India, Vegetation Maps on scale 1:2,50,00,000 showing orchards, reserve forests, clusters of social forestry areas etc. which may be helpful in special cases in the selection of alignment. Nowadays, many State Govts have digitized their forest maps which can be acquired from respective DFOs/Head offices.

(iii) Maps prepared by National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) indicating information about soil, wasteland, etc. and Geological Survey of India (GSI) Maps (on scale 1:2,50,000 or smaller) with information on geology, geomorphology and changes in drainage, river courses, etc. are available for many areas. GSI has now launched their web portal http://bhukosh.gsi.gov.in/, geological maps of 1:250k and 1:50k can be downloaded in digital format from this website, free of cost.
(iv) Data of Google Earth, Aster DEM, Cartosat -1 & 2 imageries and DEM, LISS etc. can be accessed free of cost. CartoDEM data can be downloaded free of cost, from NRSC’s Bhuvan Portal i.e. https://bhuvan-app3.nrsc.gov.in/data/download/index.php. List of few open source digital data websites is as under:

   a. Google Earth: https://earth.google.com/web/
   b. Bing Maps: https://www.bing.com/maps
   c. Open Street Map: https://www.openstreetmap.org/
   d. Wikimapia: https://wikimapia.org
   e. https://www.mosdac.gov.in/
   f. https://earthexplorer.usgs.gov/ - paid data site

After study of topographical features on the maps and details from adjoining existing Railway lines, Terms of Reference are prepared.

1.1.4 Marking of alignment

1.1.4.1 Conventional method

After study of topographical features on the maps, a number of feasible alignment option are selected and marked on toposheets after considering approved terms of reference. Following points should be kept in mind while marking alignment on toposheets:

(i) The alignment should take into account all the control points and should be the shortest and most economical, compatible with the requirement of gradient and curvature.

(ii) Shape of the alignment.

(iii) Avoidance, as far as possible, of marshy ground, steep terrain, unstable hill features and areas subject to severe climatic conditions, floods and inundation.

(iv) Need to connect important villages and towns.

(v) Bridging cross drainage and drainage problems.

(vi) Proper location and orientation of cross drainage structures is an important factor in selection of alignment. For bridges having linear waterway more than 300m i.e. for important bridges, siting of bridge will be the primary guiding factor in route selection.

(vii) Need to preserve the environment and maintain ecological balance.

1.1.4.2 Field Survey

After the paper alignment is finalized, the alignment is marked in the field with help of instruments such as total station, compass, Abney level/ Alti-meter, Pedometer, Aneroid barometer, Clinometer, Ghat tracer etc. Walkie-talkie sets, mobile phones etc. are useful for communication, particularly in difficult terrain.

1.1.4.3 Technological advancements in Survey

Digital Terrain Model (DTM) may be prepared, by digitizing 1:25,000 or 1:50,000 scale toposheets for various features viz contours, roads, rivers, streams etc.
Readymade digital formats are also available these days, free of cost.

Since toposheets supplied by Survey of India may be quite old, these are required to be updated for various ground features. This updation is done through satellite imageries/DEM available with NRSC, Hyderabad. Digital Elevation Model (DEM) from CARTOSET is available free of cost at BHUVAN website.

Study of project area should preferably be done on the digital interface instead of paper maps. This can be done by visualizing the project area in Google Earth, Terra Explorer etc. As per approved TOR, three or more tentative feasible alignments are marked on Google Earth, without providing engineering parameters at this stage. These alignments are then transferred to Auto-CAD or Bentley MX Rail software where engineering parameters to these alignments are provided on the surface/contours generated from the available DEM of the project area (DEM may be opened as base layer while performing the job). Most of the alignment software are able to open Google Earth in the background for better visualization.

Generally, three alternatives are first marked and with the help of available software, detailed analysis is carried out to find out the best economical, feasible option. Best alignment option is finally selected based on various technical & commercial criteria. The alignment file can also be superimposed on the vector maps of the area where layers of Road, River, streams, structures etc are available. Open source vector maps can be obtained from https://www.openstreetmap.org/. These vector maps along with DEM are very useful in finalizing planning of structures like ROB/RUB, Bridges etc during the development of alignment and further estimating the cost of construction. The quantity of earthwork, list of gradients, curves, viaducts, tunnels and other relevant data can directly be extracted from these software.

The set of co-ordinates (X,Y,Z) or KMZ file of the alignments is extracted and verified in the field using DGPS or Total station. The co-ordinates are required to be checked at all important locations like crossing of roads, major/important bridges and every 500m apart in accessible area. Effort should be made to fix permanent bench marks/ control points in field at every 5 KM using DGPS.

1.1.5 Terms of Reference

After finalizing rough alignment on toposheets, Terms of References (TOR) are prepared, indicating category of line, ruling gradient etc (para 209 of IR Engineering Code). TOR should include scope and nature of investigation to be carried out, particulars of any railway line already existing in the area and standard of construction.

1.1.6 Final Details

After confirmation and suggestion from the field, the alignment is rectified and finalized. The final details as described below are prepared.

General description of Area, Topography, Climate indices (viz Humidity, Temperature, Wind) etc. Alignment & L-section in Scale of 1:25,000/50,000 for horizontal and 1:1,000 for vertical.

Index Map in Scale of 1:2,50,000 and General Map in Scale of 1:25,00,000.

Conceptual Yard Plan/Line Diagram
List of Gradients
List of Curves
List of ROBs/RUBs/LHS
List of Stations
List of Quarters
Land details showing area of land to be acquired, the type of land (Rural/Urban, Agriculture/Forest etc).
Estimate for Earthwork/Blanket
List of Electric & Telephone Crossings
List of Bridges indicating size, waterway, height and type of foundation.
List of Major Bridges
List of Tunnels
List of RAW if any
List of SSP
Standard of Interlocking/PI/SSI.

1.1.7 Preparation of Detailed Engineering Estimate

Project cost is then prepared which includes cost of Civil Engineering, Electrical, TRD and S&T works required in the project. The unit rates for cost estimation of civil engineering works are obtained from latest LARs or rates circulated by Zonal headquarter. Detailed Project Estimate is framed by compiling sub-estimates of all concerned departments, in formats available in IR Engineering Code (para 553-554), which is then processed for scrutiny and vetting by associate finance.

1.1.8 Rate of Return (ROR)

Rate of Return of the project is calculated on the basis of expenditure and earnings from the project if implemented for obtaining the financial viability of the project. Traffic cell provides expected earnings by traffic, expenditure of rolling stocks etc. and expenditure on construction is taken from engineering estimates and ROR is calculated.

1.1.9 Project Report

Project report is prepared based on the information collected from the reconnaissance survey, prepared maps, vetted estimate and ROR. The report should be prepared as per IR Engineering Code para 555 and 576. The report should include all relevant information collected during the survey, a plan to the scale of 1:50,000 or larger showing various alternatives of alignments studied along with their general profile. It should discuss the merits and demerits of different alternative alignments and the procedure adopted for selection of best alignment for detailed survey and investigation. The project report is then submitted to Railway Board after approval of General Manager.

1.2 PRELIMINARY SURVEY:

1.2.1 Purpose

1. The preliminary survey is a relatively large scale instrument survey conducted for the purpose of collecting all the physical information which affects the proposed location of a new Railway alignment or doubling of existing Railway line. In the case of new Railway alignment, it consists of running an accurate traverse line along the route previously selected on the basis of the reconnaissance survey. In the case of existing Railway line where only doubling is proposed, the survey line is run along the existing alignment. During this phase of the survey, topographic features and other features like houses, monuments, places of worship,
1.2.2

cremation or burial grounds, utility lines, existing road and level crossings, stream, river, canal crossings, cross drainage structures etc are tied to the traverse line. Longitudinal sections and cross sections are taken and bench marks established. The data collected at this stage will form the basis for the determination of the final center line of the proposed alignment. For this reason, it is essential that every precaution should be taken to maintain a high degree of accuracy.

2. Besides the above, general information which may be useful in fixing design features within close limits is collected during this phase. The information may concern soil, construction materials, drainage etc and may be collected from existing records as through intelligent inspection/ simple measurements. With data collected, it should be possible to prepare a rough cost estimate within reasonably close limits for obtaining administrative approval, if not already accorded and for planning further detailed survey and investigations. In particular, information may be collected regarding:

(i) The highest sub soil and flood water levels, the variation between the maximum and minimum, and the nature and extent of inundation, if any, gathered from local enquires or available records.

(ii) The character of embankment foundation including the presence of any unstable strata like micaceous schists, poor drainage or marshy areas etc. Any particular construction problem of the area, like subterranean flow, high level water storage resulting in steep hydraulic gradient across the alignment, canal crossings and their closure periods. Information regarding earlier failure in the area of slides or settlement of slopes, embankments and foundation, together with causes thereof may also be gathered from records and enquiry where feasible.

(iii) In cut sections, the nature of rock, i.e. hard, soft etc should be determined visually. This is essential to make realistic cost estimate.

1.2.2 Survey Procedure

1. The preliminary survey starts with running of a traverse along the selected route, adhering as far as possible to the probable final center line of the proposed railway alignment. In difficult situations, a secondary traverse connected to the primary one at either end may also be run. In hilly areas, a trace cut 1.0 to 1.2 m side, if required may be made during the preliminary survey.

2. The traverse consists of a series of straight lines with their lengths and intermediate angles measured very carefully. In difficult terrains, the alignment may have to be negotiated through a series of short chords, preferably the traverse should be done with a theodolite with Electronic Distance Measurement (EDM) and all angles measured with double reversal method.

3. Traversing procedure by Total Station for stacking the alignment:

A total station is an electronic/optical instrument used in modern surveying that uses electronic transit theodolite in conjunction with an electronic distance meter. It is also integrated with microprocessors, electronic data collectors and storage system. The instrument is used to measure sloping distance of object to the instrument, horizontal angles and vertical angles. The Microprocessor unit enables computation of data collected to further calculate the horizontal distance, coordinates of a point and reduced level of point. Data collected from total station can be downloaded into computers for further processing. Total stations are mainly used by land surveyors to record topographic features. The process of fixing Alignment Center-line points on the ground using its coordinates is known as staking. The following procedure may be applied during traversing, for staking
the co-ordinates in field:

(i) Set up the total station on known Ground control point.

(ii) Then go to survey option in instrument’s control panel and setup the total station by any one of two methods i.e. “known back side” or “resection”.

(iii) Set up the instrument by giving the coordinates of known point used as station, then feed input of 2nd point coordinates used as back site. Then setup total station.

(iv) Next go in menu option, search for stakeout function. Select stakeout and enter the coordinates of the points to be stake out.

(v) As the coordinates of point to be staked, are entered, total station will give the direction and distance of point.

(vi) Measure the point with reflector (Prism-pole) by total station until the horizontal circle reads zero.

(vii) Position the reflector at this point.

(viii) Save the point after getting accuracy of 5-10mm.

The same procedure may be followed for further completion of the survey.

4. Differential Global Positioning System (DGPS) is also very useful and appropriate for preliminary survey. The DGPS will give location coordinates at all necessary points on the traverse. DGPS is very fast, reasonably accurate equipment for preliminary system and is computer friendly for data transfer. Control pillars in cement concrete should be fixed at suitable interval (ranging from 500m to 2kms) to have control on accuracy. It also helps in repeating the survey, if required, within the control pillars.

5. Distance between two consecutive transit stations, depends upon directional changes in the alignment, terrain conditions and visibility. The transit stations should be marked by means of stakes and numbered in sequence and if possible co-ordinates on permanent structures should also be recorded. These should be protected and preserved till the final location survey.

6. Physical features such as buildings, monuments, burial grounds, cremation grounds, places of worship, posts, pipelines, existing roads and electric lines, stream/river/canal crossings, cross drainage structures etc that are likely to affect the project proposals should be located by means of offsets measured from the traverse line. Where the survey is for doubling of an existing railway line, measurements should also be made for existing railway line, railway land boundary and location and radii of horizontal curves. In case of railway alignment in rolling and hilly terrain, the nature and extent of grades, ridges and valleys and vertical curves should necessarily be covered. The width of land to be surveyed will depend on the terrain and other related factors.

Generally, the survey should cover the entire proposed corridor with adequate provision for possible shifting of the center line from the traverse line.

7. Levelling work during a preliminary survey is usually kept to the minimum. Generally, fly levels are taken along the traverse line at 50m intervals and at all intermediate breaks in ground. To draw contours of the strip of land surveyed, cross sections should be taken at suitable intervals, generally 100 to 250m in plain terrain, up to 50m in rolling terrain, and up to 20m in hilly terrain. To facilitate the levelling work, bench marks, either temporary or permanent, should be established at intervals of 250 to 500m. The levels should be connected to GTS datum. Fly level can be taken with the help of Total Station.
8. Field notes of the survey should be clear and concise, yet comprehensive enough for easy and accurate plotting.

9. Apart from traverse survey, general information about soil, drainage should be collected while the traverse is being run.

1.2.3 Map Preparation

1.2.3.1 Plans and longitudinal sections (tied to an accurate base line) prepared as a sequel to the preliminary survey are referred to for detailed study to determine the final center line of the proposed Railway alignment.

1.2.3.2 Scales for the maps should generally be the same as adopted for the final drawings. The following scales are suggested:

- Built up areas and stretches in hilly terrain - 1:50,000 for horizontal scale and 1:1,000 for vertical scale.

1.2.3.3 For study of difficult locations, such as steep terrain, sharp curves, bridge crossings etc, it may be convenient to have plans to a larger scale than recommended above.

1.2.4 Final Details, Preparation of Detailed Engineering Estimate, Rate of Return (ROR) & Project Report

Final Details, Detailed Engineering Estimate and Rate of Return (ROR) are dealt as per details covered in para 1.1.6 to 1.1.8.

Project Report is intended to serve as basis for according Administrative Approval (AA) for the project by the Ministry of Railway. The Project Report must establish the economic viability and technical soundness of the alternative selected. Thus, it must be preceded by engineering surveys and investigations of sufficient accuracy and detail, so as to result in a fairly firm estimation of the cost of the project. The Project Report may include discussion on different alternative alignments, for deciding most suitable alternative.

Feasibility of stage construction should also be examined in the light of the rate of growth of traffic and other relevant parameters.

A brief outline of the organisational structure of the Engineering, Traffic and other various Departments of Railway must be given, establishing its adequacy in handling the project and giving details of any augmentation support system proposed.

The Report should give a brief description of the scope of the project, its need, source of funding, budget and plan provision, selection of route alignment and construction methodology.

The design standards and methodology adopted must be explained.

The Report must contain a reasonably accurate estimate of costs, giving the basis for adopted rates. Any provision for escalation of costs must be explained.

It must be based on accurate traffic projections and must contain an economic analysis i.e. ROR of the project.

The project report is submitted to Railway Board after approval of General Manager.
1.3 FINAL LOCATION SURVEY:

1.3.1 Purpose

After sanction of the project and inclusion in the pink book, Final Location Survey (FLS) for new line/doubling/GC works is done by concerned executing unit. Survey unit also carries out Final Location Survey of some projects as decided by Railway administration.

The purpose of FLS is to lay down and mark center line of alignment in field based on the alignment selected in the design office and after RET/PET survey to collect necessary data for the preparation of working drawings. The completeness and accuracy of the project drawings and estimates of quantities depend a great deal on the precision with which this survey is carried out. The accuracy of the survey should be test checked by senior Railway officers. This will also help in assessing precise land acquisition requirement.

FLS is generally a post-sanction decision for investigation & preparation of accurate working details. Principal difference between FLS and Preliminary Survey is that the alignment finally selected during FLS is fully staked on ground with a Theodolite or Electronic Distance Measuring Instrument (Total stations etc). Detailed plans and sections are developed after FLS. This also includes preparation of Site plans marking loco sheds/ EMU car sheds, maintenance depots, control office, repeater stations, staff quarters, land acquisition plans etc.

Main activities in FLS are the staking out of final center line of proposed Railway alignment by means of a continuous survey and detailed leveling, preparation of detailed plan and L-section of alignment, preliminary design & drawings of structures and assessment of nearly accurate project cost. FLS is basically Pre-construction Survey.

1.3.2 Staking Out Final Center Line

1. The center line of the proposed Railway alignment, as determined in the design office and after RET/PET survey, is transferred on the ground by means of continuous transit survey and staking of the center line as the survey proceeds. Double reversal method should be adopted at all horizontal intersection points and intermediate points of transit (POT) on long tangents. The horizontal intersection points should be fixed on hubs driven flush with the ground and suitably referenced so that they may be readily located. Usually, these should be serially numbered for easy identification and shall be defined by coordinates. On long tangents, the intermediate transit points should also be fixed on hubs in the case of new roads with proper referencing.

2. The reference points should be so located that these will not be disturbed during construction. Description and location by coordinate of the reference points should be noted for reproduction on the final plan drawings.

3. All the curve points, namely the beginning of transition curves (TTP), beginning of circular curve (TP), end of circular curve (TP) and the end of transition (TTP) should be fixed and referenced in the same manner as for POTs described earlier.

4. The final center line of the proposed Railway alignment should be suitably staked. Stakes should be fixed at 50m intervals in plain and rolling terrain, and 20m intervals in hilly terrain. The stakes are intended only for short period for taking levels of the ground along the center line and cross section with reference thereto.

5. Distance measurements along the final center line should be continuous following
1.3. The traverse in case of proposed Railway alignment would be open and should be controlled by establishing control points to be established by DGPS survey or by astronomical observations or Total Station or by running cut-off lines between intermediate stations.

7. At road crossings, the angles which the intersecting roads make with the final center line should be measured.

1.3.3 Establishment of Permanent Control Points / Bench Marks

The permanent control points or Benchmarks are established along the final alignment for purpose of construction. These permanent control points are also called Ground Control Points (GCP) and should be established in a pair of two RCC pillars (minimum) at one location preferably 100m to 300m apart because any new point to be established during the construction stage with the help of total station needs at least two known points. The X & Y coordinates of GCPs can be established with the help of DGPS or Total Station by taking reference from known SOI GCPs. The Z coordinate of the GCP is derived by carrying out levelling survey using Auto level/ Total station from known SOI GTS benchmarks. Reference points for POTs and HIPs, could also be used as bench marks. It is particularly important that a single datum, preferably WGS-84 & GTS/MSL datum, should be used to tie up all the points. For bench mark levelling, check levels should be run over the entire line back to the first bench mark. The detailed procedure to establish permanent control points is explained further in this chapter.

1.3.4 Longitudinal Sections and Cross-Sections

1. Levels along the final center line should be taken at all staked stations and at all breaks in the ground.

2. Cross-sections should be generally taken at 50-100m intervals in plain terrain and 50-75m in rolling terrain depending on the nature of work.

3. Center line profile should normally be continued at least 200m beyond the limits of the project.

1.3.5 Proper Protection of Points of Reference

1. FLS is considered complete when all the necessary information is available and ready for the designer to be able to plot the final proposed Railway alignment profile and prepare the project drawings.

2. At the time of execution, all construction lines will be set out and checked with reference to the final center line established during the final location survey. It is therefore important, that not only all the points referencing the center line should be protected and preserved but these are so fixed at site that there is little possibility of their being disturbed or removed till the construction is completed.

1.3.6 Soil and Material Surveys

General

Soil investigation and other materials survey is carried out with respect to sources and availability/suitability of materials. Additional investigations in respect of landslide or avalanche prone locations may also be carried out at this stage. Detailed investigation at important locations viz high embankments, deep cuttings, major/important bridges, tunnels, weak subsoil, marshy land etc may
also be conducted. RDSO has recently issued specification no. RDSO/2018/GE: IRS-0004 (D) Part-IV (July’2019) titled “Rationalization of Formation Layer Thickness on Indian Railway Track” vide letter no. GE/GEN/Comments/Formation Layer/185/Part-I dated 25.07.2019. Design of formation should be finalized after comprehensive study of all related technical reports/ specifications issued by RDSO (with latest amendments) regarding earthwork, blanketing, sub-grade, slope stabilization, geosynthetics, drainage etc.

Soil and materials survey is required:

(i) to determine the nature and physical characteristics of soil and soil profile for design of embankment.
(ii) to determine the salt content in soil in areas known to have problems or where the composition of the design crust requires such testing.
(iii) to determine proper method(s) of handling soils
(iv) to classify earthwork involved into various categories such as rock excavation, earthwork in hard soil etc.
(v) to gather general information regarding sub-soil water level and flooding.
(vi) to locate sources for aggregate required for ballast, concrete and to ascertain their suitability for use.
(vii) To locate source of good quality water suitable for use in construction.

1.3.7 Study of Available Information

1. Soil and materials survey should include study of all available information such as geological maps, data published by various authorities regarding availability of suitable construction materials and information available with ground water authorities regarding depth of water table. Soil maps prepared by local agricultural department and records of existing highways may also provide useful information. A study of these data, if available, will be of great help in the planning and conduct of further surveys and investigations. This information should be perused in conjunction with general information gathered during the preliminary survey.

2. After studying the available information, detailed Programme of survey can be drawn up. Points needing attention during detailed soil survey are highlighted further on.

1.3.8 Soil Investigations for Low Embankments

1. The first operation in the detailed soil survey is to demarcate the possible borrow areas.

2. The general character of material excavated from test pits should be recorded and tests conducted on it in the laboratory for required properties. Where the type of material varies in a single pit, the tests should be conducted on each type of soil separately and the horizon of occurrence noted. Similar tests should be carried out on material from cuts for ascertaining the suitability of its use in the embankment.

   (i) Gradation test (IS:2720 Part IV)
   (ii) Liquid limit and Plastic limit (IS:2720 Part V)
   (iii) Density and optimum moisture content (IS:2720 Part VII or Part VIII as relevant)
   (iv) Deleterious constituents (only in salt infested areas or where presence of
salt is suspected (IS:2720 Part XXVII).

However, in case of highly plastic, poorly draining and unstable soils, some additional soil tests (e.g. shrinkage limit test) may also need to be performed before accepting the borrow.

1.3.9 Special Investigations for High Embankments

The basic objective of investigations in such cases is to obtain engineering data for soil and rock necessary for a quantitative design of embankment at the chosen sites. Generally, for checking stability against slip failures, the basic properties to be investigated are shear parameters, unit weight and moistures conditions.

1.3.10 Soil Investigations for Cuttings

In the same manner as described in preceding paras for embankment material, soil in cut sections along the center line of the proposed Railway alignment at an elevation corresponding to the design subgrade level should be tested for the following general properties:

(i) Gradation
(ii) Atterberg limits
(iii) Field density and moisture content
(iv) Proctor density.

1.3.11 Special Investigations in Landslide-Prone Areas

Information collected during preliminary survey would normally identify the landslide prone areas along the alignment and every effort would have been made to avoid these while fixing the center line of proposed Railway alignment. However, in case where the same is not feasible, further investigations would be required to study the extent of the problem and plan appropriate remedial measures. For this purpose, services of geologist or soil specialist may often be needed.

1.3.12 Geological Investigations

Before starting the work, particularly in hilly terrain, geological investigations are required for finding out the location of various thrusts/faults if any, coming in the proposed alignment. Such surveys are being done by Geological Survey of India (GSI) and other Govt/Pvt agencies. The study of underground sub-structures is most important for design & construction of tunnels. Geological studies are explained further in detail in this chapter. Avalanche prone areas are also required to be identified in snow-clad mountains. Snow & Avalanche Study Establishment (SASE), Chandigarh/Manali conducts avalanche studies.

1.3.13 Hydrological Studies for Important Rivers

Hydrological studies may also be conducted to find out the design discharge, highest flood level (HFL), lowest water level (LWL), afflux, free board, scour depth and waterway requirement for important rivers which are required to be passed by alignment. RBF-16 report published by RDSO should be followed for conducting hydrological studies.

1.3.14 Other Relevant Legislation

(i) Environmental (protection) Act, 1986
(ii) Wild life (protection) Act, 1972
(iii) Forest (conservation) Act, 1980
(vi) Coastal Zone Regulation

1.3.15 Preparation of Maps & Drawings

After collecting all details from the site, the following detailed drawings are prepared as per para 443 of IR Engineering code:

(i) General Map of the country traversed by project scale about 25 Km to 1 cm.
(ii) Index Map, scale about 2.5 Km to 1 cm.
(iii) Index Plan and Sections.
(iv) Detailed Plans and Sections.
(v) Plans and Cross Section.
(vi) Plans of Station Yards.
(vii) Detailed Drawings of Structures.
(viii) Plans of Junction Arrangements.

1.3.16 Engineering Annexures

Final Engineering Annexures as described below are prepared in formats prescribed in IR Engineering Code (Para 547 – 552):

(i) List of Gradient
(ii) List of Curves
(iii) List of ROBs/RUBs/LHS
(iv) List of Stations & Station sites
(v) List of Station Machinery
(vi) List of quarters
(vii) Land details showing area of land to be acquired, the type of land Rural/Urban Agriculture/ Forest land etc.
(viii) Estimate for Earthwork/Blanket
(ix) List of Electric & telephone crossings
(x) List of Bridges indicating their size waterway height and type of foundation.
(xi) List of major Bridges
(xii) List of tunnels

1.3.17 Preparation of Detailed Engineering Estimate

Project cost is prepared as per formats available in IR Engineering Code (para 553-554). This includes the cost of Civil Engineering, Electrical, TRD and S&T works required in the project.

1.3.18 Detailed Project Report

A Detailed Project Report is prepared in the end for the Final Location Survey. The Project Report may be compiled as per para 502 of the IR Engineering Code under following major chapters:
(i) Introduction
(ii) Characteristics of the project area
(iii) Standards of construction
(iv) Route selection
(v) Project Engineering, Estimation of Cost and Construction Schedule
(vi) Conclusions and recommendations

All the documents pertaining to Final Location Survey Report should be bound in the following order (IR Engineering Code Para 546):

(i) Covering Note
(ii) Index
(iii) Report, followed by a "list of Drawings accompanying the Report"
(iv) Appendices to the Report
(v) Historical and Geographical features
(vi) Location Reports
(vii) Rates for construction work

Detailed Project Report (DPR) is submitted to Railway Board after Finance Concurrence and approval of General Manager.

1.4 MODERN SURVEYING

Revolutionary changes have taken place in last few years in the field of topographical surveying. With rapid advancement in the technology like GNSS (Global Navigation Satellite System), LiDAR (Light Detection and Ranging), Aerial Photogrammetry from aircraft/ UAV (Unmanned Aerial Vehicle) etc, there has been drastic improvement in the manner of determining dimensions and contour of the Earth’s surface. Sophisticated equipment like total station & digital auto level has made the traversing & levelling much faster & more accurate. The use of seismic & electromagnetic waves (geophysical survey) to interpret the lithology of the area has vastly increased the pace & reduced the cost of survey & design works by reducing the need of geotechnical investigation.

1.4.1 Digital Elevation Model (DEM) and High-Resolution Satellite Imagery

1.4.1.1 High-Resolution Satellite Imagery

Satellite images are captured by remote sensing satellites like WorldView series, GeoEye, Pleiades, QuickBird, Cartosat etc. These Satellite Imagery have application in diversified fields depending upon its resolution & band type. Stereo satellite imageries which come in pairs are used for creation of DEM (Digital elevation model). Stereo Images are the two pictures of an area taken from two slightly different angles which are then overlapped to produce the illusion of depth.
1.4.1.2 Procurement Process:

National Remote Sensing Center (NRSC) is responsible for Indian Remote Sensing Satellite (IRS) data dissemination in India. NRSC is also responsible for distribution of foreign high-resolution satellite data to Indian Users (Govt, Private & Academic) against their indent in prescribed high-resolution data request form with the required undertakings as per Government guidelines. The major foreign missions from where the data is captured are RADARSAT, IKONOS, QUICKBIRD, ORBIMAGE, ENVISAT, World View -1/2/3, Pleiades etc from vendors like digital globe, skymap, Airbus etc. As per the Remote Sensing Data Policy (RSDP – 2011), with a view to protect national security interests, all data of better than 1m resolution is screened and cleared by NRSC prior to distribution. A layer of restricted areas like important Defence posts, military airports etc is prepared by Military Intelligence and provided to NRSC for masking these sensitive locations before the data is provided to the user.

1.4.1.3 Terminology of Satellite Imagery

Radiometric resolution/Bit: Amount of detail in each pixel expressed in units of bits. 1-bit raster contains two values (0&1) and has two shades black and white. 8-bit raster ranges from 0-255 \(2^8=256\) values in total means 256 colours of shades of each band will be available.

Off Nadir angle (ONA): Angle at which an image is captured by Satellite. Straight vertical view (0 degree) is the most preferred and the more is the ONA the more is the distortion of an image.

In Orthorectified products, ONA is to be restricted to 30 degrees in the worst case. Less than 10 degrees is preferable.

Image Resolution: Defines the pixel size, detail and the accuracy of the image.

(i) Spatial Resolution: Specifies the pixel size of a satellite image. The higher the spatial resolution, the finer details it will contain. 30cm spatial resolution satellite image means the pixel size is 30cmx30cm.

(ii) Spectral Resolution: Ability of the sensor to define fine wavelength interval. It is number of bands in the spectrum in which the instrument can take measurements. For instance

a. Panchromatic: A single band image which is black and white

b. Multispectral: Multispectral products include the Multispectral bands (Color and Near-Infrared). For example, the band order in a 4-band multispectral product is Blue, Green, Red and Near Infrared.
c. Hyperspectral: A Hyperspectral image consists of hundred or more contiguous spectral bands. These images have potential applications in agricultural and coastal management.

1.4.1.4 Types of Digital Elevation Models:

There are three types of elevation models prepared from imagery:

(i) DSM (Digital Surface Model): 3D Surface elevation model which contains all the natural and man-made features (i.e. vegetation, buildings etc)

(ii) DEM (Digital Elevation Model): 3D elevation model without natural and man-made features and furnished in raster format.

(iii) DTM (Digital Terrain Model): It is the DEM in which terrain data is further enhanced with break lines (Ridge & valley line, cutting etc), creating greater accuracy as it contains additional information of defined terrain features like roads, rivers, bridges etc.

1.4.1.5 Processing of Satellite Imagery for creation of DEM.

(i) Step-1: Image Inventory Study

Quality checking of the satellite images i.e. Nadir angle, snow & cloud cover, overlapping of images, gap area etc is done in various GIS software such as ERDAS Imagine, Global Mapper, ARCGIS etc. Along with this GCP locations are also verified. Any discrepancy with the satellite image is reported and the image is replaced.

(ii) Step-2: Visual Enhancement

Quality of image is improved by removing or reducing the cloud effects, histogram equalization (Colour balancing between two images), haze reduction etc.

(iii) Step-3 Aerial Triangulation (AT)

AT is carried out for georeferencing of the satellite imagery. Georeferencing is the process of assigning geographic coordinates to a raster (grid of x and y) image to define its location in the world based on a map coordinate system (Everest/ WGS-84/ NAD-83 etc). Satellite images which are captured don't perfectly match with the Earth's surface and neither the images coincide with any projected coordinate system map (e.g. UTM). These satellite images (stereo pair) need to be georeferenced or transformed according to the constraints of map projections for the purpose of topographical survey / creation of DEM. The georeferencing of satellite images is done by identifying some prominent points on satellite images which are identifiable on ground for (X, Y & Z) coordinate measurement. These points are called as ground control points (GCP) or photo control points (PCP).

In the Aerial Triangulation process, firstly tie points which are generated at a certain interval are used to connect two stereo images and remove tiling of images. It is done to provide relative accuracy between images. For absolute accuracy measured value of GCP is assigned in the image and the process of bundle block adjustment is carried out. A quality report is finally prepared to compare the adjusted GCPs coordinates on image with the measured GCPs coordinates and the difference should be within the permissible limits.

(iv) Step 4: DTM/DEM Generation

DSM is first generated using the georeferenced satellite image which includes all the natural and manmade features like trees, buildings etc. After the DSM is
generated, mass points at certain interval on ground and break lines at ridges & valleys are generated to remove these natural & manmade features. These mass points & break lines help in creation of smooth contours of natural ground/ terrain. A check is done on contours and wherever abrupt changes are seen (Depicting sudden rise due to tree or building), mass points are deleted to get the smooth contours. Digitization of all the topographical features such as Roads, water body, bridges, building etc with break lines are done using the 3D glasses. Finally, DTM is generated using the software which is the 3-D model of terrain and is further used for different purposes.

![Digital Elevation Model](image)

(v) **Orthophoto Generation**

Orthophoto is a high resolution georeferenced colored 2D image generated in software using DTM & georeferenced image on which further pan sharpening is performed. Pan sharpening is the process in which colour of multi spectral low-resolution image is fused over Pan (black & white) image of high resolution.

![Orthophoto](image)

1.4.1.6 **Measurement of Ground Control Points (GCP) for Georeferencing of Satellite imageries:**

The GCP locations are selected based on following criteria:

(i) One GCP to be selected for every 50 Sq.km and made uniformly distributed according to the area of the image.
(ii) Selected location should be easy to identify like the corner of a building, bridge, corner of a field etc.

(iii) Common or repetitive features like parking lots or lines on a highway should be avoided.

(iv) Collect GCPs in the area of overlap between two or more images wherever possible. GCPs collected in multiple images helps to increase the accuracy.

The GCP locations which are first identified qualitatively on raw satellite images are measured at site with the help of DGPS/ Total Station/ Levelling/ RTX as explained below:

(i) DGPS: The differential Global Positioning System is used to measure latitude, longitude & ellipsoid height with reference to some known point (X,Y&Z) established by Survey of India (SOI). The measurement can be done in static mode or real time kinematic (RTK) mode. The ellipsoid height has to be converted to orthometric height (MSL) with the help of the latest earth gravitational model (EGM-08).

(ii) Total station: The (X,Y&Z) coordinates of a point can also be measured with traversing from a known SOI point to the point of interest (GCP).

(iii) Levelling: The Z coordinate of a GCP can be established by doing levelling survey from a known GTS benchmark of SOI to the identified GCP.

(iv) RTX: RTX (real time measurement) is a GNSS based technology which does not need a reference known point as required for DGPS to measure the latitude, longitude & ellipsoid height of a GCP under 15 cm horizontal accuracy at 95% confidence levels. RTX method of measurement uses Advanced PPP (Post Precise Positioning) technique which unlike the usual DGPS does not require any office process after the measurement and coordinates taken from the site are usable as final coordinates. Trimble R10 GNSS receivers are used to perform this measurement.

1.4.1.7 Geoid Model

All the GNSS based measurements provide the ellipsoidal height at any location which needs to be transformed to orthometric height (MSL) with the help of earth gravitation model (EGM)/ Geoid model. Transformation from ellipsoidal height (h) determined by GPS surveys to orthometric height (H) is directly achieved with precise Geoid (N) model. Geoid is an equipotential surface which is a very close approximation of mean sea level and N is the Geoid undulation from imaginary ellipsoid (Datum for any reference system). Relationship between ellipsoidal height, orthometric height and Geoid height/undulation is depicted in the figure below.

![Geoid Model Diagram](image)

Basic equation relating Orthometric and Ellipsoidal heights: \( H = h - N \)
1.4.2 **Permanent Control Points**

The permanent control points are established along the final alignment for construction purposes. These permanent control points are also called Ground Control Points (GCP) and should be established in a pair of two RCC pillars (minimum) at one location preferably 100 to 300m apart because any new point to be established during the construction phase with the help of total station needs at least two known points. These GCPs are to be located preferably at every 5KM, stations, important bridges/ viaducts and tunnel portals. These locations are first identified on toposheets/ satellite image/ orthophoto/ google earth and then reconnaissance survey is done along the final alignment to choose the locations for construction of RCC pillars. The location of GCP pillar should be selected in such a way that it does not interfere with the GNSS/GPS signal from the satellite. Following precautions should be taken while selecting the location.

(i) The locations are clear of HT/LT lines which may cause interference during DGPS survey.

(ii) The station selected should be obstruction free towards sky at an angle of 15 degrees with horizontal plane so that maximum number of satellites are visible to the equipment for greater time.

(iii) Inter-visibility of traverse points should be maintained for the use of total station at construction stage.

(iv) The locations should be free from foliage so that satellite signal reaches the DGPS equipment unobstructed.

(v) The location should not be near to a shiny rock/ mountain and water body as reflected signal from these can provide false input to DGPS equipment while measurement.

(vi) The location should be stable in terms of landslide & debris flow.

The horizontal and vertical coordinates are to be established on the RCC pillars constructed at selected locations with prescribed level of accuracy as these are to be used for construction purpose. DGPS survey is the most accurate and economical method to measure the horizontal coordinates of a point. But for the Z coordinate, it only gives the ellipsoidal height which has to be converted to orthometric/ MSL height by using the Geoid model and accuracy of which is only up to 50cm and not good enough for establishing the vertical control. Double tertiary levelling from known SOI (Survey of India) GTS benchmarks to permanent control pillar is the most accurate method to establish Z coordinate in desired accuracy.

1.4.2.1 **DGPS (Differential Global Positioning System) Survey**

**GNSS/GPS:** GNSS stands for Global Navigation Satellite System and is the standard term for all the satellite navigation systems in the world that provide geospatial positioning (X,Y&Z) with global coverage. Common GNSS Systems are GPS (United States), GLONASS (Russia), Galileo (European Union), Beidou (China) and other regional systems. NavIC is the Indian Regional Navigation Satellite System (IRNSS) with 7 satellites. A GNSS/GPS receiver must acquire signals from at least four satellites to reliably calculate a three-dimensional position. Ideally, these satellites should be distributed across the sky. The receiver performs mathematical calculations to establish the distance from a satellite, which in turn is used to determine its position. The GNSS receiver knows where each satellite is at the instant its distance is measured. Common GNSS receivers from Trimble, Leica, Topcon, Geomax, Stonex etc. are able to receive signals from most of the GNSS satellite systems and more are the satellites the more is the accuracy, redundancy and availability at all times. GPS is the most widely used GNSS in the world and therefore GNSS is sometimes commonly
called as GPS.

**Error in GNSS/GPS measurement:** GPS signals coming from satellites down to the ground have to travel through layers of the earth’s atmosphere, so they are subjected to delays. This affects the time taken for the signal to travel from any given satellite to a GPS receiver, which introduces slight error into the GPS engine, causing an error in the measured position. Radio signals coming down from satellites have to travel through the ionosphere where signal delays are caused and it depends upon receiver location, satellite location, time of day, solar flare activity, etc. Then further delay is caused when these signals travel through troposphere having clouds, rain and lightning. These delays are random delays which fluctuate and as such, there is no way to precisely measure it at any given time. This cause an approximate error up to 5 m in every GPS measurement and DGPS is used to achieve higher accuracy in measurement.

**Principle behind DGPS:** Any two receivers that are relatively close together will experience similar atmospheric errors. Requirement of DGPS is that one GPS receiver be set up on a precisely known location and it is called as the base or reference station. The base station receiver calculates its position based on satellite signals and compares it to the known location. This difference is applied to the GPS data recorded by the second GPS receiver, which is known as the roving receiver. The corrected information can be applied to data from the roving receiver in real time in the field called as (RTK) Real Time Kinematic or through post-processing after data capture using special processing software (Static DGPS). Static DGPS is more accurate than the RTK mode but RTK mode is much faster (2-3 minutes) than the Static mode. Measurement of coordinates of permanent control points is done by static DGPS.

The known base points with highly precise coordinates are provided by Survey of India (SOI) which they have already established across India. The base station can also be setup by recording the GPS data for as long as possible (48 hours normally). Over the time that the base station is capturing data, the ionosphere and troposphere change, causing the delays in the signals to change, randomly. Because the delays are subject to random changes, they can be averaged out to find out very precise location.

**DGPS receiver on the GCP pillar & DGPS subnetwork snapshot**

**Procedure to Carry out Static DGPS Survey:** SOI-GCP points which are used as a base station have been measured many years ago and therefore a compatibility survey is first performed in order to find out whether the points are
fixed at their original location or not. A DGPS session (8 hours preferably) is first
carried out on all the known SOI GCP points. One of the SOI GCP is considered
as the known base point and rest of the SOI GCPs as unknown and then
compared with their known values. This process is repeated one by one for all
the points and most compatible base point is found out (having least error). The
coordinates of all the SOI GCPs are modified with respect to the most compatible
SOI GCP.

As the SOI GCPs are located very far from each other and therefore the second
step is to create a subnetwork of points comprising of few known SOI GCPs and
some of our unknown project GCPs. A DGPS session (8 hours preferably) is
carried out for this subnetwork and coordinates of unknown project GCPs/
permanent control pillars are found. By now we have known coordinates at a fairly
close distance (approximately 20 KM). Now we can run a small session of about
(1 to 2 hours) by including a few known points from sub-network and some of the
remaining unknown points of project GCP to find out the coordinates of unknown
GCPs. Some of the points in one small session are overlapped with other small
session to ensure compatibility between all the GCP points in our area of interest
(AoI). In this way we find out very precise (X & Y) coordinates for all of our
permanent control pillars/project GCPs.

1.4.2.2 Double Tertiary levelling

As we have already discussed that DGPS survey measures X&Y coordinates
very precisely but not the Z coordinate. SOI (Survey of India) has established its
GTS (Great Trigonometrical Survey) benchmarks across India with very precise
MSL heights. Double tertiary levelling is performed from these known GTS bench
marks to Unknown project GCP locations to find out the MSL heights (Z-Value).
The double tertiary levelling procedure is explained below.

Double Tertiary levelling is a method to obtain point elevations based on a known
point. In this method, a team consist of 1 operator, 2 staff holder and 1 writer
perform the survey. When operator sets up and level the Digital Auto Level, 1
back sight and 1 foresight measurement are made. In this process, levelling
instrument is located between two staff then back-sight and fore-sight
measurements are read in order to calculate elevation differences (∆h=bs/fs).
Then, same measurement is done by disturbing and re-locating the Digital Auto
Level and obtained delta heights of these two measurements are compared in
order to be sure that there is no significant difference between them. If these two
measurements are consistent then measurement is continued. This process is
repeated until the final destination is reached. Then elevation difference between
two benchmarks is calculated by differencing sum of back-sight and sum of
foresight readings. Tolerance of these measurements are distance dependent
and can be found by 12√K(km) formula.

1.4.3 Remote sensing studies

"Remote" means away from or at a distance whereas “sensing” means detecting
a property or characteristics. Thus, the term Remote Sensing refers to
examination, measurement and analysis of an object without being in contact with
it. Remote sensing is defined as the measurement of object properties on the
earth’s surface using data acquired from aircrafts/ Drones/ Satellites.

The remote-sensing analysis corresponds to the image-interpretation of
satellite/aircraft by making use of its spatial resolution (pixel size of an image),
spectral resolution (different bands of electromagnetic radiations used e.g. blue,
green, red, near infrared etc.), temporal resolution (time difference between two
different images of a location) & radiometric resolution (number of digital levels
used to express the data e.g. 8 bit image = 256 levels) to interpret vegetation
type, lithology, alluvial fans etc. Moreover, 3D stereo features reflect the feature
of terrain, lineaments/fractures, slope, aspect, drainage pattern, geohazards etc. and this data is very helpful for section of and railway route. Remote sensing analysis is done in GIS software like ERDAS LPS, ARCGIS, QGIS, PCI Geomatica etc. Different kind of thematic maps which can be derived from remote sensing studies are briefly explained in below.

- **Geological lineament map**: Lineaments are the fractures, faults, thrusts, valley lines, submit lines etc. in the area of interest. These are extracted with the help of GIS software and verified later in the field by geologist to further carry out geological mapping studies. Lineament density maps is also drawn and area of high lineament density are avoided while deciding the railway route. ROSE diagram of lineaments can also be made to find out the direction of lineament sets and alignment is designed in such a way it crosses this area in perpendicular direction if needed.

- **Quaternary Deposits Map**: Quaternary Deposits are the lithological formations which are younger than 2.58 million years and are the most unconsolidated & unstable. The area of quaternary deposits is segregated with the help of remote sensing for further studies.

- **Alluvial / Fluvial Map**: The alluvial/ fluvial areas are identified along the river basins for these deposits and suitable measures can be taken while designing the alignment through this area.

- **Water drainage network maps**: The water drainage maps are extracted with the help DEM in GIS software. Location of bridges/viaducts can be planed accordingly while design of alignment.

- **Topographical Analysis Maps (SLOPE, ASPECT)**: The slope and aspect maps are prepared with the help of DEM to carry out the slope stability, landslide or other geohazard analysis along the alignment. Aspect map is generated with the aim to reveal the direction of landslides (0° to 360° of North) and slope map is prepared in terms of percentage and degree in order to determine the inclination of the landslide.

- **NDVI**: Normalized Difference Vegetation Index study is carried out in order to determine the open areas and vegetation-covered zones in the study area. This analysis helps in avoiding the green zones while design of alignment.

- **Anaglyph Maps**: The Anaglyph Creation map provides a simple means of producing a color anaglyph simulation of the terrain in 3D using a DEM and an image. Sometimes detecting an image in 3D makes it much easier to interpret the data and to pick out the details, such as the comparative height of neighboring peaks and valley floors.
1.4.4 LiDAR (Light Detection and Ranging)

LiDAR, which stands for Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser/ point cloud to measure distance to the Earth from LiDAR equipment. These light pulses combined with other GPS data recorded by the airborne/terrestrial system generate precise, three-dimensional information about the shape of the Earth and its surface characteristics. The laser pulses are sent from a particular height in such a way that it reaches the ground with a minimum point density (no of pulses/meter²). These laser beams are able to penetrate small gaps in between the tree and provide the ground terrain data in dense forest areas as well unlike the satellite photogrammetry. There are two type of LiDAR systems.

LiDAR Point Cloud & Actual Photograph
**Airborne/Aerial LiDAR:** Airborne LiDAR system is installed on a helicopter/aircraft or drone for collecting data. Airborne LiDAR emits light towards the ground surface, which returns to the sensor immediately after hitting the object, giving an exact measurement of its distance. Airborne LiDAR is further divided into two types i.e. Topological LiDAR and Bathymetric LiDAR. Topographic LiDAR typically uses a near-infrared laser to map the land, while bathymetric LiDAR uses water-penetrating green light to also measure seafloor and riverbed elevations.

**Terrestrial LiDAR:** Terrestrial LiDAR systems are installed on moving vehicles or tripods on the earth surface for collecting accurate data points. These are quite common for observing highways, Railways, analyzing infrastructure or even collecting point clouds from the inside and outside of buildings. Terrestrial LiDAR systems have two types i.e. Mobile LiDAR and Static LiDAR.

All LiDAR systems have mainly these major components:

(i) Laser source and laser detector emits the light and then receive it back after reflection from the surface.

(ii) The timing electronics records the exact time the laser pulse leaves and returns to the scanner. Each pulse sent out can have up to multiple returns as it reflects off of objects on the surface.

(iii) The Global Positioning System (GPS) records the precise X, Y & Z location of the scanner.

(iv) The Inertia Measurement Unit (IMU) along with Global Positioning System (GPS) records the precise X, Y & Z location of the scanner. The IMU contains an accelerometer, gyroscope, and magnetometer sensors that measure the velocity, orientation, and gravitational forces and constantly records the pitch, roll, and yaw of the aircraft.

(v) Computer is needed to store the raw data.

The procedure to be adopted to carry out LiDAR survey is as below:

(i) The agency for conducting the LiDAR survey is first fixed by the client.

(ii) The client issues a support letter to agency with the details of security officers along with their identity proofs for carrying out LiDAR survey.

(iii) The LiDAR survey conducting agency then submit the application enclosing all the details like Area of Interest (AoI), Aircraft/Helicopter details, other equipment, flying staff etc. to Directorate General of Civil Aviation (DGCA) for clearance from MoD.

(iv) The DGCA scrutinize the application & other documents and forward it to Ministry of Defence (MoD).

(v) MoD forward the copy of application to five organizations i.e. Ministry of Home Affairs (Intelligence Bureau), Directorate General of Military intelligence, Directorate of Naval Intelligence, Directorate of Intelligence Air Force & Deputy Director General Military operations for furnishing their comments after scrutinizing the same from security point of view.

(vi) Based on the remarks of above five offices, MoD intimate DGCA for the clearance to carry out LiDAR survey.

(vii) If the area of interest (AoI) fall under the sensitive zones then single point clearance committee (SPCC) above five organizations for their joint remarks and accordingly take decision on issuing clearance to carry out LiDAR survey in sensitive zones.
(viii) After the clearances are obtained from DGCA, the inspection of aircraft and equipment are done by Intelligence bureau, Air Intelligence & Military operations (GSGS) for giving final permission for flying for one year.

(ix) After the permission is obtained, the flight planning and preliminary preparations are done to carry out LiDAR survey.

(x) The data captured on daily basis remains in the safe custody of security officer till the time it is handed over to nodal agency i.e. Survey of India for security vetting and masking of restricted areas.

(xi) The task number for the work is allocated by Sol (Directorate of Survey) and data is handed over to LiDAR conducting agency for further processing after security vetting of raw data and masking of restricted areas is done by Sol.

(xii) The processing of data is done by the agency to get the desired deliverables (DSM/ DTM/ Orthophotos/ Contour map) and handed over to Client.

1.4.5 Unmanned Aerial Vehicle (UAV)/ Drone survey

Unmanned aerial vehicle (UAV) commonly known as a drone is an aircraft without a human pilot on board and a type of unmanned vehicle. UAVs are a component of an unmanned aircraft system (UAS) which include an UAV, a ground-based controller and a system of communication between them. The flight of UAVs may operate either under remote control by a human operator or autonomously by onboard computers. Drone surveys have number of applications these days like surveillance, Forestry management and planning, Flood modelling, Pollution modelling, Urban planning, Coastline management, Oil and gas exploration, Archaeology etc.

LiDAR technology is based on a scanning laser combined with both GPS and inertial technology to create a three-dimensional point i.e. 3D point cloud. The LiDAR equipment in this case is mounted on a Drone rather than on a manned aircraft/ helicopter which makes it a lot cheaper than LiDAR survey conducted by later. The only disadvantages of Drone based LiDAR in comparison to helicopter mounted LiDAR is that it has a small swath (Width of capture in one flight) & as a result it may be very time consuming for huge areas and Moreover, it is also problematic to use Drone LiDAR in locations with very high (Due to thin air) sudden change (problem in deciding flight path) in altitude. For sections with lesser width of area of interest (AoI) drone LiDAR is very accurate, fast & cheap method of topographical survey. The LiDAR data can also be used for other remote sensing studies as discussed in sections above. The LiDAR equipment can also be mounted on locomotives or last vehicles of train for capturing the data and which is very useful for doubling projects.
Drone Photogrammetry is a passive technology, based on the images that are transformed from 2D into 3D cartometric models. It uses the same principle that human eyes or 3D videos do i.e. to establish a depth perception, allowing the user to view and measure objects in three dimensions. The limitation of photogrammetry is that it can only generate points based on what the camera sensor can detect illuminated by ambient light.

Photogrammetry is the science of making measurements from photographs, especially for recovering the exact positions of surface points. Stereo-photogrammetry, involves estimating the three-dimensional coordinates of points on an object employing measurements made in two or more photographic images captured from different positions. High-resolution cameras are mounted on Drone to take overlapping photographs and they are processed to create digital elevation model (DEM) & Orthophotos in the similar way as the satellite images are processed (explained in sections above). Drone photogrammetry in best cases provide 1-3 cm of accuracy which is very good in comparison to Satellite imagery. Satellite image processing is most suitable for large area of interest & for works which do not require very high accuracy and Drone photogrammetry is most suitable for small area of interest & for works requiring very high accuracy. The data from Drone photogrammetry can also be used for other remote sensing studies as discussed in sections above. The cameras can also be mounted on locomotives or last vehicles of train for capturing the overlapping images and which is very useful for doubling projects.

1.4.6 Geology & Rock Mass Classification

Geology is the study of the Earth, the materials of which it is made, the structure of those materials and the processes acting upon them. It mainly focuses on:

(i) Lithological study: the study of the general physical characteristics of rocks.

(ii) Geomorphological study: the study of the origin and evolution of earth strata and various landforms.

(iii) Tectonic study: study of the deformation of the rocks that make up the Earth’s crust and the forces that produce such deformation. It deals with the folding and faulting associated with mountain building.

(iv) Geo-mechanical characteristics of Rocks: The mechanical properties like Poisson’s ratio, elastic modulus, bulk modulus, shear modulus etc. are studied for different rock types.

(v) Rock mass classification: The quantitative classification of different rocks along with joints/fractures to select the support system.

1.4.6.1 Pre Assessment of the geology

The first step in Geological mapping is the pre assessment of the geology of the area by studying Geological Survey of India (GSI) maps and available literature for that area. The results derived from Remote sensing study such as critical geological Lineaments, Geohazards, drainage networks etc. are also studied. Based on the studies, a preliminary Geological map is prepared which helps in finding critical locations for detailed geological study. GSI maps are freely available at their web portal http://bhukosh.gsi.gov.in/.

The next step is the detailed foot to foot field survey by geologists. The details of lithological unit along with their GPS location is noted in area of interest and beyond. Various outcrops of rocks are identified and their features along with Dip/Strike data is noted. Necessary sketches are also made in field book.
wherever required. The location of probable fault/thrust zones are visited by geologists and inference is made based on site characteristics. The discontinuity & scanline survey are conducted at the locations where rock cut is required (portal areas and deep cutting). The scanline sampling method is based on data collected from all the fractures that intersect a scanline. The method allows a quick measurement of fracture/ discontinuity characteristics in the field. In the discontinuity survey, discontinuities such as joints, faults, shear zones, bedding etc. are described in terms of orientation & other features i.e. Dip & strike, spacing, persistence (length of joint), roughness, aperture (width), weathering etc. Predominant discontinuity planes are identified using stereographic projection techniques which are used in detailed geological mapping of an area. Kinematic analysis is performed on software based the data collected from field to analyze the potential rock slope failures (planar, wedge, toppling failures) at different cut locations (tunnel portals & deep cuttings).

Based on the above field studies and data obtained from other field tests (geophysical & geotechnical) a 3-D geological mapping model is prepared in software like AutoCAD. The plans & sections with relevant information about various lithological units & their boundaries, joints, faults, thrusts, geohazards etc. is provided.

![Kinematic Analysis Results](image)

**1.4.6.2 Geo-mechanical Characteristics of Rock Masses:**

The mechanical properties of rocks like Poisson’s ratio, elastic modulus, bulk modulus, shear modulus etc. are very important for deciding the support structure of tunnels or steep slopes. Core sample are collected from different area and tests are done in the laboratory. UCS (Unconfined compression strength) which is one of important parameters to determine the strength of rock mass by rock classification method can be measured at site by use of Schmidt Hammer. It’s been used worldwide for a quick rock strength assessment due to its portability, ease of use, rapidity, low cost and its non-destructive procedure of application. Various empirical formulas are available to calculate UCS based on the SHR (Schmidt Hammer Rebound) value.

**1.4.6.3 Rock Mass classification:**

The rock mass classification is the classification of rocks based on their strength,
discontinuities, water ingress, aperture & roughness of joints, persistency & spacing of joints, weathering etc. The boundaries of the structural units usually coincide with major structural feature such as a fault and in some cases, significant changes in discontinuity spacing or characteristics are within the same rock type. This necessitate the division of the rock mass into several small structural regions or domains for select suitable support structure for tunnels.

**RQD (Rock Quality designation):**

The rock quality designation (RQD) is one of important parameters to determine rock mass classification indices such as rock mass rating (RMR), Q-system (Q) and geological strength index (GSI). The RQD is defined as the ratio (in percentage) of the total length of sound core pieces that is 0.1 m or longer to the length of the core run. Besides the direct method for determining RQD based on core cut, different indirect methods are also available for finding RQD like It can be determined from the frequency of discontinuity obtained from scanline survey.

The two type of rock mass classification which are used to select the tunnel support system are across the world are explained are briefly explained below:

(i) **Rock Tunneling Quality Index (Q)**

(ii) It is a classification system for rock masses with respect to stability of underground openings. Q – value is calculated based on 6 parameters using the following formula.

\[
Q = \frac{\text{RQD}}{\text{Jn}} \times \frac{\text{Jr}}{\text{Ja}} \times \frac{\text{Jw}}{\text{SRF}}
\]

Where:

- RQD = Rock Quality Designation
- Jn = Joint set number
- Jr = Joint roughness number
- Ja = Joint alteration number
- Jw = Joint water reduction factor
- SRF = Stress reduction factor

The numerical value of the index Q varies on a logarithmic scale from 0.001 to a maximum of 1,000.

(iii) **Rock Mass Rating (RMR):**

RMR is used to assess the stability and support requirements of tunnels. It utilizes the following six parameters which are measured in the field. The rating value is given to all the six parameters and these ratings are added to calculate the RMR value for a rock mass. The six parameters are:

- Uniaxial compressive strength of intact rock material
- Rock quality designation (RQD)
- Spacing of discontinuities
- Condition of discontinuities
- Groundwater conditions
- Orientation of discontinuities

The support system for the tunnel is selected based on Q and RMR value as per Austrian Code (ON 2203)

1.4.7 **Geophysical Survey:**
This is non-destructive, indirect, cheap and quick technique carried out to measure physical properties of medium for subsurface characterization, ground water condition, geological structures etc. The results of geophysical survey can later be verified by doing geo-technical investigations. Various methods of geophysical survey are listed below:

(i) Seismic Method
   a. Seismic Reflection survey
   b. Seismic Refraction Survey
   c. MASW (Multi channel analysis of surface waves)
(ii) Electrical resistivity Method
(iii) Gravity Method
(iv) Electromagnetic method
(v) Radioactive method

1.4.7.1 Seismic Methods

The principle behind seismic method is that velocity of seismic waves varies as per different sub-surface rock formations. The seismic waves when passed though the different subsurface layer of earth, it gets reflected or refracted depending upon the medium density. These seismic waves are detected by geophones kept at suitable interval when waves arrived back to earth surface. The type of rock/soil and its thickness is derived from the time taken by the waves to travel through each subsurface formation and their velocities in that particular media.

![Position of Geophones and Source of Seismic Waves](image)

Seismic Reflection method: The seismic waves are created by minor explosive/sledge hammer at the source location. The impact on the ground creates two types of stress wave: P wave (plane wave) and S Wave (shear wave). P waves travel faster than S waves. Thus, the first arrival waves will be related to the velocities of the P waves in the various layers. These waves travel the earth strata and reflected back to surface by first lithological boundary. The reflected wave is
detected by geophones and time of travel & Velocity is calculated. The based on
the velocity and time travel.

**Seismic refraction surveys:** The refraction method also works on the same
principle of velocity & time of travel as the reflection method except that instead
of reflected seismic wave, refracted seismic waves from two or more lithological
layers is calculated.

![Seismic Refraction Survey](image)

**Velocity/depth profile based on seismic refraction survey**

**MASW (Multi channel analysis of surface waves) or shear wave velocity
profile:** This type of seismic survey works well for the area with high noise. As
the name suggest, it uses surface waves to interpret the sub-surface strata. The
surface wave velocity is converted to shear wave velocity with the help of relation
with them. Surface Waves-Rayleigh waves which is related to shear wave velocity
as \( V_r = 0.9194V_s \). Shear wave velocity helps to find material stiffness and this
method is more suitable for near surface strata investigation.

MASW survey can be broken down into three steps:

a. **Field Measurements**-Geophones are lined up in a straight, equally spaced
line on the surface of the test site. A wave is generated with an impact load
at one end of the line-up and the geophones record the resulting wave
motion as a function of time.
b. Data processing- A dispersion curve is extracted from the measured surface wave data.

c. Inversion analysis- Shear wave velocity profile, generally by inversion of the fundamental mode Rayleigh wave dispersion curve is made.

1.4.7.2 Electrical Resistivity Survey:

The electrical resistivity survey method works on the principle that different soil/rock formations have different apparent resistivity value as shown in figure below. This method involves the measurement of the apparent resistivity of soils and rocks as a function of depth or position. This is also the most important method for groundwater investigations. The groundwater with various dissolved salts it contains is ironically conductive and enables electric currents to flow into the ground. Consequently, measuring the ground resistivity gives the possibility to identify the presence of water. This survey is performed generally at tunnel portals, stations & viaduct locations to investigate geological structure, groundwater level and saturated zones.

**Resistivity Vs Soil Type**

The resistivity of soils is a complicated function of porosity, permeability, ionic content of the pore fluids, and clay mineralization. In this method, current is injected into the earth through a pair of current electrodes, and the potential difference is measured between a pair of potential electrodes. The current and potential electrodes are generally arranged in a linear array. This test gives the variation in resistivity with the depth. As the spacing between the electrode increases, more layer information can be obtained.

**Resistivity survey set up**
1.4.8 Hydrological Studies:

Estimation of the design flood is very essential for deciding the water way and the foundation structure for the bridge locations along the alignment. Design engineers essentially need the design flood of a specific return period for fixing up the waterway vis-à-vis the design HFL (High Flood Level) and the foundation depths of bridges, culverts and other types of cross drainage hydraulic structures, depending on their expected life and importance to ensure safety as well as economy. If not properly established, the situation may lead to under or over estimation of the design flood resulting in the loss and destruction of structures or un-economic structure with an un-acceptable cost component.

With the advancement in technology, the cumbersome task of plotting & finding out the catchment area, length of the longest main stream course from origin up to bridge crossing, distance from a point on the main stream opposite to the center of gravity of the catchment up to the bridge crossing and mean slope of the main stream from Survey of India Toposheets can now be done very easily on GIS software. GIS software first provide the possible streams in the area of interest based on the digital elevation model (DEM) to select the location of bridges and based on the location of bridge which is selected, it calculates the catchment area & other parameters by automatically identifying the ridges & valleys in the area.

The hydraulic modelling of the river reach can be carried out by using hydrological analysis software like HEC-RAS (Hydrological Engineering Center – River Analysis System) to estimate water surface profiles for various return periods. Based on the topographical description of the area, sufficient number of cross-sections can be defined to study the variation in river shape with rainfall. Simulation of river reach can also be carried out with design floods and water level can also be computed for different return periods.
1.4.9 Design of Alignment:

Design of alignment is most important output of all survey procedures. It is the most preferable route between two obligatory points considering all the terms of reference. The shortest path is the direct straight connection but due to topographical, strategic, commercial and geological constraints, alignment deviation is done with the help of introduction of curves. The first step while designing the alignment is the marking of all the obligatory points (locations which are mandatory to connect) on the Google earth or Orthophotos. The minimum distance requirement between two obligatory points (stations) is calculated based on their elevation difference & ruling gradient on the section. If the Crow fly distance is more than the calculated distance based on gradient requirement, then crow fly distance is the minimum distance between two stations. On the basis of varying terrain, it can be divided into number of sections if needed. The obstructions in the form of natural & manmade features are avoided by introduction of permissible curves. The viaducts & tunnels are introduced at the required locations. All possible efforts should be made to design the alignment along the contours to have minimum cut/fill along the alignment. Large viaducts, long tunnels and geologically unstable areas/ geohazards should be avoided as far as possible. Minimum three alignments should be studied before the finalization of route based on the technical parameters such as Gradient, Degree of Curve etc. and later most appropriate alignment is decided. The main things to keep in mind while design of alignments are the following:

a. Minimum Cut and Fill
b. Tunnel Length (in case of Hilly Terrain)
c. Open Area
d. Bridge Length and Height
e. Safety and Comfort
f. Accessibility for ease of construction
g. Geological Constraints
h. Environmental Impact

All the different alignment alternatives are designed in software like, AutoCAD Civil 3D, Bentley Rail Track (BRT) etc. Horizontal curvatures are first set at required locations by keeping orthophotos/ google earth in the background. Thereafter profile is created by generating 3D surface in software with the help of Contour data or DEM or directly though the topographical survey data. The alignment is modified accordingly to minimize the cut/fill, tunnel length, bridge length/height and keeping suitable locations to station yards.

![Surface Image created in AutoCAD](image)

The final grade lines are then marked for all alignment alternative and Cross-sections are generated at the required interval. Earthwork quantity is also be calculated directly through the software.

![Profile View](image)

### 1.4.10 Cost estimate:

Cost estimate for an alignment includes the cost of Expropriation & Resettlement, Civil Engineering, Electrical, TRD and S&T Works. Cost of Civil Engineering works are calculated considering cost of all the relevant items like earthwork, P-way, Tunnel, Bridges, Road crossings, approach roads etc. Detailed cost estimates of all the designed alternative alignments are prepared for making economical comparison among them.
1.4.11 Selection of most preferred alignment:

A detailed techno-commercial analysis is done to select the most technically feasible and economically viable alignment from among the alternatives. A multi-criteria analysis is done for the purpose of selection of most preferred alignment. A weightage is decided for all the factors which are taken into consideration and rating is given to each factor for every alignment. A combined score is calculated for all the alternatives and the best alternative is finalized. The main factors which are taken into consideration are the following:

a. Cost Consideration
b. Ease of Construction Consideration
c. Serviceability Consideration
d. Geological Consideration
e. Environmental and Social Impact Consideration

Further studies like geological mapping, geophysical & geotechnical survey, hydrological studies, design of structures etc. are done on the selected alignment and further refinement of alignment is done based on these studies. After getting most appropriate alignment required investigations such as detailed geological survey, geotechnical investigations are planned which may further can cause the change of alignment depending upon the output of various investigation.
CHAPTER-2

LAND ACQUISITION

2.1 BACKGROUND:

Since independence, Land Acquisition in India has been done through Land Acquisition Act, 1894 (Act No. 1 of 1894). In 1998, Rural Development Ministry initiated the process of amending the Act. Govt of India sought to amend the Act in 2007 and introduced a bill in Parliament. The bill was passed in August 2013 as "The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (Act no. 30 of 2013)" and came into effect on 1st Jan, 2014.

Further, with the objective of empowering Ministry of Railways for land acquisition for Special Railway Projects on fast track basis, a new Chapter-IV A has been added in "the Railways Act, 1989" Central Govt now acquire land under the provisions of "Railways (Amendment) Act, 2008" for a public purpose. It came into force on the 31st day of January, 2008.

2.2 GUIDELINES FOR ACQUISITION OF LAND:

a) The rules for acquisition are contained in Chapter-VIII of the Indian Railway Code for the Engineering Department (Appendix-III of Engineering Code related to Chapter-VIII is attached as Annexure-2.01).

b) Important points to be borne in mind while initiating action for land acquisition for Railway projects (compiled from codes and field experience):

   - Whenever land is required for Railway purpose, an application should first be made to Revenue Officer incharge of the District or to Commissioner, if land is situated in more than one District.

   - Every endeavor should be made to avoid interference with religious structures, burial grounds or other places or objects which may be considered as sacred.

   - For lines having potential to develop beyond carrying capacity of a single line within 15 years after opening, the width of land strip should be as per requirement of a double line.

   - Minimum width of land to be acquired for a single line should normally be as per Appendix-III in Engineering Code (Annexure-2.01).

   - Tunnels: - As per latest instructions issued vide Railway Board letter no. 2018/W-I/Genl./Land Acquisition/ Pt I dt. 05.09.2018 (Annexure-2.02), the land should be acquired only for portal/adit/shaft construction or for provision of safety measures. No land should be acquired in the balance alignment of the tunnel.

   - Viaduct: - The land should be acquired for minimum width along the span and pier locations (approx. 8.0m width is sufficient for single line).

   - Cut & Cover: - The land required in this case is though temporary, however if required, minimum land shall be acquired for construction...
affected zone, also covering requirement for portal, ventilation and access for maintenance etc.

2.3  **PROCEDURE OF LAND ACQUISITION:**

Following Acts/Procedures of Govt. of India are in vogue, for Railway land acquisition:-

3. Land Acquisition Act, 1894 (No.1 of 1894).
4. Through Direct Negotiation with land owners as per State Govt. Policy.

Railway Board vide its letter no. 2015/W-2/SCR/NL/22 dated 20.10.2016 (Annexure-2.03) has issued guidelines about Act/Procedure under which land should be acquired for various Railway projects.

The procedure for land acquisition through various Acts is explained below:-

2.3.1 **The Right to Fair Compensation and Transparency in Land Acquisition and Rehabilitation and Resettlement Act, 2013**

It extends to the whole of India (including Union Territory of Jammu & Kashmir w.e.f. 31.10.2019, as per THE JAMMU AND KASHMIR REORGANISATION ACT, 2019).

2.3.1.1 **Application of Act (Section 2 of the Act)**

➢ The provisions of this Act shall apply, when the appropriate Govt acquires land for its own use, hold and control, including for Public Sector Undertakings and for public purpose

➢ The provisions of this Act shall also apply, when the appropriate Govt acquires land for the following purposes, namely:-

A) for Public Pvt Partnership (PPP) projects, where the ownership of the land continues to vest with the Govt, for public purpose (prior consent of at least 70% of affected families is compulsory).

B) for Pvt Companies for public purpose (prior consent of at least 80% of affected families is compulsory).

➢ The provisions relating to Rehabilitation and Resettlement (R&R) under this Act shall apply in the cases where,

(a) a Pvt Company purchases land, equal to or more than such limits in rural areas or urban areas, as may be prescribed by the appropriate Govt (at present these limits are 100 Acres for rural area and 50 acres in urban areas), through Pvt negotiation with the owner of the land in accordance with the provision of section 46.

(b) If Pvt Company requests the appropriate Govt for acquisition of a part of an area so prescribed for a public purpose (however, provisions of R&R will apply to whole project area).

2.3.1.2 **Activity Flow Chart for FLS-cum-LAND ACQUISITION as per new Act, 2013**
• Marking of Centre Line (C. L.) on Ground
• Preparation of L-Section
• Calculation of Required Land width as per Engg. Code
• Transfer of C.L. on Revenue Land Plan/Sazra by field measurements/references with the help of Revenue officials.
• Marking of land boundary on Sazra map
  (Least count of revenue measurement unit is 1 Karam = 1.68 Mtr or 5’6”)
• Preparation of field book for calculation of land area by Revenue official
  (Revenue village-wise)

Unit of Land Area –
  i) Prior to Consolidation/ CHAKBANDI - Hectare, Acre, Bigha, Biswa
  ii) After Consolidation/ CHAKBANDI - Hectare, Acre, Kanal, Marla

• Commencement of Land Acquisition Proceedings:-

Respective Govt shall notify the officers who shall work as Collector, Administrator R&R (under Sub-section (i) of Section 43) and Commissioner R&R (under Sub-section (i) of Section 44).

• Requiring Body (i.e. Railway) shall request Collector for land acquisition under intimation to Commissioner R&R.

• Collector shall constitute a Committee of officers of concerned Departments viz Revenue, Agriculture, Forest, Water Resources, PWD and Railway.

• The Committee shall make field visit and submit a report to Collector to make preliminary enquiry regarding availability of waste or arid land and bare minimum land required for the project.

• After considering report, Collector shall arrange to make a Preliminary Estimate of the cost of Acquisition + Administrative Expenses (i.e. 5% or max 5 Cr).

• Railway will deposit Estimated Amount or part thereof as decided by Collector.

• Social Impact Assessment unit (i.e. SIA unit) shall prepare terms of reference for SIA Study and estimate of processing fee for SIA study.

• Railway will deposit processing fee for SIA study, SIA unit of State Govt will appoint an agency for SIA study.

• If land is being acquired under urgency clause of the Act i.e. Sec 40, SIA study is not required.

❖ Section 4

• SIA team or agency shall be appointed by inviting applications from Departments of Social Welfare of various Universities, College Faculties, NGOs and Professionals.
• SIA team shall prepare draft SIA Report and Social Impact Management Plan (SIM Plan) in consultation with Panchayat or Municipal Corpn. and by making field visits.

• Notice (3 weeks in advance) for public hearing for objections and suggestions by affected persons in affected area.

• Draft SIA Report and SIM Plan shall be published and/or shall be made available in the office of DC/SDM/Tehsil/Gram Sabha.

Section 5

• Public hearings shall be conducted by State Govt.

• Responsible representative of Requiring Body, designated as Land Acquisition Functionary, designated R&R functionary shall be present in public hearings to respond to the queries.

Section 6

• After considering objections & suggestions received in public hearings, revised SIA report and SIM Plan will be prepared and submitted to Govt.

• SIA Report and SIM plan to be published.

Section 7

• Govt shall constitute a multi-disciplinary expert Group for evaluation of SIA report.

Section 8

• After consideration of SIA report & recommendation of Expert Group by State Govt, decision of State Govt shall be published.

Procedure for getting ‘Consent’ from affected land owners in case of PPP projects and projects by Pvt Companies for public purpose:

• State Govt shall initiate the process for obtaining prior consent from land owners.

• District Collector shall arrange to update the land records, title in the land & other revenue records.

• Collector shall appoint such officers as required to assist him in obtaining consent and shall draw a list of all affected land owners from whom consent is required.

• The list shall be published 15 days prior to public meeting.

• In case of acquisition of land in scheduled area, consent of Gram Sabha shall also be taken.

• Publication of date, time & place of public meeting with Gram Sabha.

• Representative of Requiring Body who are competent to take decision and negotiate the terms of R&R, compensation and members of SIA team shall also be present in the meeting along with members of Gram Sabha and officers of State Govt.
• A resolution of majority of Gram Sabha members shall be passed and signed by them. Terms & conditions of R&R, compensation and other measures committed by the Requiring Body shall be recorded in written and signed by all.

• Public meeting with affected land owners, with date, time and place of the meeting, shall be published 3 weeks in advance.

• Representative(s) of Requiring Body who are competent to take decision and negotiate the terms of R&R, compensation and members of SIA team shall also be present in the meeting along with members of Gram Sabha & officers of State Govt.

• Terms & conditions of R&R, compensation and other measures committed by the Requiring Body shall be explained to land owners in local language and signature of affected land owners as well as representative(s) of requiring body shall be recorded.

• Declaration of affected land owners about consent in prescribed format by State Govt and declaration shall be countersigned by Collector or nominated officer.

• When requirement of prior consent is fulfilled, then further land acquisition proceedings will be initiated.

❖ Section 11

• Preliminary notification that State Govt is likely to acquire the land, under Section 11 of the Act shall be published by State Govt.

• Notification shall be published in:-
  - Official Gazette,
  - 2 daily newspapers of the locality,
  - In offices of DC, SDM, Tehsil, Gram Sabha,
  - Govt Website,
  - In the affected areas in manner as prescribed.

• Collector shall ensure updating of land records within 2 months from the date of publication of Preliminary Notification.

❖ Section 12

• Preliminary survey of land proposed for acquisition.

• To enter upon and survey and take levels.

• To dig or bore into the sub-soil.

• To do all other acts necessary to ascertain whether the land is suitable for such purpose.

• To set out boundaries of land proposed to be taken.
• The above acts are to be done in presence of owner or his representative. In case of absence, a prior notice of minimum 60 days to be served.

❖ **Section 13**

• Tender payment of damage during preliminary survey

❖ **Section 14 (Lapse of SIA report)**

• Where a Preliminary Notification u/s 11 is not issued within 12 months from the date of appraisal of SIA report submitted by expert group, such report shall be deemed to have lapsed and a fresh SIA study shall have to be conducted. Govt can extend this 12 months period but reason for doing so will be recorded in writing and published.

❖ **Section 15 (Hearing of objections)**

• Any person interested may, within 60 days from the date of publication of the preliminary notification, object to
  ✓ The area and suitability of land proposed
  ✓ Justification offered for public purpose
  ✓ The findings of SIA report

• Collector shall submit a report on objections along with his recommendations to Govt.

• Decision of Govt on this report shall be final.

❖ **Section 16 (Preparation of Rehabilitation and Resettlement (R&R) scheme)**

• Preparation of R&R scheme by Administrator:-
  ✓ Within 2 months from notification u/s 11.

• Administrator of R&R shall conduct a survey & undertake a census of the affected families.

• Draft R&R scheme to be given wide publicity in the affected area in the same way as notification u/s 11.

• Public hearing in affected area (notice of date, time & place 3 weeks in advance).

• Administrator or the officer authorized by him, shall conduct public hearing.

• Representative(s) of Requiring Body, members of SIA team shall be present to respond to queries.

❖ **Section 17 & 18 (Review and Approval of R&R)**

• Considering objections and suggestions in Public meeting,
• Final R&R scheme shall be prepared and submitted for review of Collector & approval of Commissioner.

• Publication of approved R&R scheme.

• Commissioner shall inform State Monitoring Committee about the publication of R&R scheme.

• After deposit of full amount by Requiring Body, a Declaration u/s 19 that the land is required for a public purpose shall be published along with the summary of approved R&R scheme by Govt in the same manner as notification u/s 11 was done.

❖ Section 20 (Survey)
• Land to be marked on ground, measured and planned including marking of specific areas if not done u/s 12.

❖ Section 26 (Land Rate)
• Determination of market value of land by Collector.

❖ Section 21 (Notice to persons interested)
• Collector shall publish a notice inviting claims from all persons interested in the land.

❖ Section 23 (Enquiry and land acquisition award by Collector)
• The Collector shall proceed to enquire into objections (if any) and into the value of the land and shall make an award.

❖ Section 25
• The Collector shall make an Award within a period of 12 months from the date of publication of declaration u/s 19 and if no award is made within that period, the entire proceedings for acquisition of the land shall lapse.

❖ Sections 26 to 29 of the Act
• The collector shall determine market value of land and determine amount of compensation based on certain parameters as given in section 28 of the act. He will also determine value of things attached to land or building.

❖ Sections 30 to 37 of the Act
• The Collector shall, after determination of fair compensation, solatium (i.e.100%) and multiplier (to be decided by State Govt), pass an Award of the amount and R&R Award and apportionment of compensation.

• However, while implementing R&R award and determining compensation, Railway Board vide its letter no. E(NG)II/2010/RC-5/1 dated 11.11.2019 (Annexure-2.04) has issued its modalities and done away with choice of employment to affected land losers.

❖ Section 38 (Possession of land)
• Collector shall take possession of land after ensuring payment of
- Full amount of compensation (within 3 months)
- Monetary part of R&R entitlements (within 6 months)
- Infrastructural R&R entitlements (within 18 months)

- Requiring Body shall take possession from Collector. Collector shall be responsible for ensuring that the R&R process is completed in all aspects before displacing the affected families.

- In case of urgency, whenever the Govt so directs, the Collector, though no such award has been made, may, on expiry of 30 days from the publication of the notice u/s 21 of the Act, take possession of any land needed for a public purpose.

- Mutation of the land in favour of Railway in Revenue records (it is very important activity to enter the name of Railways in the revenue records). Railway (Govt of India) will not be owner of land in revenue records without ensuring Mutation.

❖ Section 63

❖ Jurisdiction of Civil Courts barred:
No civil court shall have jurisdiction to entertain any dispute relating to land acquisition in respect of which the Collector or the authority, is empowered by or under this Act.

❖ Section 51 (Authority)

❖ Establishment of Land Acquisition, Rehabilitation and Resettlement Authority:

The Govt shall for the purpose of providing speedy disposal of disputes, establish by notification, one or more authorities to be known as “The Land Acquisition, R&R Authority” to exercise jurisdiction for entertaining and deciding the references made to it u/s 64 of the Act.

❖ Section 64

❖ Reference to Authority:

Any person interested who has not accepted the Award may, by written application to the Collector, require that the matter be referred by the Collector for the determination of the authority, with respect to objections, to the measurement of the land, the amount of compensation, the person to whom it is payable, the rights of R&R or the apportionment of the compensation.

❖ Section 69

❖ Determination of Award by authority:

The award determined by authority shall be paid to the interested person. Requiring body shall deposit the amount of award to Collector.

❖ Section 74

❖ Appeal to High Court:
The Requiring Body or any person aggrieved by the Award passed by an authority u/s 69 may file an appeal to the High Court within 60 days from the date of Award.

- **Section 87**

  - **Offences & Penalties:**

    Where an offence under this Act has been committed by any Department of the Govt, the Head of the Department, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly.

- **Section 114**

  - **Repeal and Saving:**

    The Land Acquisition Act, 1894 is hereby repealed.

- **Section 101**

  - **Return of Unutilized Land:**

    When land acquired under this Act remains unutilized for a period of 5 years from the date of taking over the possession, the same shall be returned to the original owners or their legal heirs or the land bank of the Govt by reversion.

### 2.3.1.3 Anticipated Time Frame for Land Acquisition as per NEW Act:-

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Activity</th>
<th>Time</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From Starting to notification for SIA study</td>
<td>Depends on size of project</td>
<td></td>
</tr>
<tr>
<td></td>
<td>From notification for SIA study to submission of SIA Report to Govt</td>
<td>3-6 months</td>
<td>Section-4(2)</td>
</tr>
<tr>
<td></td>
<td>Appraisal of SIA report by Expert Group</td>
<td>1-2 months</td>
<td>Section-7(4)</td>
</tr>
<tr>
<td></td>
<td>From the date of appraisal of SIA Report by expert group to preliminary notification u/s 11</td>
<td>3-12 months</td>
<td>Section-14</td>
</tr>
<tr>
<td></td>
<td>From preliminary notification u/s 11 to declaration u/s 19</td>
<td>3-12 months</td>
<td>Section-19(7)</td>
</tr>
<tr>
<td></td>
<td>From declaration u/s 19 to date of award u/s 23</td>
<td>3-12 months</td>
<td>Section-25</td>
</tr>
<tr>
<td></td>
<td>From date of Award u/s 23 to Possession of Land u/s 38</td>
<td>2-6 months</td>
<td>Section-38(1)</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td>1 year 2 months to 4 years 2 months + period for survey of the project</td>
<td></td>
</tr>
</tbody>
</table>
2.3.2 THE RAILWAYS (AMENDMENT) ACT, 2008:

2.3.2.1 SALIENT FEATURES:

To empower Central Govt (Ministry of Railways) for land acquisition on fast track basis for Special Railway Projects, a new Chapter-IV A was added in ‘The Railways Act, 1989’. When the Central Govt is satisfied that for a public purpose, any land is required for execution of a Special Railway Project, it may acquire land under the provisions of this Act.

➢ It came into force on the 31st day of January, 2008.

➢ “Special Railway Project” means a project, notified as such by the Central Govt from time to time, for providing national infrastructure fora public purpose in a specified time-frame, covering one or more States or the Union Territories.

➢ “Competent Authority” (CA) means any person authorized by Central Government, through Gazette notification (Annexure-2.05), to perform the functions of the Competent Authority for such area as may be specified in the notification.

➢ “Principal Act” is The Railways Act, 1989.

➢ CAO/C is authorized to issue notification of Special Railway Projects in the Gazette under clause 37A of Section 2 of Railways (Amendment) Act, 2008, with the approval of General Manager of Zonal Railway (Railway Board letter no. 2010/LML/12/8 Dt. 19.12.2014 & 2008/LML/12/8 Dt. 08.04.2010 as (Annexure-2.06).

➢ The provisions of the Rehabilitation and Resettlement Policy, 2007 as notified by Central Govt shall apply.

➢ As per Railway Board’s letter No. 2010/LML/12/8 dated 21.02.2020 (ANNEXURE-2.08), “for all such Railway infrastructure projects which have to be completed in a specified time frame, the land should invariably be acquired through the provisions of Railway Act, 1989 by declaring them “Special Railway Projects”.

2.3.2.2. FLOW CHART FOR LAND ACQUISITION (Sections 20-A to 20-I)

- Final location survey and preparation of land plans
- Section 20A (Notification)
  - Central Govt, by notification, declare its intension to acquire land.
  - State Govt shall provide the details of the land records to the Competent Authority (CA), whenever required.
  - CA shall publish the Notification in two local newspapers (one in vernacular language).
- Section 20B (Power to enter for Survey etc)
  - After notification, it shall be lawful to
➢ Make inspection, survey, measurement, valuation or enquiry
➢ Take levels
➢ Dig or bore into sub-soil
➢ Set out boundaries
➢ Do such other acts or things

- **Section 20C (Evaluation)**
  - Evaluation of damages during survey, measurement etc done and paid within a period of 6 months from the completion of the said works.

- **Section 20D (Hearing of Objections etc)**
  - Interested persons may object to the acquisition of land for the purpose mentioned in notification u/s 20A within a period of 30 days from the date of publication of notification.
  - Objections shall be made to CA in writing and shall set out grounds thereof.
  - CA may either allow or disallow the objections.
  - The order made by CA shall be final.

- **Section 20E (Declaration)**
  - CA shall prepare a report on objections and submit to Central Govt.
  - Central Govt shall declare, by notification, that the land should be acquired for the purpose mentioned in section 20A.
  - On publication of declaration, the land shall vest absolutely in the Central Govt, free from all encumbrances.
  - The notification u/s 20A shall cease to have any effect if no declaration u/s 20E has been published within one year from notification.
  - Declaration shall not be called in question in any court or by any authority.

- **Section 20F (Determination of Compensation)**
  - Notice to invite claims (in two local newspapers including one in a vernacular language) and require all persons to appear before CA at specified time/date and place.
  - As per Railway Board's letter no.2009/LML/12/18 dt 17.12.2009 (Annexure-2.07), if objections are in respect of compensation/resettlement packages, then discussion and negotiation may be held with land losers by the CA prior to declaration of award.
• CA shall make an award within one year from the date of declaration u/s 20E, otherwise the entire proceedings shall lapse.

• CA may make award within extended period (6 months) and the reasons for delay shall be recorded in writing.

• If award made in extended period, an additional compensation shall be paid i.e. minimum 5% of the value of award per month.

• If the amount determined by the CA is not acceptable to either of the parties, the amount shall be determined by the Arbitrator to be appointed by Central Govt.

• In addition to market value of land, CA shall award in every case, 60% of the market value (solatium) due to compulsory nature of the acquisition.

• **Section 20G (Criterion for determination of market value of land)**

  • The Competent Authority shall adopt the following criteria for assessing and determining the market value of the land:

  > The minimum land value specified in the Indian Stamp Act, 1899 for registration of sale deeds in the area.

  OR

  > The average of sale price for similar type of land situated in the village or vicinity, ascertained from not less than 50% (higher side) of the sale deeds during last 3 years.

• Higher in above shall be market value of the land.

• If above rates are not available, then the concerned State shall specify the floor price per unit area of the said land.

• To determine the market value of building and other immovable property or assets and trees, plants and standing crop, CA may use the services of experienced persons/engineer/specialist.

• **Section 20H (Deposit and Payment of Amount)**

  • Central Govt shall deposit the amount determined, to CA before taking possession of the land by opening a joint account as per *Land Acquisition (Special Railways Projects) Rules, 2016* andas per Rly Bd letter No. 2018/W-I/Genl./Land Acquisition dated 05.02.2020 (*Annexure-2.09*).

  • CA shall, on behalf of Central Govt, pay the amount to the persons entitled. A procedure order for payment of compensation amount to the persons entitled has to be drafted with concurrence of Associate Finance before releasing the payment for compensation (copy of Procedure Order issued by Lucknow Construction Unit is attached as *Annexure-2.10*).

  • If the amount determined by Arbitrator is in excess of the amount determined by CA, the excess amount together with interest shall be deposited by Central Govt to CA.
• Section 20-l (Power to take Possession)

❖ After Central Govt has deposited the amount to CA, CA may, by notice in writing, direct the owner to surrender or deliver the possession within a period of 60 days of the service of the notice.

• Section 20J (Right to enter into Land)

❖ Where the land has vested in the Central Govt u/s 20E, it shall be lawful for any person authorized by the Central Govt in this behalf, to enter and to do other act necessary upon the land for carrying out the building, maintenance, management or operation of the Special Railway Project or part thereof or any other work connected.

• Section 20N (Land Acquisition Act 1 of 1894 not to apply)

❖ Nothing in the Land Acquisition Act, 1894 shall apply to an acquisition under this Act.

• Section 20-O (R&R Policy)

❖ The provisions of the national rehabilitation and resettlement policy, 2007 for project affected families, notified by the Government of India in the Ministry of Rural Development shall apply.

2.3.2.3 Tentative Time Frame for Land Acquisition through Rly (Amendment) Act, 2008

<table>
<thead>
<tr>
<th>SN</th>
<th>Activity</th>
<th>Time</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>From FSL to Notification u/s 20A</td>
<td>Depends upon size of project</td>
<td></td>
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<tr>
<td>2</td>
<td>From Notification u/s 20A to Declaration u/s 20E</td>
<td>One year</td>
<td>Section 20E (3)</td>
</tr>
<tr>
<td>3</td>
<td>From Declaration u/s 20E to Award u/s 20F</td>
<td>One year + 6 months, can be extended by CA</td>
<td>Section 20F (2)</td>
</tr>
<tr>
<td>4</td>
<td>From Declaration u/s 20E to Possession of land u/s 20 I</td>
<td>60 days after deposit of amount to CA by Central Govt</td>
<td>Section u/s 20 I</td>
</tr>
</tbody>
</table>

2.3.3 Land Acquisition Act, 1894 (Act No.1 of 1894):

2.3.3.1 Applicability of Land:

The Land Acquisition Act, 1894 has been repealed but this Act is applicable for the land acquisition already in progress except in the following conditions:-

(1) In any case of land acquisition proceedings initiated under the Land Acquisition Act, 1894.
Where no award u/s 11 of LA Act, 1894 has been made, then, all provisions of the Act, 2013 relating to the determination of compensation shall apply; or

Where an award u/s 11 of LA Act, 1894 has been made, then such proceedings shall continue under the provisions of LA Act, 1894, as if the said Act has not been repealed.

(2) In case of land acquisition proceedings initiated under LA Act, 1894, where an award u/s 11 has been made, 5 yrs or more, prior to the commencement of new Act but the physical possession of the land has not been taken or the compensation has not been paid, the said proceedings shall be deemed to have lapsed and the appropriate Government, if it so chooses, shall initiate the proceedings of such land acquisition afresh in accordance with the provision of new Act.

Provided that where an award has been made and compensation in respect of majority of land holdings has not been deposited in the account of the beneficiaries, then, all beneficiaries specified in the Notification for acquisition under Section 4 of the said LA Act, shall be entitled to compensation in accordance with the provision of new Act.

### 2.3.3.2 COMPARISON OF PROVISIONS IN VARIOUS LAND ACQUISITION ACTS

<table>
<thead>
<tr>
<th>SN</th>
<th>ITEM</th>
<th>OLD LAND ACT</th>
<th>NEW LAND ACT</th>
<th>RAILWAY ACT</th>
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<tbody>
<tr>
<td>1</td>
<td>Name of the act</td>
<td>The Land Acquisition Act, 1894</td>
<td>The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013</td>
<td>The Railways (Amendment) Act, 2008</td>
</tr>
<tr>
<td>2</td>
<td>SIA and SIA related studies</td>
<td>This was not in old Act.</td>
<td>Under section 4 to section 9</td>
<td>This is not required</td>
</tr>
<tr>
<td>3</td>
<td>Publication of preliminary notification for acquisition of land</td>
<td>Under section 4</td>
<td>Under section 11</td>
<td>Under section 20-A</td>
</tr>
<tr>
<td>4</td>
<td>Publication of declaration that land is required for public purpose</td>
<td>Under section 6</td>
<td>Under section 19</td>
<td>Under section 20-E</td>
</tr>
<tr>
<td>5</td>
<td>Enquiry and Award by the Collector</td>
<td>Under section 11</td>
<td>Under section 23</td>
<td>Under section 20-F</td>
</tr>
<tr>
<td>6</td>
<td>R&amp; R Award</td>
<td>This was not in old act.</td>
<td>Section 31 to section 37</td>
<td>Under section 20-O</td>
</tr>
</tbody>
</table>

### 2.3.4 Land Acquisition through Direct Negotiation with land owners
The process of land acquisition as per new Act is very lengthy and time-taking. To save time, land acquisition through direct negotiation with land owners can be opted in the State where policy in this regard has been formulated by the concerned State Govt. For land acquisition through direct negotiation, following steps are required to be followed:

2.3.4.1 Procedure for Land Acquisition through Direct Negotiation:

a) Final Location Survey of the project and marking centre line on ground.
b) Joint survey of alignment with Revenue officials.
c) Marking of alignment on Revenue maps by the Patwari and Kanoongo.
d) Calculation of Khasra-wise area and preparation of land plans by Revenue staff.
e) Checking and verification of land plans by Railways.
f) Placing indent of land to be acquired, to Land Acquisition Officer (LAO) nominated by State authorities.
g) Constitution of Negotiation Committee by State Govt, associating Railway representative also in Committee (Annexure-2.11).
h) Joint inspection of alignment with all concerned departments & land owners.
i) Negotiation with land owners for fixing rate of the land.
j) Recommendation by Committee and approval by State Govt (Annexure-2.12).
k) Award by CA:
l) Agreement with Land Owner (Annexure-2.13) and Deposit of requisite amount by Railways with State Government.
m) Payment to land owners through State Government.
n) Possession of land.

2.4 MANAGEMENT OF LAND:

After land acquisition, its proper demarcation and protection from encroachment is of paramount importance. For this, following action as stipulated in Para 808 to 811 of Indian Railways Works Manual (IRWM) should be taken.

a) All land permanently occupied for the purposes of Railway, shall have its boundaries defined on the ground in such a manner as to enable such boundaries to be readily ascertained and identified. For this purpose, the boundary of the Railway land may be defined by a continuous wall, fence or ditch or by detached marks, posts or pillars.
b) Where the boundary mark is continuous, the boundary of the Railway land is to be on the outer edge of the wall, fence or ditch, that is to say, the wall, fence or ditch will be situated wholly on Railway land.
c) Where detached marks, such as isolated posts or pillars are used, the boundary of the Railway land will pass along the outside of such posts and
pills. Between marks, the boundary shall in each case be taken in a straight line from the outside of one mark to the outside of the next mark.

d) Detached marks should, in no case, be at a greater distance apart (centre to centre) than 50m. They should be of a substantial character, not easily destroyed or moved by accident or mischief, and of such size and form as can be readily found and recognized.

e) Each detached boundary mark should bear a number. The position and number of each detached boundary mark should be shown on the land plan.

f) Where a fence, wall or ditch is situated at some distance within the boundary and does not mark the actual limit of the railway land, it will be necessary (in addition to such fence, wall or ditch) to have the actual boundary of the Railway land properly marked and defined in accordance with these rules.

g) The boundary stones to be used for this purpose should be as per para 809 of IRWM.

h) High boundary pillars on each bank of river of important waterways crossed by Railway bridges should be erected so as to prevent and control encroachments.

i) CONSTRUCTION OF BOUNDARY WALL:- In areas having habitation bordering Railway land and also where habitation is likely in near future, boundary wall should be provided so that potential encroachments are prevented and outsiders do not develop any right of entry on railway land. Boundary walls are an operational necessity in such situations, so as to prevent trespassing, cattle being run over by trains, use of railway tracks for easing etc. and theft of P.Way fittings and other railway materials. It is also necessary for boundary walls to be extended right from the Station outwards along the tracks of vulnerable locations within towns so that outsiders do not find an easy access to the stations.

j) Fencing:- Fencing as a rule should be provided at the following locations:

1. In Municipal limits and notified area limits.
2. Around busy station yards.
3. On either side of level crossings.
4. For protection of Railway land from encroachments.
5. On High-Speed routes.

2.5 HANDING OVER OF LAND DOCUMENTS:

a) After land acquisition proceedings are completed, following records should be handed over to Open Line in original in bound registers as per para 807 (f) of IRWM and Railway Board’s letter No. 2014/LML-11/13/7 dated 09.07.2014:-

i) Indent for acquisition of land for Railways as submitted to Revenue authority

ii) Shajra duly verified

iii) Award under Railways (Amendment) Act, 2008 (Annexure-2.14)
iv) Taking/handing over note (Annexure-2.15)

v) Attested copy of Mutation

vi) Land plan duly verified by the Revenue authorities showing details of Mutation.

b) These documents must be handed over duly pasted in machine numbered registers. Each register should have index in beginning, showing the details of documents pasted in the register. The first register containing land documents for a project should be numbered as land-1/x and subsequent registers may be numbered as land-2/x land-3/x etc where x is total number of registers.

c) All the above documents should be prepared in six copies (1 original + 5 copies), to be distributed as under:-

   i) Original copy to Open Line HQ
   ii) One copy to Divisional HQ
   iii) One copy to IOW Open Line
   iv) One copy to Railway Board
   v) One copy to Construction HQ
   vi) One copy to be retained by Construction Field Unit

2.6 Annexures:


   (ii) Annexure- 2.02- Land acquisition for Railway projects in tunneling portion.

   (iii) Annexure-2.03-Railway Board Letter No.2015/W-2/SCR/NL/22 dated 20.11.16 regarding land acquisition.


   (v) Annexure - 2.05 - Notification dated 10.7.2018 clause 37 A of section 2 of Railway Act 1989 regarding Sultanpur-Amethi new broad gauge rail line project.

   (vi) Annexure -2.06 - Notification of Special Railway Projects under the Railways Amendments Act 2008 for land acquisition.

   (vii) Annexure- 2.07- Land acquisition for Railway projects .

   (viii) Annexure- 2.08- Acquisition of land for Railway infrastructure projects for public purpose.

   (ix) Annexure- 2.09- Execution of New Line projects-Policy regarding.

   (x) Annexure- 2.10- Procedure order for payment of compensation amount in land acquisition for new lines.

   (xi) Annexure- 2.11- Office order regarding land acquisition.
(xii) Annexure- 2.12- Minutes of meeting regarding land rates.
(xiii) Annexure- 2.13- MOU between land owner and purchaser.
(xiv) Annexure- 2.14- Award.
(xv) Annexure- 2.15- Taking/handing over note.
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Plot No.</th>
<th>Size (Acre)</th>
<th>Rate of Land (Rs)</th>
<th>Total Value (Rs)</th>
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<tbody>
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</tbody>
</table>

Note: Rate of Land is subject to change based on market conditions.

 ANNEXURE-241

APPENDIX III

(See page 821-827)
## TABLE OF LAND WIDTHS

<table>
<thead>
<tr>
<th>Land Width (feet)</th>
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*Note: The table above provides the ground distance for various land widths. For a comprehensive understanding, please refer to the appendix for additional details.*

### Appendix 3

**Schedule of land widths to be taken up for a single house to confirm the exact land (local land) usage:**

- **Land Width:** The width of the land on which the house is to be built.
- **Ground Distance:** The distance from the ground level to the foundation level of the house.
- **Foundation:** The base of the house structure.
- **Building:** The main structure of the house.
- **Roof:** The top part of the house.
- **System:** The overall design and construction of the house.
The General Managers,
All Indian Railways

Sub: Land acquisition for Railway Projects in tunneling portion

With expansion of Railways in hilly and inaccessible regions, tunneling lengths are major portions in many projects. Issue of land acquisition for tunneling portion has been raised several times. Engineering Code Para 819 mentions about the land acquisition in the tunnel portion.

It has been observed that for different projects in different Zonal Railways, uniform practice of land acquisition is not being followed.

In order to maintain uniformity over different Zonal Railways, following guidelines are to be followed regarding land acquisition near tunnels:

i) No land acquisition over tunnels except at the entrances to the tunnels i.e. portals and for any adits/shafts which may be required for facilitation of rate of construction or for provision of safety features.

ii) For geologically unstable regions, where there are chances of cave-ins during tunneling/excavations and also at locations of low over burdens - the land acquisition may be resorted to on case to case basis by Zonal Railways based on practical considerations.

This has the approval of Board (ME).

(B.K. Gupta)
Executive Director (Project Monitoring)
Tel./Fax: 011-2338 2102

Copy to: PCEs & CAO/Gs of all Zonal Railways.
Chief Administrative Officers,
All Indian Railways.

Sub: Land Acquisition.

Subsequent to enactment of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (RFCTLARR) Act, 2013, most of the State Governments have framed a policy in terms of section 108 of the Act for land acquisition in their respective states. The policy formulated by most of the states provide for acquisition of land through direct negotiation with fixation of price/compensation by District level Committee. Some of the State Governments are insisting that all land acquisition be acquired through direct negotiation only. Thus there is no uniformity regarding route to be followed for land acquisition by various State Governments. This issue has been examined and it has been decided that:

1. In case of Doubling, Traffic facilities, Passenger amenities works and other works, normally requirement of land is minimal as most of the land required is available with Railways, therefore acquisition of land can be done through direct negotiation if the State Government has formulated policy/guidelines under section 108 of RFCTLARR Act 2013. If State Government has not formulated any policy that acquisition of land has to be either through RA Act 2016 or RFCTLARR Act 2013.

2. In case of New Lines & Gauge Conversion, acquisition should be carried out either through RA Act 2016 or RFCTLARR Act 2013. For projects which have been declared as Special Railway Project, land should be acquire through RAA 2008.

However, if the left over/balance acquisition due to missing plots from bulk acquisition, deviation in the boundaries while interpreting the revenue map, change in Khalsa number, additional requirement to accommodate minor alteration necessitated due to unforeseen technical, social or environmental considerations is less than 10% of the total acquisition of land for particular phase (if phasing has been done in advance) or targeted stretch, then balance land can be acquired through direct negotiation through policy formulated by State Government in term of section 108 of RFCTLARR Act 2013, with approval of General Manager.

3. In case all land acquisition in a State, either by State Government or by Centre Government agencies, is being done through direct negotiation only and State Government is categorically stating that they are not in a position to acquire land through RFCTLARR Act 2013 & are not ready/willing to spare/associate any District officials as competent authority for facilitating acquisition under RA Act 2008, than land for New Line/Gauge Conversion can also be acquired through direct negotiation through the policy/guidelines formulated by the respective state in term of section 108 of RFCTLARR Act 2013 with approval of General Manager.

(Signed)

Executive Director/Project Monitoring
Railway Board

Tele/Fax: 011-23388256
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

RBE No. 1/93 /2019
To
The General Manager,
All Zonal Railways/ Production Units
(As per standard mailing list)

Sub: Revision of policy regarding compensation of Land losers affected by land acquisition for Railway projects.

Ref: (i) RBE No. 99/2010 dated 16.07.2010
(ii) RBE No. 120/2010 dated 13.08.2010

1. On notification of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013 (Removal of Difficulties) Order 2015 dated 28.06.2015, provisions of RFCTLARR Act 2013 related to determination of compensation in accordance with First, Second and Third Schedules of the RFCTLARR Act 2013 have become applicable to all cases of land acquisition under the Railways Act 1989 also. This inter alia means that, irrespective of whether land acquisition for Railway projects is done through Railways Act 1989 after declaring it as a Special Railway Project or through RFCTLARR Act 2013 through State Governments, determination of compensation shall be in accordance with First, Second and Third Schedules of the RFCTLARR Act 2013.

2. The modalities for implementation of Serial No. 4 of the Second schedule of the RFCTLARR Act 2013 were examined by Ministry of Railways and it has been decided that:

i. Ministry of Railways’ earlier policy of offering appointment in Railways to affected land-losers issued vide references above is withdrawn and circulars issued in this regard vide reference above stand superseded.

ii. Lump sum payment of Rs. 5 Lakhs to be provided to affected families who were primarily dependent on acquired land for livelihood, i.e., cases where their livelihood is affected by such
acquisition or where entire land-holding of the affected family have been acquired.

3. Before considering grant of any relief under Second Schedule, however, the Competent Authority for Land Acquisition (CALA) or Collector should unequivocally certify that the affected family has been displaced and dislocated to another area or their entire land holding has been acquired. Further, in case of joint ownership of a plot of land, lump sum payment of Rs. 5 Lakhs should be shared between joint owners of plot in same ratio in which land value is to be shared.

4. This may be brought to the notice of all concerned authorities dealing with the acquisition of land and ensure that all determination of compensation for acquisition of land under the Railways Act, 1989 are in consonance with the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (RFCTLARR) Act, 2013.

5. This policy shall be effective from the date of issue of this letter.

6. This issues with the concurrence of Finance and approval of the Competent Authority.

[Signature]
Jt. Director Land & Amenities
Railway Board

[Signature]
Jt. Director Estt.(N)II
Railway Board

No. E[NG]II/2010/RC-5/1

New Delhi, dated 11.11.2019

Copy to:

(i) The General Secretary, AIRF, Room No. 253, Rail Bhawan, New Delhi (35 spares).
(ii) The General Secretary, NFIR, Room No. 256-B, Rail Bhawan, New Delhi (35 spares).
(iii) All Members of Departmental Council and National Council and Secretary, Staff Side, National Council, 13-C, Peroezeshah Road, New Delhi (60 spares).
(iv) The Secretary General, FROA, Room No. 256-A, Railway Board (5 spares).
(v) The Secretary, RBSS, Group 'A' Officers' Association.
(vi) The President, Railway Board Class II Officers' Association.
(vii) The Secretary General, IRPOF.
(viii) The Secretary, Indian Railways Class II Officers' Association.
(ix) The Secretary, Railways Board Ministerial Staff Association.
(x) The President, Railway Board Class IV Officers' Association.
(xi) The General Secretary, AIRPF Association.

(xii) The General Secretary, All India SCs ST Railway Employees Association, Room No-7, Rail Bhavan, New Delhi.

(xiii) Chief Commissioner for Railway Safety, Lucknow.

(xiv) Chief Administrative Officer, RCF/Raebareli Project, Kishanganj, Delhi-7

Copy to: PSs to MR and MOS(R)

Copy to: PSO/Sr.PPS/PPSS/PSs/PA to:
CRB, FC, MS, M(RS), ME, M(T), MT, M(S&T), M(MM), Secretary/Railway Board, DG(Pers.), DG/RHS, DG/RPF.

AM(Comml), AM(CE), AM(C&tS), AM(Elec), AM(Budget), AM(ME), AM(Mech), AM(Pig), AM(PU), AM(Tele), AM(Sig), AM(Store), AM(TT), AM(Works), AM(T&C), AM(Staff), AM(P), PED(Vig), PED(Infra), PED(Transformation).

EDE(N), EDC(E), EDF(E), ED(R), ED(Safety), EDV(A), EDE(RRB), EDE(Sports), ED(E&R), EDE(GC), EDE(Resl), EDH(F), ED(T&M), EDE, EDFC-I & II, EDFC(B), ED(E&F), EDE(G) Chairman/HRRC, JS, JS(G), JS(E), JS(C), DE(N), DE(N II), Dir. (MPP), DS(E), DF(E), DE(GP), DE(Rep.), JDF(E), JDE(N), JDE(P&A), JDE(GC), JDE(W), JDE(Resl), JDE(Rep.), DE(RRB), DE(II), DDF(E) & III, DDE (MPP), DDE (R)-II, DDE (LR)-I ,II & III.


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रेल मंत्रालय
(राज्य रेलवे)
(निर्माण भाग)

अधिनियम
नई दिल्ली, 10 जुलाई, 2018

भा. 3414(रेल)-निर्माण सरकार, राजस्थान अधिनियम, 1989 (1989 के 24) की प्रारंभ 2 के प्रणाली (उपरांत) द्वारा प्रतिष्ठित
संस्थाओं का प्रदर्शन करने हेतु, इस अधिनियम के तहत रेलवे राज्य की सरकार से सुलभता-कोशी 24.88 रेलवे। यह रेल
समीक्षक को सुलभता-कोशी के तहत लोक प्रतिस्पर्धा के लिए प्रत्येक अवसर के प्रकार के दृष्टि में लोक प्रतिस्पर्धा के
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MINISTRY OF RAILWAYS
(NORTHERN RAILWAY)
(CONSTRUCTION DEPARTMENT)

NOTIFICATION
New Delhi, the 10th July, 2018

S.O. 3414(E)—In exercise of the power conferred by clause (37A) of Section 2 of the Railway Act, 1989,
(24 of 1989), the central Government hereby notifies Sultanpur—Ameri new Broad Gauge rail line project as a Special
Railway Project for acquisition of 130.63 hectare land, having length of 34.66 Km between Sultanpur station to Ameri
station in Sultanpur and Amethi District in the State of Uttar Pradesh, for providing national infrastructure for a public purpose with effect from the date of publication of this notification in the Official Gazette.

[F.No. No.350-W/DYCE/C-4/LKO]
ALOK KUMAR, Chief Administrative Officer

NOTIFICATION
New Delhi, the 10th July, 2018

S.O. 3415(E)—In exercise of the power conferred by clause (7A) of Section 2 of the Railway Act, 1989, (24 of 1989), the Central Government hereby authorizes the officer mentioned in column (2) of the table below to perform the functions of the Competent Authority in respect of the Railway Project as mentioned in column (4) of the table, for execution, maintenance, management and operation in the state mentioned in column (3) of the said Table, with effect from the date of publication of this notification in the official Gazette.

<table>
<thead>
<tr>
<th>Serial Number</th>
<th>Competent Authority</th>
<th>State</th>
<th>Name of Railway Project</th>
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<td>Special land Acquisition officer Amethi</td>
<td>Uttar Pradesh</td>
<td>Sultanpur-Amethi new Broad Gauge Rail line project for acquisition of 81.90 Hectare land in Amethi District.</td>
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<td>Special land Acquisition officer Sultanpur</td>
<td>Uttar Pradesh</td>
<td>Sultanpur-Amethi new Broad Gauge Rail line project for acquisition of 48.73 Hectare land in Sultanpur District.</td>
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[F. No. 350-W/DYCE/C-4/LKO]
ALOK KUMAR, Chief Administrative Officer
NOTIFICATION

New Delhi, the 10th July, 2018

S.O. 3416(E).—In exercise of the power conferred by Section 20(6) of the Railway Act, 1989, (24 of 1989), the Central Government hereby authorises the officer mentioned in column (2) of the table below to perform the functions of the Arbitrator in respect of the Railway Project as mentioned in column (4) of the table, for execution, maintenance, management and operation in the state mentioned in column (3) of the said Table, with effect from the date of publication of this notification in the official Gazette.

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<th>Serial Number</th>
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<tr>
<td>1</td>
<td>District Magistrate Amethi</td>
<td>Uttar Pradesh</td>
<td>Sultanpur-Amethi new Broad Gauge Rail line project for acquisition of 81.90 Hectare land in Amethi District.</td>
</tr>
<tr>
<td>2</td>
<td>District Magistrate Sultanpur</td>
<td>Uttar Pradesh</td>
<td>Sultanpur-Amethi new Broad Gauge Rail line project for acquisition of 48.73 Hectare land in Sultanpur District.</td>
</tr>
</tbody>
</table>

[For No. 350-W/DYCEC-I(LKO)]

ALOK KUMAR, Chief Administrative Officer
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2010/LML/12/8

New Delhi, dated: 19.12.2014

General Manager's
All Zones Railways

General Manager (Commt)
N. F., Railway

Subj: Notification of Special Railway Projects under the Railways Amendment Act, 2006 for Land Acquisition.

Ref: Railway Board’s letter No. 2010/LML/12/8 dated 06.04.2010.

In continuation of above referred Railway Board’s letter, Ministry of Railways has decided that to expedite the process of notification of Railway projects (Projects appearing in Pink Book funded by Railways) as Special Railway Projects, concerned CAO/CE/CO (Coord.) are now been authorized to issue notification in the gazette under clause 37 A of Section 2 of the Railways Amendment Act, 2006 with the approval of General Manager of the Zonal Railway.

Receipt of this letter may please be acknowledged.

(Shashi Kumar)
Director/ Land & Amenities
Railway Board.

Copy to: All Executive Directors of Railway Board – They are requested to take immediate necessary action regarding notification of projects in their jurisdiction.

ANNEXURE-2.06
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

No. 2008/LML/12/8

New Delhi date 8-4-2010

The General Managers,
All Zonal Railways

General Manager (Com.),
NF Railway

Subject: Notification of Special Railway Projects under the Railways (Amendment) Act, 2008 for Land Acquisition.


1. In order to expedite the acquisition of land for railway projects, the Railways (Amendment) Act, 2008 has been enacted by Parliament which empowers the Central Government to acquire land in a time bound manner by notifying these projects as Special Railway Projects.

2. Under the provisions of the Railways (Amendment) Act-2008, there are four notifications required to be issued by the Central Government-

(a) notification of special railway project under clause (37A) of section 2;
(b) notification of competent authority under clause (7A) of section 2;
(c) notification of intention to acquire land under sub-section (1) of section 20A; and
(d) notification of declaration of acquisition of land under sub-section (1) of section 20B.

3. General Managers of the Zonal Railways and Chief Administrative Officers of the concerned Project have been authorized to exercise all powers of Central Government except Clause 37A of Section 2 of the Railways (Amendment) Act-2008 vide Railway Board letter No. 2008/LML/12/2 dated 13-2-2008.

4. In order to expedite the process of land acquisition, Ministry of Railways has granted approval for notification of all Railway projects which involve land acquisition as Special Railway Projects under Clause 37A of Section 2 of the Railways (Amendment) Act-2008. All railways are advised to take necessary action for notification of the projects involving acquisition of land as Special Railway Projects with the approval of respective Board Member through the concerned Directorates in the Board.

Please acknowledge receipt.

(J.S. Lakra)
Director (Land & Amenities)
Railway Board

Copy to: All Executive Directors of Railway Board - They are requested to take immediate necessary action regarding notification of projects in their jurisdiction.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2008/LML/12/2

New Delhi, Dated 12/02/2008

The General Managers,
All Indian Railways.

Sub: Delegation of Power to GMs and CAOs under Railway
(AMendment) Ordinance, 2008.

Consequent upon the promulgation of 'The Railways (Amendment) Ordinance, 2008 (copy enclosed for ready reference), Ministry of Railways, Railway Board has decided to authorise General Managers of the concerned Zonal Railways and Chief Administrative Officers of the concerned project for exercising all powers of Central Government except clause 37A of section 2 under the Railways (Amendment) Ordinance, 2008.

2. This has the approval of the President.

DA: one.

Copy to:
CAOs/All Indian Zonal Railways.
FA&COs/All Indian Zonal Railways.

Copy for kind information to:-
CAB, FC, ME, MM, MT, MS & ML
All Additional Members/Advisers
Concerned Executive Directors.

(Mathew John)
Secretary/Railway Board
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2009/LML/12/18

New Delhi, dt. 17.12.2009

General Managers,
All Zonal Railways
& Managing Directors of all Railway PSU's.

Sub: Land Acquisition for Projects.

Despite reformatory actions taken by Ministry of Railways, a study of
acquisition proceedings under the Railways (Amendment) Act, 2008 indicates
that there are large numbers of representations received against acquisition of
land. It is indicative of resentment among the land losers who feel that their land
is being forcibly acquired from them.

Whereas extant guidelines regarding acquisition of land have been
enumerated in Chapter VIII of Engineering Code, 1999 and Para 803 of Chapter
VIII of Indian Railways Works Manual 2000, however to dispel the feeling of
forcible acquisition of land among the land losers, to make acquisition more
attractive and timely and to streamline the process of acquisition of land following
action be taken:

a) Acquisition of private land may be done only when very essential and
   unavoidable.

b) Projects shall be planned in such a manner so as to cause minimum
   acquisition of land particularly agricultural land, and dislocation of land
   owners.

c) Whenever any land is to be acquired by Railways/PSUs, it will be done
   with full transparency and compassion for land losers.

d) Railways/PSUs shall proceed with the acquisition amicably by
   undertaking consultations with the prospective land owners in the
   project affected area even before the start of the Survey. The project
   affected persons shall be apprised of the project alignment and other
   details and also the compensation payable to them.

e) In projects other than "New Lines" Railways/PSUs should review the
   proposed alignment & construction methodology to ensure that the
   construction is contained within the existing railway boundary to the
   extent possible. Towards this end, the distance between the existing
   railway track and the proposed track should not be more than the
   stipulated track centres, and use of reinforced earth or retaining wall
   may be encouraged. In case, it is technically not possible to
accommodate the construction within the existing railway land or diversion from existing railway alignment is inevitable due to existence of villages or urban/industrial conglomerates, the alignment should be fixed so as to cause minimum possible acquisition of agricultural land. Alternatively, if possible, overhead alignment may be planned so that after completion of the construction work, the land underneath the alignment may be reverted back to their owners.

f) Land acquisition in Railways has normally been undertaken through Land Acquisition Act, 1984. Considering the delays in acquisition of the land and commissioning of the projects involving national infrastructure and required to be completed in a specified time frame, the Railways Act 1989 was amended to facilitate time bound acquisition of land. The Railways (Amendment) Act, 2008 provides for additional payment and application of provisions of National Rehabilitation and Resettlement Policy, 2007 as incentives to the land losers. In-spite of above, representations are being received in case of land being acquired under the Railways (Amendment) Act, 2008. In case of acquisition of land under the Railways (Amendment) Act, 2008 Railways/PSU’s should therefore, organize a workshop of the notified Competent Authorities and other officials involved in the land acquisition process to suitably sensitise them regarding handling of prospective land losers so as to avoid controversies and confrontation and to ensure amicable acquisition of land.

g) In case of land acquisition under the Railways (Amendment) Act, 2008, Railways should analyse all the objections received in reference to notifications issued regarding acquisition of land in a pragmatic way categorising them in the following groups:

i) Objections against acquisition itself,
ii) Objections in respect of compensation/resettlement packages
iii) Other than categories (i) & (ii) above

The analysis/ review be conducted kilometre-wise. For objections in category (i) above, the alignment may be reviewed. In case of objections in categories (ii) & (iii) discussions and negotiations may be held with the land losers by the Competent Authority in a sympathetic, transparent and objective way while hearing their objections under section 20D of the Railways (Amendment) Act, 2008, prior to declaration of award.

The above instructions should be brought to the knowledge of all concerned officers and staff immediately.

Please acknowledge receipt.

(Jagdip Rai)
Executive Director (Land & Amenities)
Railway Board.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No. 2010/LML/12/8

New Delhi, dated 21.02.2020

The General Managers,
All Indian Railways.

Sub: Acquisition of land for Railway Infrastructure Projects for public purpose.

Ref: Railway Board’s letter of even number dated 22.11.2017.

In supersession of Railway Board’s letter of even number dated 22.11.2017, following instructions are issued:

It has been found as per procedure laid down in the Railway Act, 1989, it takes only 27 months for acquisition of land against 47-50 months as per “The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013”. As such, it is desired for all such railway infrastructure projects which have to be completed in a specified time frame, the land should invariably be acquired through the provisions of Railway Act, 1989 by declaring them “Special Railway Projects”. This is within the competence of the Zonal Railways as per Railway Board’s letter of even number dated 19.12.2014.

This issues with the approval of Board (ME).

(Ajay Sharma)
Executive Director/LBA-1
Railway Board.
Sub: Execution of new Line Projects—Policy regarding.

Ref: (i) Board’s letter no. 2017/W-1/Genl./Budget dated 06-01-2018.

Reference above, instructions were issued to Zonal Railways vide letter under reference (i) stipulating that “payment for establishment charges and joint measurement charges for land acquisition may be made to State Government on their demand & that payment for land acquisition should be made only after finalisation of award by the State Government”.

Consequent to above, a large number of construction projects became stalled because aforesaid instructions were not in line with the provisions of section 19 of land acquisition act 2013 and Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement (Gujarat) Rules 2017.

The matter has been examined in consultation with L&A Directorate and accordingly to streamline the issue of land acquisition in Railway projects, it has been decided by Railway Board (ME & FC) that:

1. All Doubling & Gauge Conversion & only important New Line projects should be declared as Special Railway Projects & land acquisition should be done as per Railway Amendment Act, 2008 by opening a joint account. However, authority to declare any project as Special Railway Project still rests with General Manager of Zonal Railway as communicated vide Board’s letter No. 2010/LML/A-1/2 dated 22.11.2017.

2. Board’s letter No. 2017/W-1/Genl./Misc. dated 29.05.2018 stands withdrawn with immediate effect.

Annexure-2.09
NORTHERN RAILWAY
OFFICE OF
CHIEF PROJECT MANAGER
OPPOSITE SEWAGRAM COLONY
CHARBAGH, LUCKNOW

PROCEDURE ORDER FOR PAYMENT OF COMPENSATION
AMOUNT IN LAND ACQUISITION FOR NEW LINES BY LUCKNOW
CONSTRUCTION UNIT UNDER RAILWAY (AMENDMENT) ACT-
2008

Following procedure will be followed for releasing of payment by Northern Railway and
disbursement of compensation amount in land acquisition for New Lines by Lucknow
Construction unit:
1. The amount will be determined under section 20F of Railway (Amendment) Act' 2008
and shall be deposited by Central Govt in joint account operated in a nationalized bank
(refer act 2016 sub section 4).
2. Before depositing the amount, the Competent Authority (CALA) as per Railway
(Amendment) Act' 2008 will determine amount payable for compensation as per 20F
and follow the criteria of determination of market value of land as per section 20-G.
3. As per section 20K, Competent Authority (CALA) will have certain power of Civil
Court and if there is any objection under 20F, then 20F will be rectified by visiting the
actual site depending on the ground realities. It will be examined and the arbitrator will
be approached if required, under sub Section 4 of section 20K.
4. As per Land Acquisition (Special Railway Projects) Rules' 2016, the funds shall be
under control of Competent Authority (CALA) and shall be operated by Competent
Authority (CALA) jointly with Accounts Officer nominated by Central Govt for the
purpose.
5. The list of the beneficiaries for disbursement of compensation duly signed by
Competent Authority (CALA) will be submitted to Northern Railway before releasing
compensation amount. That list of beneficiaries will be duly signed and forwarded by
Executive for disbursing the compensation amount.
6. After the amount has been deposited by Central Govt, the Competent Authority
(CALA) shall on behalf of Central Government, pay the amount to the person
authorized there to.
7. As provided in Railway (Amendment) Act' 2008, every objection under sub Section 1
of section 20I), shall be made to the Competent Authority (CALA) as per sub Section
(2) & (3) of section 20D.

This is issued with concurrence of DyFA&CAO/C/LKO and sanction of CPM/NR/LKO.
No. 2-A/c/DyCE/C-I/LKO
dated 31.12.2018

(Gaurav Verma)
DyCE/C-I/LKO

Copy for information:
1. DyFA&CAO/C/LKO
2. CPM/NR/LKO
3. FA&CAO/C/Central/NR
4. CAO/C-II/NR, Kashmiri Gate, Delhi
नामक: 1979/आद--विभ(सं००३०) (सं००३०)
दिनांक: 3-7-2018

कार्यालय ज्ञाप

कृपया अवगत कराना है कि चारणी स्टेशन पर नवामित गुवाही के फायदे पर वहाँ के ग्राम संचालन हेतु भूमि अधिवेशन के सम्बन्ध में अधित तौर पर वाली भूमि को दर निर्धारण हेतु अपर जिलाधिकारी (विभ./रक.) की अध्यक्षता में हेतु दिनांक-04.07.2018 समय 11.00 बजे स्थान-अपर जिलाधिकारी (विभ./रक.) का मैत्री प्रदान करेगा। चौथे हफ्ते 19 मार्च 2015 में हो गयी व्यवस्था के अनुसार 1 कोलों से कम लागत मुख्य के पश्चात रहने हेतु निम्न सध्य समिति गठित की गई है।

1.- अपर जिलाधिकारी (विभ./रक.) वाराणसी। सदस्य
2.- विशेष भूमि अध्यादेश अधिकारी (सं००३०) वाराणसी। सदस्य
3.- उप जिलाधिकारी राजातलाव वाराणसी। सदस्य
4.- सभ सिल्सिला गंगापुर वाराणसी। सदस्य
5.- सहायक अधिशासी अभियंता निम्न उप रेलवे वाराणसी। सदस्य/सचिव

अधि: उपर सभी समानित सदस्यांग के अपर जिलाधिकारी (विभ./रक.) महोदय की अध्यक्षता में दिनांक-04.07.2018 समय 11.00 बजे अपर जिलाधिकारी (विभ./रक.) में होने वाली बैठक में सभी से उपस्थित होने का काफी करें।

(अभय कुमार गुप्ता)
विशेष भूमि अध्यादेश अधिकारी (सं००३०) वाराणसी।

निदित्तिक-निम्नसिलिटिक को साझे अवमानना प्रबंध।
1.- विशेष भूमि अध्यादेश अधिकारी (सं००३०) वाराणसी।
1/2.- उप जिलाधिकारी राजातलाव वाराणसी।
3.- सभ सिल्सिला गंगापुर वाराणसी।
4.- सहायक अधिशासी अभियंता निम्न उप रेलवे वाराणसी।

(अभय कुमार गुप्ता)
विशेष भूमि अध्यादेश अधिकारी (सं००३०) वाराणसी।
<table>
<thead>
<tr>
<th>सं.</th>
<th>साधन वर्ग</th>
<th>ग्रामपंचायत अधिकारियों व वर्गवार</th>
<th>ग्रामपंचायत की कार्यवाही</th>
<th>परिवर्तन प्रयोगों व जलवायुक्रियाओं के प्रवर्तन</th>
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<td>1</td>
<td>(सोनेचर घाट) अप्रो विलिसिटी (डी/डी) वारणारी।</td>
<td>जागतिक वालिकाओं के फॉर्म ज्ञापन हेतु हेतु की जाने वाली भूमि शालान्यूडेस संख्या -2/2015/1-13-2015-20 (48)/2011 विवरण-1903.2015 में दिये गये निर्देश के अनुसार ग्राम भूमि, राजीव- राजकीय राजस्थान विस्तार-वालिकाओं में विस्तार भूमि के आरक्षण 1191 रक्षा 24.51 प्रणाली पूर्व-सामग्री के साथ एक प्राप्त सामग्री के द्वारा ब्रांड दिये जाने हैं।</td>
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<td>3</td>
<td>(गर्म धुंधार गुरुका) दिवसीय भूमि अनूठीकरण अधिकारियों (टेबलो) वालिकाओं।</td>
<td>पूर्व दुभाना पर जाने विवरण-04.07.2018 को ब्रांड भूमि का आयोजन किया गया। उपनिवेशिक नगरपालिका वालिकाएं के जन्म संख्या 140 विवरण-27.08.2018 द्वारा भूमि का मूल्यांकन 2451×13000=318530.00 नियायित कर प्रस्तुत किया गया है। भूमि के मूल्यांकन हेतु ब्रांड अपर विलिसिटी (डी/डी) की अभावशाला ने शालान्यूडेस में अचल सदस्यगण की उपस्थिति में वैश्विक विवरण के सम्बन्ध में उपरोक्त शालान्यूडेस के द्वारा-5(7) में दी गयी व्यवस्था के अनुसार द्वारा प्राप्त किया गया।</td>
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<td>4</td>
<td>उपनिवेशिक नगरपालिका वालिकाएं।</td>
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<td>5</td>
<td>(बीमारी समापन) साहायक अधिकारियों अधिकारियों निर्देश द्वारा रखी वालिकाओं।</td>
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अनुगॊष्ठी  

(पूर्व निंदें)  

विलिसिटी  

वालिकाएं।
प्रतिविधि/पूजानिमित्व और क्रम निर्णय के माध्यम से संबंधित दोषकर्म के लिए समयकालीन दृष्टि क्रम किये जाने हेतु निर्णयकारिता कीमत या प्रति समयकालीन प्रति।

यह समझिए कि यह आज धिरायक को निम्न पूजानिमित्व/पूजानिमित्व द्वारा सम्बन्धित क्रम के पूर्व स्थित नहीं है, तथा यह स्थिति एवं निम्न पूजानिमित्व के लिए हमेशा होता है।

(1) (98) अंग...
(2) (98)

इस प्रकार (हेतुरस्त पूजानिमित्व “पूजानिमित्व” कहा गया है) और:

प्रति समय के गायबन से कार्य कर रहे (क्रम निर्णय का क्रम)

दितीय प्रकार (हेतुरस्त पूजानिमित्व “क्रम निर्णय” कहा गया है) के माध्यम से आयुक्तकृत व्यक्ति क्रम निर्णय का गया है।

पूर्व के पूजानिमित्व प्राप्ती के सापेक्ष देय पर तत्काल बुद्धिमत्व पर सम्मान है, जिसका विवरण अनुप्रस्तुत किया गया है।

और पूर्व के पूजानिमित्व प्राप्ती के सापेक्ष देय पर तत्काल बुद्धिमत्व पर सम्मान है, जिसका विवरण अनुप्रस्तुत किया गया है।

वर्तमान क्रम आयुक्तकृत और क्रम निर्णय के से एटाहारा हिस्से प्रति समय होता है।

(1) यह कि क्रम निर्णय इस समझौते प्रकार के निर्णय की रिश्ता से अधिकतम 12 महीने के भीतर अनिवार्य अवधि के मूल्य कीमत में लक्ष्य होगा।

(2) यह कि यह क्रम निर्णय क्रम के दृष्टि के अधिकतम 12 महीने के भीतर अनिवार्य अवधि के मूल्य कीमत में लक्ष्य होगा।

प्रतिविधि का क्रम आज कम हेतुरस्त पूजानिमित्व तत्काल बुद्धिमत्व का प्रयोग कर दिया गया।
प्रतिवर्ती धर्मस्पति क्रय निकाय को आधार पर हर कदा है/हर है तो यह निधन की कारणता के लक्ष्य के साथ से उसे भू-प्राधनक के कारण के रूप में समझ करने या ऐसी धर्मस्पति की समझ के संबंध में तीसरा क्षण की स्मिति के प्रकीर्तन कायवाही करने का/आदेश देने का पूरा अधिकार होगा।

(5) यदि अनुमोदन में वर्तमान धूम को कोई सरकारि देख/अवलोकन भूमध्य द्वारा देख है तो इसी विश्वास निधन के रूप में पहुँच करने का भूमध्य धर्मस्पति का वातावरण है धर्मस्पति की समझ के वातावरण के भूमध्य धर्मस्पति की समझ क्षेत्र के बाजार का भूमध्य धर्मस्पति की वातावरण।

(6) क्रय निकाय और भू-प्राधनक के सम्बन्धित इस समझौते पत्र के अनुमान के उपरान्त अवश्य निकाय निदेश का निर्देशन किया जाएगा जिसके निर्देशनन निदेशन निदेशन निदेशन निदेशन।

(7) निधन निदेश के निर्देशन के दिनांक पर ही समझौता भू-प्राधनक के अनुमोदन-1 में वर्तमान सूचना का क्रय निकाय वातावरण क्रय निकाय वातावरण क्रय निकाय वातावरण क्रय निकाय वातावरण।

(8) क्रय निकाय के द्वारा निर्देशित साधारण पर इस समझौते पत्र को भूमध्य द्वारा 15 दिन का तेजबेद देश निर्देशन करना या इसका--

(i) यदि भूमध्य ने समझौता पत्र को कमलपूर्व में इसके समाधान करता है।

(ii) यदि भूमध्य के बाद समझौता पत्र के इसी नाम के उल्लेख किया जाता है।

(iii) यदि इस समझौते पत्र के निर्देशन के उपरान्त यह प्रकट होता है कि अनुमोदन-1 में वर्तमान धूम का समाधान भू-प्राधनक में नहीं है।
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<th>काला क्रम</th>
<th>जेवण (२० ग)</th>
<th>पूर्वि का निवास पड़ाद का नंबरांकन संख्या का नंबर हो (माया श्रीमती और तरी ही पूर्वि का स्थानिक प्रक्रियाओं को संलग्न करती है)</th>
<th>पूर्वि के कुल मूल से लिए संक्लित या विद्यमान हो (२० ग)</th>
<th>पूर्वि पर सबसे क्रमांक</th>
<th>विवरण</th>
<th>पूर्वि पर क्रमांक के अनुसार देय विधि (२० ग)</th>
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<th>देश पत्र काल (स्थन बालात्मक -330)</th>
<th>प्रमिति/विविधता का/के फल और ग्राहक सूचना देव है और उचिता अवशेष</th>
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पुष्पकी/अनुदानियों के हस्ताक्षर

1. 
2. 

कय निर्माण की ओर से अधिकृत अधिकारी के

हस्ताक्षर: रामजी रामचंद्र
पूरा नाम: रामजी रामचंद्र
पद नाम: सी.ई./कर्मचारी

माफ/अभिव्यक्ति

1. 
2. 

प्रथम शरण अनुसार नुक्ली बी. सं 20/09/82 दिन को पानी का बालात्मक नुक्ली 3-353 कर 2488 तथा नुक्ली 2453 कर 2288 सुरक्षा के लिए उपयोग करें, जिसके लिए यह 20/09/82 दिन को पानी का बालात्मक नुक्ली 3-353 कर 2488 तथा नुक्ली 2453 कर 2288 सुरक्षा के लिए उपयोग करें.
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<tr>
<th>नं.</th>
<th>विवरण</th>
<th>इंटरकल्यूट</th>
<th>उपलब्धि</th>
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<td>1 / 2018</td>
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<td>ग्राम का नाम</td>
<td>कसारावती लावाड़</td>
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<td>3.</td>
<td>सहस्त्राल / वडाणा</td>
<td>दादरी</td>
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<td>4.</td>
<td>जिला</td>
<td>गोशापुर</td>
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<td>5.</td>
<td>अर्जन हेतु विभागन क्षेत्र का (क) मूल विभागन क्षेत्र का (ख) प्रांग समुद्र पूर्व (ग) शेष अर्जित पूर्व सिस्टे का अधिवेशन की करारीयता की जा रही है।</td>
<td>9.0933 है।</td>
<td>0.1010 है।</td>
</tr>
<tr>
<td>6.</td>
<td>पूर्व अधिग्रहण का प्रणोदन</td>
<td>विशेष रूप से सर्विस इंस्ट्रेक्ट जेट कॉरिडोर के सिद्धान्त, अनुक्रमण, प्रबंध और प्रकाशन के लिए स्वाभाविक है।</td>
<td></td>
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<tr>
<td>7.</td>
<td>कमांड निबंधन का नाम</td>
<td>राष्ट्रीय (भारत सरकार) जांच इक्विटेड जेट कॉरिडोर कॉन्सर्टेन्स ऑफ कीविया श्रों-भ्रं. प्राथमिक मिडिया नेटवर्क एजेंसियों, नई दिल्ली-110001</td>
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<td>8.</td>
<td>उप राजनीतिक संगठन का क्षेत्र है।</td>
<td>है।</td>
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</tr>
<tr>
<td>9.</td>
<td>रेल संचालन अधिनियम 2008 की (भाग-20(5)) की अधिनियम का प्रकाशन</td>
<td>अधिनियम संरचना-कॉन्फ्रेंस 2016(9) रिपोर्ट 28-08-2016 को भारत के संसद अनुसार भाग 2 खंड-3, उपरेखण डिविजन रिपोर्ट 30-08-2016 को प्रकाशित हुई।</td>
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<td>10.</td>
<td>ग्राम-वार (4) की उपवास (4) के अन्तर्गत घरीय समाजवादी पदों में प्रवक्तार का प्रकाशन</td>
<td>1. राष्ट्रीय जारीपेक्षा, सज्जनवाद पत्र जारीकरण-21-09-2016</td>
<td></td>
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<tr>
<td>11.</td>
<td>रेल संचालन अधिनियम 2008 की (भाग-20(8)) की अधिनियम का प्रकाशन</td>
<td>अधिनियम संरचना-कॉन्फ्रेंस 1224(9) रिपोर्ट 25-04-2017 को भारत के संसद अनुसार भाग 2 खंड-3, उपरेखण डिविजन रिपोर्ट-27-04-2017 को प्रकाशित हुई।</td>
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<td>12.</td>
<td>सार-65 के अन्तर्गत लघु-लघु संस्थाओं पर योजना का प्रकाशन</td>
<td>1. अनुमसान के दल, समाजवाद पत्र जारीकरण-25-06-2017</td>
<td>2. राष्ट्रीय जारीपेक्षा, सज्जनवाद पत्र जारीकरण-25-05-2017</td>
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<td>13.</td>
<td>रेल संचालन अधिनियम 2008 की (भाग-70(6)) की उपवास (4 व 5) के अन्तर्गत सार्वजनिक सुनामार का लघु-लघु संस्थाओं पर योजना का प्रकाशन</td>
<td>1. अनुमसान के दल, समाजवाद पत्र जारीकरण-14-04-2018</td>
<td>2. राष्ट्रीय जारीपेक्षा, सज्जनवाद पत्र जारीकरण-14-04-2018</td>
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<td>14.</td>
<td>अधिनियम का लिखित स्वीकार</td>
<td>23-04-2018</td>
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<td>15.</td>
<td>पूर्व प्रति नियंत्रक दर्जे के निर्वाचन हेतु अपराध / कृषण की पुष्टि की प्राप्ति करने हेतु निम्नलिखित</td>
<td>20 जून 2018 दिन 11:00 बिंदु देने जारीपेक्षा तथा अनुमान उत्तर में प्रकाशित विमीन की अनुक्रमण करें।</td>
<td>11:00 बिंदु</td>
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</tbody>
</table>
| नं. | रेट अधिनियम-1989 तथा शहरस्थान रेट लंबाईक अधिनियम-2008 के अनुसार अधिकता की जाने वाली भूमि के प्रतिक्रिया के निर्णय पर भूमि के अधिकता, पुनर्वित्तापर और पुनर्वित्तापर प्रदक्षिण करार अधिनियम-2013 की अनुमति-1 के प्रभावितों के अनुसार अधिकता भूमि के कारण मूल निर्णय के रूप 301.07 या एवं 100 से गुणा करने के उपरान्त मूल प्रतिक्रिया करें।
| रेट अधिनियम-1989 तथा शहरस्थान रेट लंबाईक अधिनियम-2008 के अनुसार अधिकता की जाने वाली भूमि के प्रतिक्रिया के निर्णय पर भूमि के अधिकता, पुनर्वित्तापर और पुनर्वित्तापर प्रदक्षिण करार अधिनियम-2013 की अनुमति-1 के प्रभावितों के अनुसार अधिकता भूमि के कारण मूल निर्णय के रूप 301.07 या एवं 100 से गुणा करने के उपरान्त मूल प्रतिक्रिया करें।
| मूल प्रतिक्रिया 15,29,65,317.81 पर धारा-20(1) की अंतिम वर्षीय कर की दिनांक 30.08.2016 की अधिनियम की दिनांक 23.04.2018 तक की अवधि का 12 अधिता वार्षिक की दर से अधिता प्रतिक्रिया की धारणा।
| अधिकता भूमि पर सिस्टर परिवर्तनकारण के मूल संकर को प्रतिक्रिया की धारणा।
| रेट अधिनियम-1989 तथा शहरस्थान रेट लंबाईक अधिनियम-2008 के अनुसार अधिकता की जाने वाली भूमि के प्रतिक्रिया के निर्णय पर भूमि के अधिकता, पुनर्वित्तापर और पुनर्वित्तापर प्रदक्षिण करार अधिनियम-2013 की अनुमति-1 के सर्वाधिकारिक प्रभावितों के अनुसार अधिकता भूमि के कारण मूल निर्णय के रूप 301.07 या एवं 100 से गुणा करने के उपरान्त मूल प्रतिक्रिया करें।
| नेता 33,63,79,887.65 अधिता 33,63,79,888.00
d | 3 प्रतिक्रिया भूमि के अधिकता की धारणा।
| पूर्ण भूमि के धारणा का मूल संकर का अधिकता अवधि के अनुसार मूल प्रतिक्रिया करें।
| सम्पूर्ण 34,84,71,286.00
अभिनिबंध (Award) का आयोजन

अभिनिबंध (Award) का आयोजन

अभिनिबंध (Award) का आयोजन
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<th>खरा सं.</th>
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<th>2001 में माकरणत हिस (₹)</th>
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सं 737 क्षेत्रफल 0.0250डौ, तथा उससे सं 738 क्षेत्रफल 0.0750डौ सरकारी भूमि का मूल क्षेत्रफल 0.1010डौ है। इस प्रकार धारा 28(3) की अधिसूचना संख्या 1324(36) दिनांक 25.04.2017 में प्रकाशित हो न 9.0933डौ ने से सरकारी भूमि 0.1010डौ को पूर्वपक्ष करता हुए ग्राम भरमयकली चमकढ़, तहसील गांव, जिला गीतमुखम भूमि 8.9923डौ अवशेष 8923 या मौ 10 भूमि का प्रतिकर का निर्धारण कीया जा रहा है।

रेखेवे अधिनियम, 1989 यथासंभवित रेख संरक्षण अधिनियम, 2008 की धारा 20(3) की उपधारा (4) ए (5) से अनुसार ईंट में संरक्षक प्राधिकार एवं प्रमाण पता देनेवाला समावे अगर उपजाता दैनिक निर्देशन के दिनांक 14.04.2018 में विशिष्ट प्राधिकारित करार 20.04.2018 दिन जनतादूत/प्रभावी मुन्त-मुक्ती/कार्यकर्ताओं से अपत्ति अभिनिधित्व से पूर्वांग प्राधिकार की गयी। निर्धारित अदब में प्राधिकार मुन्त-मुक्ती/कार्यकर्ताओं द्वारा कोई भी अपत्ति प्राप्त नहीं हुई।

प्रतिकर का निर्धारण

प्रतिकर निर्धारण हेतु रेखेवे संरक्षण अधिनियम, 2008 की धारा 20 (क) (8) (क) से अनुसार इस अधिनियम की धारा 2017 के अधीन अभिसूचना प्रकाशन के दिनांक की भूमि का बाजार मूल्य देना है।

इसी अधिनियम की धारा 2017 (7) से अनुसार धारा 2017 की अभिसूचना की दिनांक को बाजार मूल्य का निर्धारण निम्नानुसार किया जायेगा—

(i) उस क्षेत्र में जिस भूमि विक्रय है विक्रय विशेषों के लिए दिनांक देने के लिए विधिमार्ग के लिए भारतीय सर्वेक्षण अधिनियम, 1899 में विनिर्देश निम्नानुसार भूमि मूल्य वर्तमान कोई हो

या

(ii) उस क्षेत्र की उम्मीद वीर्यों संस्करण की गई है या यहाँ पर विद्युत उत्ती प्रकार की भूमि के लिए, पूर्वतली होंने के दीर्घ अस्तित्व विधिवत विशेष विशेषों के पास निर्णय से अनुसरण से अभिनिधित्व, विधिवत शिक्षाएँ नहीं है।

इसमें से जी अदब हो, के आवार पर अभिनिधित्व भूमि का बाजार मूल्य निर्धारित किया जायेगा।

अभिनिधित्व भूमि के बाजार मूल्य का निर्धारण करने से पूर्व रेख संरक्षण अधिनियम, 2008 की धारा 2017 की दिनांक 14.04.2018 में स्वस्ति (3) के अनुसार अभिनिधित्व भूमि के उपयोग प्राप्त करने की अभिनिधित्व करने के लिए तथा आवश्यक प्रकार के क्षेत्रों की भूमि का मूल्य ज्ञात करने के लिए भरे द्वारा अभिनिधित्व ने समाप्तित भूमि का स्वस्ति ज्ञात की गयी।

रेख संरक्षण अधिनियम, 2008 की धारा 2017 (1) में दिए गए प्रकाशन के अनुसार कार्यान्वयन अभिनिधित्व, राजस्व से धारा 2017 की अभिसूचना के भारत सरकार के राजस्व में प्रकाशक की दिनांक 03.06.2014 से पूर्वतली होंने की आवश्यक में नियमित विधिवत अभिनिधित्व/अनुबंध पद्धति की सुरक्षा पूर्व विधिवत, दार्शनी ज्ञात की गई। प्रचार सुरक्षा के आवार पर प्राधिकार एवं मुन्त-मुक्ती के स्वस्ति ज्ञात के आवार पर प्राधिकार एवं आवारी से सम्बन्धित नियमित विधिवत पद्धति का संचालन नहीं किया गया।

[23/4/11]
गया है। उत्तर आदेश में कुल 02 विक्रय पत्रों का निर्धारण होना पाया गया, जिसे सक्षम स्थापना परिषद संख्या-2 (दू) से रूप में पूर्व से निर्दिष्ट किया गया है। परिषद-2 (दू) में प्रकटित 02 विक्रय पत्रों में से उच्चतम पर प्रतिष्ठित करने वाले निर्माणस्थल आदि विक्रय पत्रों अवधि 01 विक्रय अभियंताओं की प्रतिष्ठा दर के करोड़ 2:100:40 में रूप में मीटर प्रमाणित है, जोकि पाइपिलिस नहीं है। उत्तर आदेश में अनुसूची-2 पर निर्माणित निर्माणित विक्रय पत्र 02 में से विक्रय पत्र रूप से है।

उत्तराखंड मुख्यमंत्री नरेंद्र मोदी की दिनांक 01.08.2016 से भावनी स्तंभ वर्गों के अनुसार रज्जु देश भरावती गराँगा अपने बाली ध्वनि हेतु मुख्य 1,70,10,700.00 में संचालित की गई है, जिसके गणना का अनुसूची ध्वनि की प्रति रूप 1,701.07/— में बाली ध्वनि होती है।

रेल अधिनियम—1989 के संबंध में संयोजित रेल सरकारी अधिनियम—2008 के अनुसार अधिकार की जाने वाली मुख्य के प्रतिक्रिया के निर्भर ध्वनि पर ध्वनि अनुशंसा, पुरुषार्थी और पुरुषार्थीकरण के द्वारा प्रतिक्रिया और परदर्शित अधिकार अधिनियम—2015 के अनुसूची-1 दे प्रतिवेदन के अनुसार अधिकार ध्वनि को बाली मुख्य निर्दिष्ट में 1701.07 लागू मात्र, ये गणना के लिए रेल अधिनियम ध्वनि 2019 की लिस्ट के दिनांक 19.04.2018 से आवश्यक ध्वनि की विधि 23.04.2018 तक भारतीय ध्वनि पर 12 प्रति ध्वनि की प्रति से कुल 01 ध्वनि के अधिकतम प्रति क्रम प्रतिध्वनि मिश्रण के प्राप्ति है।

अधिक जानकारी के लिए लिखित कृपया विस्तार से निर्धारित होने वाली मुख्य निर्धारण में निर्दिष्ट होने के लिए निर्माण स्थल कार्यक्रम (मुख्य), रेल नेटवर्क अधिनियम के प्रकाश पत्रों में अपने प्रति संख्या 281(A)/2016—III/144-अधिनियम—/2018 दिनांक 19.04.2018 के साथ संबंधित निर्देश उपरोक्त प्रति अधिनियम के प्रति ध्वनि के द्वारा प्रतिवेदन अधिनियम—2008 के साथ संबंधित अधिनियम संख्या 314(6)/77—4—08-214 में—05 तत्काल दिनांक 14.08.2006 की प्रति ध्वनि के प्रति ध्वनि से, जिसके प्रति संख्या 05 प्रति क्रम संख्या 20 व पूर्व संख्या 11 प्रति क्रम संख्या 20 ध्वनि मात्र भरावती गराँगा को प्रति नेटवर्क अधिनियम ध्वनि के रूप में ध्वनि के प्रति है, जो स्वीकृत है।

रेल अधिनियम के अनुसार ध्वनि विकास संकाय की अधिनियम का कानून 2368 (पु) दिनांक 28.08.2015 जो भारत के रूप में समाप्त अवधि में—2 ध्वनि—(II) संख्या 1834 दिनांक 28.08.2015 में प्रकट की हुई है, उपरोक्त अधिनियम—1989 के संबंध में संयोजित रेल संबंधित अधिनियम—2008 के अनुसार अधिकार की जाने वाली मुख्य के प्रतिक्रिया के निर्भर ध्वनि पर ध्वनि अनुशंसा, पुरुषार्थी और पुरुषार्थीकरण में प्रतिक्रिया और प्रतिवेदन अधिकार अधिनियम—2013 की अनुसूची-1 के प्रबन्धन, प्रवीण होते हैं।
उपरोक्त मानक के अनुसार विनियमित भूमि की दर से मुल प्रतिकर एवं परिसंपत्तियों की प्रतिकर धनराशि
का विवरण निम्न प्रकार है--

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निर्धारित प्रतिकर धनराशि की विविधताओं का प्रमाण व्यक्तियाँ निम्न प्रकार है--

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विशेष नोट: हिदायत कुक्कड़ को अभिज्ञ भूमि का प्रतिभाप नवाचार करते समय राहत में से प्राप्त रूपों में हो कोई निर्देश पाई जाती है जो उपरोक्त शर्तों ने अनुसार संचालित रूप में पूर्व प्राप्त होने होते है।

* रावणग्राम व्यापारी प्रणाली प्रणाली प्रणाली प्रणाली प्रणाली प्रणाली प्रणाली, राहत में से प्राप्त रूपों नवाचार करते समय राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु राहत में से प्राप्त रूपों करने हेतु  }
Office of the Collector Land Acquisition Northern Railway  
(Addl. Deputy Commissioner) Pulwama.

Subject: Hand over / take over of possession of land of Railway Tracks

We the under signed respectively hand over / take over the possession of Additional land measuring 259 Kanals 17 Marlas 6 Baj Sarsai as per Shajra Khass in villages detailed hereunder for construction of Railway Tracks to day on 31-08-2005.

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Take over

N. Rahman, 
Addl. Deputy Commissioner, Northern Railway

Dated: 31-08-2005

Copy to:
1. Divisional Commissioner Kashmir, Srinagar.
2. Secretary to Govt. Rev. Dept Jammu/Srinagar.
3. Deputy Commissioner, Pulwama
4. Deputy Chief Engineer S&C-II Northern Railways Jdhampur.

Moltd Abid Bhat (CAS)  
Addl. Deputy Commissioner,  
Collector Northern Railways  
Pulwama
CHAPTER -3

PROJECT PLANNING

Large number of Railway projects are being planned for capacity augmentation to serve the needs of trade, specific regions or industry sectors. It is essential (and a pre-requisite) to adopt appropriate project management structure, execution methodology, project financing, constraints and disputes mechanism for smooth contract execution, to ensure design, construction and commissioning of projects without cost and time overrun. Thus, proper project planning, implementation and monitoring is important taking cognizance of the policy framework, organizational goals, availability of funds and time frame for the implementation of the project.

However, like other infrastructure sectors in India, IR’s projects also suffer from cost and time overruns, mainly attributed to inadequate funds, delay in acquisition of land, security issues, lack of supporting infrastructure, delay in finalization of detailed engineering plans, scope changes during implementation, unanticipated geological conditions and lack of familiarity with latest technology. Sometimes, cost and time overruns are also caused due to change in foreign exchange rates and statutory duties, increase in cost of rehabilitation of displaced persons, statutory environment safeguards, increase in cost of land acquisition and inflation during project execution.

Doloietal’s (2012) study of delays of Indian Construction Projects identified following critical factors in descending order of importance:

i) Lack of commitment by client and vendors leading to accidents, improper or obsolete construction methods, delay in material delivery.

ii) Inefficient site management due to ambiguous specifications, unskilled labour, ineffective supervision, inadequate experience of contractor, lack of control over sub-contractors.

iii) Poor site coordination due to lack of coordination between execution site and design office, non-availability of drawings/designs in time, unrealistic time schedule built in the contract.

iv) Improper planning in ignoring extreme weather conditions which lead to low labour productivity and therefore lead to errors in time estimation; improper planning for recruitment of skilled operators for specialized equipment; improper planning for the requirement of equipment and their utilization.

v) Lack of clarity of project scope resulting in rework or scope creep due to misunderstanding by the contractor or project manager.

vi) Lack of communication with local authorities resulting in delays in permissions; lack of communication between contractor and client resulting in delay in approval of stages, substandard contract and selection of contractor with inadequate experience or skill sets, optimistic cost and time duration built in the contract.

3.1 STANDARD OF CONSTRUCTION: POINTS FOR CONSIDERATION:

3.1.1 Policy Framework of Indian Railways for NL, DL, GC projects :-

As per the speed policy on Indian Railways, all new line projects track geometry should be planned for the speed of 160 kmph with the opening at MPS of 130 kmph with no new level crossings. For the GC/DL or 3rd line projects, the MPS should be of 130 kmph with no unmanned level crossings (Rly Bd's letter No. 2017/Mobility/2/3 dated 12.06.2018, (Annexure-3.02).
1. Any departure from the speed policy of Indian Railways may be done at the level of CAO/C with a reasoned note for the departure from the speed policy framework (Rly Bd's letter No. 2015/W-1/Gen/Corr/GM Pt dated 06.12.2018, (Annexure-3.02).

3.1.2 Axle Load, Formation and Blanketing:-

The choice of axle load shall govern the planning for bridges as well as formation and rolling stock. The choice should offer better flexibility for running trains with higher axle load, reduced length of the loop lines and higher pay to tare ratio.

The axle load to be considered for the New Line/Doubling and GC projects is 22.5 T except on the DFC and DFC feeder routes where the axle load of 32.5 T has to be considered (Rly Bd’s letter No. 2013-W/Genl/0/30/Pt-II dated 18.12.2019, (Annexure-3.03).

Design of formation and the thickness of the blanket material should be as per the provision of specification for railway formation issued by RDSO for the given axle load. Soil source shall be explored during the survey. As formation design will primarily depend upon the type of the soil being used in construction, it is essential that soil classification and assessment of bearing capacity is done during soil exploration.

Integration with existing Railway network is also an important requirement. Therefore, whatever axle load we adopt after due consideration for integration, costing aspect etc, it should be uniform for the entire corridor i.e. bridges, formation, rolling stock etc.

3.1.3 Over-head Structures:-

To be designed as per MMD proposed for the line keeping in view for double stack container traffic movement if required and also to accommodate wagons with more volumetric capacity etc.

In case of electrification of single line (3rd line in case of three lines), provision of additional line should be kept in mind while executing the electrification project. Thus, alignment of doubling project and yard plans of yards should be prepared and approved in advance. Further layout of OHE for electrification project should be decided on the basis of these approved plans and alignment (Rly Bd’s letter No. 2017/W/-/Genl/NL-RE dated 27.01.2017, (Annexure-3.04).

3.1.4 Level Crossings and ROB/RUB works:-

As per Para 901 of IRPWM, as far as possible, new level crossings may not be located in busy station yards where heavy detention to the road traffic and other operational problems are likely to be encountered. If provision of Level Crossing is inescapable, it may be located outside the outermost facing point. For level crossings already located within busy station yards affecting Railway operations and causing heavy detention to the road traffic, efforts should be made to replace them by Road Over/ Under bridges as per extant rules or shift them outside the outermost facing points, especially during planning of gauge conversions, yard remodeling and doubling and its operation from cabin should be possible. Guideline for construction of bridges during doubling is attached (Annexure 3.11).

Elimination of level crossings may exponentially increase the cost of the
project and thus making a project un-remunerative due to increase in the land acquisition, quantity of earthwork, barrel length of bridges etc. Thus, in case of New Line projects where rate of return is less than 10%, ROB/RUB/LHS may be provided only where the formation height permits else interlocked level crossing can be provided (Rly Bd’s letter no. 2019/W-1/Genl/Land-LC dated 10.06.2019 (Annexure-3.05).

In case of Doubling and GC projects, elimination of all level crossings may not only lead to cost overrun but also time overrun, thus the project should be so planned that it does not get delayed for eliminating all level crossings (Rly Bd’s letter No. 2013/W-1/Genl/O/30 Pt-II dated 10.10.2019 (Annexure-3.06 & 3.12)

Problem of drainage and construction methodology for RUBs should be properly studied and addressed at planning stage itself.

### 3.1.5 Track Center and Geometry of Track:

Minimum distance between the tracks should be as per the latest instructions issued by Railway Board or as enumerated in IRSOD. It should be ensured that reverse curves are avoided in the vicinity of bridges (at least up to 100m on either side of bridges). Reverse curve should be avoided in approaches of yards also.

Degree of the curvature should be provided as per latest Railway Board guidelines, speed policy framework of Indian Railways or as enumerated in IRSOD as applicable. Currently on the New Line projects, limiting degree of curvature is 1 degree whereas on Doubling or GC projects, limiting curvature should be such that the MPS of 130 kmph can be achieved (Rly Bd’s letter no. 2013/W-1/Genl/0/30 Pt-II dated 28.05.2018, (Annexure-3.07).

Further the Centre line distance between the tracks is directly linked to land acquisition in case of new line projects and has direct bearing on the cost of the project as well the time frame for the completion of the project. In case of Doubling or 3rd/4th line projects, existing utilities (OHE masts/portals etc) also guide the decision of track distance for additional tracks. Existing ROBs, FOBs, OHE installations, existing major bridges or abandoned substructure of major bridges and many other obligatory points have to be considered with due diligence to arrive at most optimum track center distance in case of Doubling/Tripling/Quadrupling projects.

### 3.1.6 Distance between Stations:-

It will be desirable if stations are located at a distance as per operational requirement, in New Line project. Innovative solutions for relief during emergencies and totally mechanized maintenance practices may have to be examined in detail before deciding the distance. In doubling, IBS/IBH may be planned to reduce block section if passenger’s requirement or provision of loop lines are not foremost considerations.

In 3rd/4th line projects, integration with existing network should be planned after 3-4 stations (i.e. 30-40 km apart), to avoid large scale yard remodeling. Any exception to this may require approval of Railway Board (Rly Bd’s letter no. 2013/PL/19/1 dated 05.07.2018, (Annexure-3.08).

### 3.1.6.1 Permanent Structures, Platforms and Passenger Amenities:-

Platform and other passenger amenities to be provided while executing NL,
DL or GC project should be as per the norms of the minimum essential passenger amenities. High level platforms and FOBs are now part of MEAs on all categories of stations (Rly Bd's letter no. 2018/LM/P/A 03/06 dated 09.04.2018, (Annexure-3.09). Guideline for platform length at railway stations for new line, guage conversion & doubling projects is attached (Annexure 3.13).

All the fixed structures such as gate lodges, station buildings or other permanent structures should be planned keeping provision for future doubling/quadrupling, yard remodeling etc to avoid dismantling of any of these structures in future. Gate lodges should be provided in staggered manner keeping the sufficient setback distance wherever new gate lodges are being constructed while executing Doubling projects (Rly Bd's letter no. 2013/W-1/Genl/O/30Pt- II dated 12.5.2017, (Annexure-3.10).

3.1.7 Rail section:-

It will be as per the route classification and latest instruction of Railway Board. However, 60 kg UIC 90 UTS with 1640 PSC Sleepers should be the preferred choice.

3.1.8 Ruling Gradient shall be decided based on the terrain.

3.1.9 Mode of Traction:-

Cost economics and ease of operation should decide mode of traction. However, as per extant instructions, all New Line, Doubling and Gauge Conversion Projects are to be executed with electrification.

3.2 PLANNING AND EXECUTION STRATEGY:

POINTS FOR CONSIDERATION:

3.2.1 Magnitude of work involved viz:

a) Land acquisition
b) Ballast Requirement
c) Blanketing Material
d) Rails
e) Sleepers
f) No of level crossings (ROBs/RUBs)
g) Number of Bridges/Linear waterway
h) Value of contracts excluding P-Way material

3.2.2 Project Strategy:
Project completion period should be meticulously decided, keeping in view the quantum of work, availability of construction agencies and other administrative requirements.

3.2.3 **Detailed Project Planning:**

Planning is the most critical activity for any project. It is said that "well begun is half done". Considerable importance should be attached to this aspect. Planning comprises of many aspects as elaborated below:-

3.2.3.1 **Creation of Organization:**

Manpower has to be decided based on the size of the project. More emphasis will be put on laying down systems and documentation rather than round the clock supervision.

An indicative list of field organization required for New Line or Doubling project of 50-75Km, is as under (keeping in view, implementation of e-Office, Digitization of all office records, Project Monitoring through web-application etc):

- Deputy Chief Engineer (1)
- XEN/AXEN (2 to 3)
- SSE (Works and P-Way)(8 to 10)
- Other Staff- JE (W/P.Way), Mate, Artisans, Helper/Trackman (15 to 20)
- Office Support (OS: 01, Clerk: 2, Data Entry Operator: 2 to 3)

3.2.3.2 **Survey:**

This aspect has been covered in detail in the chapter on Survey. However, following aspects should be kept in mind at the time of survey:

1. Identification of the source(s) for earth, ballast and blanketing material as per requirement.
2. Identification of utilities, structures that need to be shifted or dismantled.
3. Rate Analysis for various items of execution with regard to their source(s).
4. Geotechnical studies at bridge and high formation locations.

3.2.3.3 **Experience of NHAI, State PWDs etc:**

NHAI, State PWDs etc are executing almost similar works with similar spread and quantum nowadays. Their experience in acquisition of land, fixing of various types of contract with high value, its success/failures, experience with the consultants, disputes likely to arise during execution,
availability of const. material and agencies, should be collected immediately as this can serve the best benchmark for optimizing our performance in planning and execution and avoiding the pit-falls they have faced.

3.2.3.4 Acquisition of Land:

This is the most critical and tim consuming activity as land acquisition is spread over many states/districts and involves action by multiple authorities. This should be first activity which should be immediately taken up after the project is sanctioned and put on fast track for completion in planning stage. Procedure for Land acquisition has been dealt with, in detail, in the chapter on Land Acquisition.

3.2.3.5 Breaking down of project in workable units/fixing of Zone length:

The Zone length /value should be fixed keeping in mind, type of work, availability of reliable, competent and experienced contractors having expertise of site management, supervision and other logistics. It will be desirable to decide length/reach in such a manner that normally all works in that reach are executed by the same contractor. The value and scope of contract has to be fixed very judiciously for achieving the objective of getting reliable competent contractors who can complete the job in time. Item-rate contracts can be of 2-3 types covering various items of works as under:

1. One package for combined work of earthwork, bridges/ROB/RUBs, blanketing, all buildings (station buildings, relay huts, level crossing structures etc).
2. One contract to be planned for P.Way work covering linking of track, welding of rails, putting of ballast and bringing track to the final geometry etc.
3. One contract for supply of ballast.
4. One contract each for S&T and another for Electrical (Genl) and Electrical (TRD).

Alternatively, P.Way works and ballast supply can be part of formation works at Sl-1 above, with suitable eligibility criteria. Composite tenders can also be planned covering all works listed above.

3.2.3.6 Meeting with probable contractors for various works:

A meeting with various prospective contractors after firming up the expected scenario, will greatly help to know ground situation, market trend and likely constraints in execution of work with respect to proposed scope of work, quantum of important activities and period of completion. Similarly, a meeting with suppliers of cement, steel, rails, sleepers, blanketing material, ballast, projecting schedule of Railway’s requirement of these components over specified time span, will help the suppliers to plan their business as per forecast. Such meetings will help the industry to gear up and upgrade themselves for fulfilling the Railway's requirements in time. Their views will be very helpful in planning the contracts and working
out the realistic time period for completion.

3.2.3.7 Detailed Geotechnical/Earthquake/Hydrological/Geological studies:

These confirmatory studies can form part of the civil works. However, it is presumed that during preliminary studies, sufficient geotechnical investigation will be carried out to enable fixing of proper contracts to avoid major variations during execution.

3.2.3.8 Drawings/Design:

In-house design may or may not be possible for all items. Hence, engaging a consultant can be a better option. However, developing in-house expertise is essential to interact with various consultants to select best available solution. Standard drawings should be followed as far as possible, to expedite pace of execution. All GADs must be finalized in advance and should be available before calling of tenders.

3.2.3.9 Fixing of Eligibility/Qualification Criteria:

The criteria should be such as to have technically competent, experienced, financially sound contractors without compromising on most important aspects of competition and transparency.

3.2.3.10 Preparation of Tender Schedule:

1. Important document for successful execution of project
2. No ambiguity in specification and item description
3. No hidden items/rates for each item asked
4. A clear division of risks—unknown risks may be borne by the client.
5. Performance guarantee clause to be included.
6. Introduction of bonus/incentives and penalty for not achieving various milestones. However, inclusion of this clause requires fixing of realistic time frame and detailed, minute planning for various drawings and decisions to be given to the contractor in time.
7. In case of geotechnical investigation based on preliminary reports, a reference value band can be specified in the tender documents and any variation during actual confirmation, to be borne by the owner. This will save time.
8. Details about what is required to be done by the contractor along with quantum should be clearly brought out so that contractors can bid correctly. The practice of putting everything in specification without giving details, does not serve any purpose.

3.2.3.11 Analysis of Rates:
This job can be done as part of Detailed Engineering Studies. Analysis of rates should take into consideration the following factors:

1. Site specific features like law and order prevailing in the area.
2. Availability of access road, storage facility.
3. Availability of material and other resources.
5. Technical studies.
6. Demand and supply.

3.2.3.12 Variation in prices of Steel, Cement & other material:

Contract document should have provision to compensate contractor for variation in the prices of various input materials like cement and steel, if these are arranged by the contractor.

3.2.3.13 Tender Packaging:

As discussed in para 3.2.3.5, Tender Packaging is decided on the basis of the type of the work, time required for completion, cost, in-house experience and expertise availability besides availability of the contractors for the job to be executed.

Tenders can be of two types:

i) EPC Contract:

EPC contract (Engineering, Procurement and Construction), is a design and built contract where the lumpsum project cost is indicated and the payment is scheduled on the prorata basis according to the predefined milestones to be achieved. The risk of construction and drawings largely shifts to the contractor from Railways whereas Railways guarantees the availability of right of way, forest and other statutory clearances before undertaking the project.

The agency is liable to undertake geotechnical investigation, verifying field data, preparation of GADs, detailed drawings, structural drawings, supply of materials and executing earthwork, construction of bridges, RUBs, ROBs etc.

Railway on the other hand has to ensure the availability of right of way, forest clearance, availability of land free from encroachment, shifting of utilities, approval of GADs, SIPs, ESPs, layouts of buildings, Traffic blocks, planning for NI, Design basis report for the important bridges before floating the tender for the EPC. The quantities have to be estimated accurately to prevent any change in the scope of the work during the execution which has been capped at 10% of the total project cost.

EPC thus guarantees no cost and time overrun and in case of fault on either of the agency or Railways, there is stringent provision of penalty on both sides. The provision of single window monitoring by Railways by creating authority (SAG/HAG grade railway officer who has been entrusted with all the decisions) reduces lot of time in decision making, mitigating the project risk and shifting the same on to the contractor for both design and
construction aspect. The defect liability period has also been enhanced to two years.

As per the Railway Board's order, all the new line, doubling, important colonies work, important bridges etc having the project cost of more than Rs 100 Cr should be undertaken through EPC route and any deviation for the same requires the personal approval of GM.

ii) **Item Rate Contracts:**

In these types of contracts, detailed design and drawings are prepared in advance and contractors asked to quote the rates. The rates may be quoted as % above or below the base rate for the schedule as a whole or alternatively, the rates may be asked as % above or below against each item on base rates given. In no case, absolute rates should be asked for.

However, owner in this case is deprived of the latest state of the art technology in design and construction methodology.

3.2.3.14 **Fixing of Contracts:**

1. Eligibility/qualification criteria
2. Defining work of similar nature
3. Availability of experienced and reliable agencies in that field
4. Time for completion
5. Two packet System

Each of the above aspects are discussed in relevant chapter on Tenders and Contracts.

3.3 **QUALITY CONTROL AND ASSURANCE:**

Quality control and assurance means execution of each specific component of the project (i.e. earthwork, blanketeting, ballast, track laying, RCC, building work etc.) in time bound and recursive manner, complying with laid down quality standards and identifying ways to eliminate cause(s) of unsatisfactory performance.

Contract document must mention clear, complete, and accurate description of the standards and specifications to be followed for each component of the project, facilities to be developed by agencies either in the project area or through the third party and the documentation to be ensured and preserved while undertaking the inspections and tests for each component.

For having an effective and well-documented quality control and assurance plan, following basic elements of a Quality Control and Assurance Plan must be adhered to:

3.3.1 **Quality Control Organization:**

There must be a well-structured organizational set-up, both for the Railways and the agencies to undertake various inspections and conduct tests. Personnel engaged by the agency for undertaking the quality control should be qualified (such qualification should be part of the tender document). Duties and
responsibilities of such personnel should be well-defined in QAP. Training may be imparted to engineers of various stakeholders to ensure the quality of construction.

3.3.2 Quality Assurance Plan:

Onus for proving quality work done rests with the contractor, i.e. contractor will be required to prove and establish with the help of the documentation of various tests, procedures etc. that quality work has been done. There should be a well-documented quality audit plan comprising of:

a. Standards, Specifications and Method Statement for each component of the Project.

b. Inspection, Test Plan and Periodicities to be mentioned.

c. Check lists to undertake Inspections and Tests duly mentioning the limits and tolerances for each parameter.

d. Undertaking Field inspections and Tests: Series of inspections on each component of the project should be undertaken as per the protocol mentioned in QAP duly following the relevant codes and specifications. For undertaking each inspection, check list should be prepared as part of QAP which provides objectivity to inspections and tests as well as standardizes the whole process of quality assurance.

e. Quality Documentation and Audit: Each test carried out as per QAP should be audited to ensure that non-compliance is ruled out. Each test should be well documented to create and audit trail for future references.

f. Availability of all relevant codes and manuals.

g. Training of all officers and staff associated with the Project.

3.4 PROJECT MONITORING AND CONTROL:

Each construction project involves many uncertainties viz. availability of labour, machinery, monsoon, right of way, budget etc. Project Monitoring and Control thus becomes an important aspect of construction management. Project Monitoring includes observing and checking the progress of the project to ensure compliance with project scope, timeline, and deliverables and schedules whereas Project Control is measuring such progress by comparing and contrasting actual progress with project plans and schedules and taking corrective action as required. For ensuring the effective project monitoring and control, following aspects are important:

1. Objective of the project and each component of the project defining specific and measurable goals.

2. Schedule for the start and the end of each goal to be defined for every component of the project.

3. Sequencing: Each component of the project should have a defined sequence of execution correlating it with previous, forthcoming or parallel activities.

4. Size and Nature of Task: Clearly defining the task in terms of the
measurable units like cum, m, days etc.

5. Resources: Requirement of resources in terms of Money, Manpower and machinery for successful execution of each goal.

6. Controlling Cash flow: Controlling the cash flow for the execution including maintaining a healthy billing cycle.

7. Information and Control Systems: Well-established system should be in place to relay the information of progress in terms of the measurable units, expenditure incurred, constraints faced etc.

GANTT and BAR charts are basically two-dimensional charts depicting activity on Y axis and time on X axis, thus giving a most simplistic overview of the progress of each activity vs stipulated progress. On the basis of these charts, resource planning and augmentation can be done to achieve the stipulated progress of various activities. But nowadays, various software are available for project monitoring and control which help Project Manager to take a balanced view based on the data provided in terms of aforementioned seven points. Most of these tools analyze the project in terms of CPM or PERT and produce GANTT or BAR chart for easy appreciation and monitoring of the project. These software help in developing a proper project scheduling and monitoring thus guiding on resource deployment schedule and optimization to achieve the desired task. Use of the project monitoring tools also helps in avoiding the clash between various activities and helps the manager to take balanced decisions. Such tools thus prove cost effective by avoiding rework and optimizing the available resources. TILOS, Microsoft Project and Oracle Primavera are few modern project monitoring software.

Project Monitoring also involves preparation of Cash Flow chart, details of interfacing requirements of drawing, design, interaction with other departments/division, fixing and ensuring bill cycle in consultation with contractor, monthly presentation on project execution by top management of the contractor, availability and scheduling of resources viz men, machinery & material and prompt decision on technical/design issues cropping up during execution.

Success of timely completion of project depends upon team work and contractor is an important part of team. Bottlenecks likely to be faced by contractor should be identified in advance, ahead of problems, not behind. Cash flow with the contractor should be ensured. Regular meeting with consultants and contractors greatly helps in providing corrective inputs at right time.

3.5 CONTRACTOR MANAGEMENT:

1. Success of timely completion of Project depends upon team work. Contractor is an important part of team.

2. Identify bottlenecks in advance which contractor is likely to face ahead of problems not behind.

3. Cash flow problems with the contractor and its solutions.

4. Optimization of methodologies and procedures for better output.

5. Decisions to be given to the contractor as early as possible for better management of problems.

6. Regular meeting with consultants, contractors for corrective inputs at right
time.

3.6 IMPORTANT INGREDIENTS OF ANY SUCCESSFUL PROJECT EXECUTION SCHEME:

1. Availability of Land
2. Availability of Fund
3. Prompt Decision making use of standard details
4. Endeavour to make the contractor successful
5. Proper documentation for Safety, Quality and Payment
6. Instructions for error free execution for doubling projects has been issued vide Dos & Don'ts for doubling works issued by HQs office K.Gate is attached as Annexure-3.01.

3.7 Annexures:

(i) Annexure-3.01- Do's and Don'ts for Doubling Works in Railway Projects.
(ii) Annexure- 3.02- Speed policy framework for Indian Railways.
(iii) Annexure-3.03- construction of formation for Doubling on DFC feeder routes.
(iv) Annexure -3.04- planning of OHE Layout While Executing Electrification work on single line sections.
(v) Annexure -3.05 -Level crossing on new line projects
(vi) Annexure -3.06 -Elimination of level crossings in Doubling Projects.
(vii) Annexure- 3.07- Degree of curvature for new projects of New Line, Gauge conversion and Doubling and Level Crossing in New Line.
(viii) Annexure- 3.08- policy guidelines-Execution and Alignment of 3rd line projects.
(ix) Annexure- 3.09 -Comprehensive instructions for provision of passenger Amenities and user facilities at station.
(x) Annexure- 3.10- Provision of Fixed structures in New Line/Gauge conversion projects and setting of Gate lodges, station buildings etc. alongside the existing track.
(xi) Annexure- 3.11- construction of bridges during doubling.
(xii) Annexure- 3.12- Removal of unmanned and non-interlocked level crossings by way of construction of RUB/LHS.
(xiii) Annexure- 3.13- Platform length at Railway stations for new line, gauge conversion and doubling projects.
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<th>Sl</th>
<th>Activity</th>
<th>DOs</th>
<th>DON Ts</th>
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<tr>
<td>1</td>
<td>Survey</td>
<td>1. Fix reference points and benchmarks before start of work.  &lt;br&gt;2. Mark all such points in the field, duly numbered.  &lt;br&gt;3. Ensure indication of such reference benchmark/ points on all the drawings being prepared for the work (Index plan, L-section &amp; Bridge GADs etc.). These shall be noted in dairies/ book of field staff also for ready reference.  &lt;br&gt;4. Carry out survey of area including centre line of all existing tracks, footprint of all structures along with their height using these points.  &lt;br&gt;5. All instruments shall be calibrated at start of work and further got calibrated periodically during the progress of work.  &lt;br&gt;6. Note down all track data including curve data (TP, Super elevation, Degree, versines etc.), gradients, turnout layout parameters etc.  &lt;br&gt;7. Pick up data of all road/ rivers/ canals/ drains/ lines etc crossing the track upto required distance on either side of existing railway track.  &lt;br&gt;8. For existing ROBs, pickup location &amp; size of all piers within railway land and soffit level of spans (with reference to existing tracks).  &lt;br&gt;9. For existing RUBs, check availability of span/box provided for future line. If available, note down its location wrt to existing track as it will be obligatory point.  &lt;br&gt;10. Note down all utilities crossing the track/ running parallel to track along with their depth (Reduced Level).  &lt;br&gt;11. Collect data of all signal, electrical cables running parallel/ across the track.  &lt;br&gt;12. Note down feasibility of rising/ lowering of track at each such crossing.</td>
<td>1. Commence survey work until reference points and benchmarks have been established in the field.  &lt;br&gt;2. Disturb reference marks during course of work.</td>
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13. Carry out survey of all bridges. Note down minimum track centre at which new bridge can be made considering infringement to existing foundations and feasibility.
14. Collect hydraulic data for all bridges from existing records, markings on bridge etc. Canal data can be taken from state authorities.
15. Carry out discharge calculation for those bridges for which discharge is not available.
16. Collect data of all bridges in upstream and downstream for all major streams.
17. Prepare detailed survey plan showing all above noted details.
18. Wherever, ROB have not been proposed/ sanctioned, survey shall be carried out for elimination of level crossings by diversion/ LHS/ RUB.
19. Upgradation of level crossing, wherever justified on TVU, may be planned where RUB/ LHS is not feasible and ROB not sanctioned.

Fixing of alignment

1. Mark all obligatory points on survey plan.
2. Plan new track on side where railway land is available. Attempt to keep track on same side of existing track in long patches to minimize cut connections.
3. Mark location of cut connections.
4. Mark new line at minimum track centre as per schedule of dimensions/ IRPWM/ Engineering code from nearest existing track.
5. Mark proposed track at minimum track centre line on all bridges. Highlight locations where deviation from minimum track centre is unavoidable as per available site data.
6. Reconfirm data for all such locations.
7. Plan work with sheet pile, if required, to avoid reverse curves.
8. Attempt should be made to fix proposed alignment at locations of deviation in alignment without providing reverse curve by shifting curve.

1. Raise the track wrt existing track unless unavoidable.
2. Provide reverse curve unless unavoidable.
3. Provide excess length of loop lines.
4. Provide turnout in transition of curves.
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<td>9.</td>
<td>Reverse curve, if unavoidable, shall be provided after personal approval of CAO/C, submitting detailed justification and options exercised to avoid the reverse curve.</td>
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<tr>
<td>10.</td>
<td>Calculate curve data for all curves along with speed potential. Speed potential shall not be less than proposed sectional speed.</td>
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<td>11.</td>
<td>Attempt to ease existing curves during doubling work without involving land acquisition, if possible, while fixing new alignment.</td>
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<td>12.</td>
<td>Mark all turnouts on survey plan.</td>
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<td>13.</td>
<td>Carry out layout calculations for each layout.</td>
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<td>14.</td>
<td>In case of major bridges, if well foundation is planned, minimum distance between centre lines of exist and proposed track shall be D1 + D2 (D1 dia of exists well &amp; D2 dia of proposed well).</td>
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<td>3</td>
<td>Fixing of Gradients</td>
<td></td>
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<tr>
<td>1.</td>
<td>Proposed track shall be planned mostly at same level as for existing track, especially at all level crossings.</td>
<td>1. Provide turnout in steep gradient violating the SOD.</td>
</tr>
<tr>
<td>2.</td>
<td>Deviations may be made at bridges where clearance is less.</td>
<td>2. Provide crossover in lines at level difference without detailed layout calculations both for layout and gradients.</td>
</tr>
<tr>
<td>3.</td>
<td>Deviations in level from existing track, if required and unavoidable, should be done with personal approval of CAO/C submitting full justification.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Mark all turnouts in section also to ensure that there is no change of gradient within turnout zone.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Wherever, crossovers are provided in curve, speed potential for all lines shall be workout to ensure speed potential of section.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Marking of alignment</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Prepare Index plan and L-section. Mark all reference points in the drawings.</td>
<td>1. Work from primary reference points for long distances.</td>
</tr>
<tr>
<td>2.</td>
<td>Establish secondary reference points from primary reference points for actual working.</td>
<td>2. Do not start work unless foot by foot survey has been carried out after marking of centre line.</td>
</tr>
<tr>
<td>3.</td>
<td>Regularly check the working bench marks with reference bench mark as work progresses.</td>
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</tr>
<tr>
<td>5 Embankment/ Cutting</td>
<td>1. Survey area for importing of earth for embankment and its quantity and quality. 2. Use good soil in embankment (SQ-2 or SQ-3) 3. Provide turfing of local fast growing grass/ shrubs/sarkanda etc. having deep roots for protection of embankment against soil erosion. Protection shall be carried out along with progress of earthwork. 4. Breast wall shall be provided in cutting in place of retaining wall being economical. 5. Avoid drain between tracks by providing proper cross slope in formation. In curves, attempt shall be made to continue existing cross slope in bank to ensure proper drainage of both tracks. 6. Drain size, wherever provided, shall be finalised based on rainfall and catchment calculations. Drawing of drain (preferably using lining only) shall be prepared and got approved from HQ before execution. 7. Blanketing should be provided to minimum after studying the behaviour of existing formation. 8. If SQ1 soil is encountered in formation in cutting, top 300 mm SQ1 soil layer shall be replaced with good earth.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Use SQ-1 soil in embankment without approval of CAO/C. 2. Provide drain/ walls without approved drawing of HQ.</td>
<td></td>
</tr>
</tbody>
</table>
### Bridges

1. Bearing capacity shall be assessed in the beginning for economic planning and informed decision making.
2. For bridges smaller than 1.0 m span, provide minimum 1.0 m span.
3. While deciding spans of major streams, due consideration shall be given to development since construction of existing bridge, e.g., taking out of canal/ construction of barrage/dam etc in upstream, change in habitation pattern, change in land use etc.
4. Data of all bridges constructed in upstream and downstream of major bridges shall be given due consideration while finalising the span configuration. As far as possible, provide same span/type and height as in existing bridge.
5. Check clearance and free board of existing bridge and workout raising, if required.
6. Provide flexible pitching for abutment/ guide bund protection only up to freeboard (1.0 m) above HFL.
7. New bridges upto 24.4 m span shall be planned with ballasted deck unless unavoidable.
8. Open foundation shall be preferably be at same level as is exists bridge.
9. For providing deep foundation approval of CAO/C shall be obtained as per railway board letter.

### Structures

1. Carry out condition assessment of all affected structures.
2. Existing structures in good condition (buildings, FOBs etc.) shall be utilised to the extent possible. Suitable alterations may be carried out.
3. If new structures are to be provided, it shall be as per approved type plan. If no type plan is available, new plan may be prepared with facility level as per norms.

### Additional Notes

1. Provide box only to avoid raising of track due to clearance requirement.
2. Provide box in downstream of existing bridge.
3. Provide box in river streams.
4. Provide box on filled up earth.
5. Provide grouted/ rigid pitching.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No. 2017/Mobility/2/3

General Manager, All Indian Railways/PUs, NF (Const.), CORE
DG/RDSO/Lucknow, DG/NAIR
CAOs, DMW/Patiala, WPO/Patna, COFMOW/NDLS, RWF/Bela, CAO/IROAF
Director-IRICEN, IRITM, IRIMEE, IRIEEN, IRITM, IRISET
CMD/MD of all PSUs

Date: 08/06/18

Sub: Speed Policy framework for Indian Railways

With a view to achieve goals of Mission Rahaar by 2022, a comprehensive review of various speed raising initiatives has been done by the Board. It has been noted that benefit of many such speed raising initiatives has not been fully realized as initiatives taken by various departments/ zonal railways were not in sync thus restricting the maximum permissible speeds by the most limiting factor.

In order to align various speed raising initiatives, Board has now approved following speed policy framework:

- GQ and Diagonal routes (and any other identified routes) should be upgraded seamlessly for speed potential of 160kmph.
- All other remaining routes on BG network should be upgraded seamlessly for speed potential of minimum 130kmph.
- For speeds above 160kmph, only exclusive corridors should be considered. Such corridors could also be considered on PPF mode.
- Speed upgradation initiatives should be taken on route wise basis keeping all inputs of fixed infrastructure (track, signalling, OHE etc.) and rolling stock (coaches, locomotive) in sync with the targeted speed potential of that route.
- For new line construction, track geometry should be for 160kmph and minimum MPS on opening should be 130kmph. There should be no level crossings on new lines. For Gauge Conversion/ Doubling/ 3rd line etc. minimum MPS should be 130kmph with no unmanned level crossings.

Zonal Railways may take appropriate action for compliance.

This issue in supersession of all previous instructions on this subject with the approval of the competent authority.

(Naveen Kumar Shukla)
PED(Mobility)

1. PS to MR, PS to MOS(S), PS to MOS(G); OSD/MR
2. For kind information of CRB, FC, ME, MTR, MS, MT, MRS, Sacy, DG(S&T), DG(Stores), DG(Pers)
3. All AMS & PEDs Railway Board: To take action for harmonizing their respective policy letters, codes and manuals in accordance with the above policy framework
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No. 2015/W-I/Gen/Corr.GM/Pt. New Delhi, dt. 06.12.2018

General Manager, All Indian Railways/PUs, NF (Const).
CAO/Conv., All Indian Railways.

Sub: Speed Policy framework for Indian Railways.

Ref: Railway Railway’s letter No. 2017/Mobility/2/3 dated 08/12.06.2018.

1. Following policy guidelines regarding New Line, Gauge Conversion and Doubling were issued vide Railway Board letter mentioned above:

“For new line construction, track geometry should be for 160kmph and minimum MPS on opening should be 130kmph. There should be no level crossings on new lines. For Gauge Conversion/Doubling/3rd line etc. minimum MPS should be 130kmph with no unmanned level crossings.”

2. Representations have been received in Railway Board from different Zonal Railways regarding adopting these instructions due to problems of land acquisitions near the existing lines for flattening of curvature in case of DL, 3rd line projects. Further there will be time and cost overrun for EBR funded as well as NL projects in case these instructions are strictly adopted.

3. Matter has been deliberated in the Board and it has been decided that the directions issued vide Railway Board letter mentioned above should be treated as a policy frame work only. Each case may be examined on its own merits and CAO/C may take a reasoned decision for departure from Policy frame work. Clearance of Plans and estimates should not be delayed once CAO/C has taken a decision.

4. This has the approval of Board (ME, MT, FC and CRB).

(B.K. Gupta)
Executive Director/Proj. M
Tele/Fax: 911-23388236, Rly. 44325

Copy to:
1. For kind information of CRB, FC, ME, MTR, MS, MT, MRS, SECY, DQ(S&T), DQ(Stores), DQ(Pers).

2. All AMs, PEDs, Railway Board, Rail Bhavan.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

New Delhi, dated 18.12.2019

General Managers,
All Indian Railways.

Sub: Construction of formation for Doubling on DFC feeder routes.

The issue of loading standards to be considered for construction of formation for doubling work on DFC feeder routes has been under consideration. As per existing instructions (GE:G-0014 of Nov '99), formation specification for New Lines/Doubling/GC works to be carried out on JR have to be kept for 25 T loading standards. However, the instructions are not explicit about loading standards to be considered for formation specification on the DFC feeder routes.

* Now Board (ME) has approved that construction of formation for Doubling on DFC feeder routes should be for DFC loading standard (32.5 T Axle Load). These instructions will apply for all new doubling works on DFC feeder routes wherever detailed estimates is yet to be sanctioned.

(Pankaj Kumar)
Dir./Works-II
Railway Board
Ph (Rly.): 030-43574,
Ph: 011-23070944

Copy for information and necessary action to:

1. Chairman & Managing Directors,
RVNL, IRCON & RITES

2. Chief Administrative Officers (Const),
All Indian Railways
Sub: Planning of OHE Layout While Executing Electrification Work on Single Line Sections.

A large number of electrification works are being sanctioned on single line sections. In most cases, doubling of the line has also been sanctioned simultaneously. Even in those cases where doubling has not been sanctioned, the same is inevitable in near future, looking at the importance and traffic density of those single line sections.

In cases where Electrification work has been carried out for existing single only, it is noticed that proper planning to take care of future Double Line is not being done. A careful planning will reduce lot of OHE modification work in yards, as also in mid section, during Doubling.

A number of portals are being erected in yards with the existing 3 lines of a single line section at the time of Electrification. If these portals are provided with a future four line yard in mind, taking into account the future passenger platform which will come on the fourth line, lot of efforts during doubling will be saved. This will save lot of cost also as a large number of existing OHE Portals are to be dismantled and new Portals being provided to accommodate the new four line yard during doubling.

In most cases, even the alignment of future double line in mid-section is not being taken care of. As a result, large number of Power Supply Installations like Sectioning Posts Sub-sectioning Posts and Sub-stations require shifting to make way for the new double line.

It has, therefore, been decided that whenever a Electrification Project is sanctioned on a single line section, alignment of the future double line shall first be decided. Yard Plans for the double line section shall also be prepared in advance and got approved. The Layout plans of OHE shall be developed based on these yard plans and alignment of the new double line so decided.

In cases where railway electrification of existing single line is sanctioned as one work while doubling along with electrification of new double line is sanctioned as a separate work, electrification of both lines shall be executed by one agency only. Board’s RE and Works Directorates will jointly decide the executing agency. Aspects brought out above shall be properly taken care of by the executing agency in such cases.

Additional Member (Works)  
Additional Member (Electrical)
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2019/W-1/Genl./Land-LG

New Delhi, dt. 10.06.2019

General Manager,
All Indian Railways.

Sub:- Level Crossing on new line projects

Ref:- 1) Board’s letter No. 2006/CE-IV/LX/WP/1 dt. 09.01.2012
2) Board’s letter No. 2013/W-1/Genl./O/30 pt-II dt. 18-06-2013 &
3) Board’s letter No. 2013/W-1/Genl./O/30Pt-II dt. 11.09.2015.

It has been noted that as a consequence of Railway Board’s policy to have no level crossings on new line projects, the bank height has gone up leading to increase in land acquisition earth work having considerable financial implication. Many new line projects unremunerative to begin with, have become unaffordably expensive, as land cost itself constitutes 30 to 50% of the project cost.

With objective of keeping the project cost to the minimum, Board (ME,MT,FC and CRB) it has been decided that:

For all new line projects under execution/ sanction and under sanction on Socio-economic grounds with Rate of Return less than 10%, it is proposed to provide level crossings as interlocked LCs in the estimates instead of LHSs/RUBs to minimize the project cost by reducing land acquisition and formation cost. RUB/ROB can be provided to eliminate level crossings if the formation level permits its construction without raising or lowering the formation level specifically to accommodate them and with no extra land acquisition.

All new line projects where land has not been acquired should also be thus reviewed with immediate effect with overall objective of reducing the project cost.

(B.K. Gupta)
Executive Director (Proj. Monitoring)
NO. 2013/W-I/GenL./O/30 Pt.-II

New Delhi, dt. 10.10.2019

The General Managers,
All Indian Railways.

The CMDs,
RITES, IRCON & RVNL.

Sub: Elimination of level crossings in Doubling Projects.

Ref: (i) Board’s letter no. 2006/CE-IV/LX/WP/1 dated 09.01.12.
(ii) Board’s letter no. 2013/W1/Genl./O/30 Pt.-II dated 18.06.13 & 11.09.15.

Instructions have been issued for elimination of level crossings vide Railway Board letters under reference.

It is noted that commissioning of doubling is getting delayed due to insistence by Railways to first eliminate the manned LCs, with the result, the relief in line capacity is also getting delayed. Railways to ensure that no doubling gets delayed for want of elimination of Level Crossings. It may be better to commission doubling first and do elimination later on in second phase.

This has the approval of Board (ME).

(B.K. Gupta)
Executive Director/Proj. M
Railway Board
Tele/Fax: 011-23382366
& Rly. 44325

Copy to:
Chief Administrative Officers (Const.),
All Indian Railways.
The General Managers,  
All Indian Railways.

Sub: Degree of curvature for new projects of New Line, Gauge Conversion and Doubling and Level crossing in New Line.

Ref: i) Board’s letter of even number dated 04-05-2018.

Please refer to Board’s above referred letter dated 04-05-2018 in connection with degree of curvature for new projects of New Line, Gauge Conversion and Doubling. In view of earlier issued instructions on the subject vide letter No. 2014/CE-II/TSC/1Pt-I dated 08-09-2016, the Para (i) may be modified as under:

(i) Except for projects of hilly terrain, new sections may be designed for a speed of 160 kmph with limiting curvature of 1° (one degree).

Regarding level crossing on new line, Board (ME) has decided that “Introduction of Level Crossing either Manned or Unmanned will require Board’s approval”

Zonal Railways are advised to follow the above guidelines while designing new sections.

(B. K. Gupta)  
Exe. Director (Proj. M)  
Railway Board
Annexure-3.07/1

No. 2013/W-1/Genl./0/30 Pt-II New Delhi, dt. 04.05.2018

The General Managers,
All Indian Railways.

Sub: Degree of curvature for new projects of New Line, Gauge Conversion and Doubling.

Issue of Degree of curvature for new projects of New Line, Gauge Conversion and Doubling has been deliberated in Board. It has been decided that:

(i) Except for projects of hilly terrain, new sections may be designed for a speed of 160 kmph with limiting curvature of 1.4°.

(ii) In Doubling, 3rd & 4th line projects which are essentially sanctioned for decongesting the route, the existing standards may be allowed to continue. A policy directive to this effect has already been issued by Railway Board’s letter No. 2015/W-1/Genl./Corr.GM/Pt. dttd. 29.11.2017.

(iii) Gauge Conversion projects should be planned for 100 kmph except in hilly terrain, where case to case basis decision can be taken.

Zonal Railways are advised to follow the above guidelines while designing new sections. This has the approval of Board (ME).

(B.K. Gupta)
Executive Director/Proj. M
Railway Board
Tele/Fax: 011-23388236
Rly. 44325
The General Managers,
Central Railway, Mumbai.
East Coast Railway, Bhubaneswar.
East Central Railway, Hajipur.
Eastern Railway, Kolkata.
North Central Railway, Allahabad.
North Eastern Railway, Gorakhpur.
Northeast Frontier Railway, Malegaon.
Northern Railway, New Delhi.
North Western Railway, Jaipur.
South Central Railway, Secunderabad.
South Eastern Railway, Kolkata.
South East Central Railway, Bilaspur.
Southern Railway, Chennai.
South Western Railway, Habil.
West Central Railway, Jabalpur.
Western Railway, Mumbai.

R.No.258, Raisina Marg,
Rail Bhavan, New Delhi - 110001.

Dated 05.07.2018

No.2013/PL/19/1(Policy)

Sub: Policy Guidelines - Execution and Alignment of 3rd line Projects.
Ref: 2013/PL/19/1(Policy) dated 30.09.2013 and 10.06.2015.

In reference to above, it is reiterated that in case of construction of 3rd line, it
should be bi-directional and on one side of the existing double line. Integration of
3rd line with existing double line should be at a distance of 30 Kms or so or after 3-4
stations so that the large scale yard remodelling are avoided and project is
executed with ease without long duration of non-interlocked working. Rest of the
instructions will be the same as communicated earlier vide references above.

(Executive Director/Planning)

Tele/Fax: 011-23383354
Rly. 030-43424

Copy to: PGMs & CTPMs of All Zonal Railways.
Government of India
Ministry of Railways
(Railway Board)

No. 2018/W-I/Genl./Policy

New Delhi dt. 31.05.2018

Chairman & Managing Director,
RVNL, RITES & IRCON

General Manager,
All Indian Railways.

General Manager/Const.,
Northeast Frontier Railway,
Guwahati


Ref: Board’s letter No. 2013/PL/19(Policy) dt. 05.07.18.

Please refer to Board’s letter under reference wherein policy guidelines for execution and alignment of 3rd line projects was issued.

In this connection Board (CRB) has further issued directives that “Please ensure that these are being followed. Exception would need CRB’s approval.”

(S C Jain)
Executive Director/Works
Railway Board

Copy to:

(i) AM/Plg, AM/Traffic
(ii) Chief Administrative Officer/C, All Indian Railways – for information.
(iii) Principal Chief Operations Managers, All Indian Railways – for information.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

RB/L&A/02/2018

No. 2017/LM (PA)/03/6

New Delhi, dt. 04.09.2018

General Managers,
All Indian Railways

Sub: Comprehensive instructions for provision of Passenger Amenities and user facilities at Stations.

Railway Board had constituted a Committee of Executive Directors to review the norms for provision of passenger amenities. The terms of reference of the committee included a review of the norms for provision of Passenger Amenities viz., minimum essential, recommended and desirable amenities at stations prescribed vide Board’s letters no. 2012/LM[PA]/3/5 dated 11.09.2012, in view of the changing requirements and technological improvements in the country and suggesting measures for improving amenities for passengers, general cleanliness and ambient conditions at stations. The categorization of stations and details of minimum essential, recommended and desirable amenities are enclosed as Annexure I to V.

2. Accordingly, the Committee examined in detail the existing amenities provided at stations and reviewed the extant instructions w.r.t. passenger amenities at stations and submitted the report, which has been approved by Board. Based on this report, revised comprehensive instructions on provision of passenger amenities (enclosed) have been prepared.

3. The scheme of Adarsh stations was introduced in the year 2009. It is considered that there is an urgent need to shift the focus of Adarsh stations from beautification to utility, comfort and cleanliness. Accordingly, revised instructions on Adarsh stations in supersession of Board’s letter No. 2009/TG-IV/10/PA/Adarsh Stations dated 13.08.2013 are being issued separately.

4. These are broad guidelines for providing passenger amenities at stations. However, GMs/DRMs may make need based modification duly recording the justification thereof.

5. Railways are requested to disseminate the contents of the revised Circular (which supersedes the earlier circular issued under Board’s letter No. 2012/LM[PA]/3/5 dated 11.09.2012) widely in the field offices and take necessary action for its early implementation.

[Signature]

1
6. DRMs shall have the full powers to approve such amenities soliciting CSR funds for augmenting passenger amenities in the stations and the same shall be aggressively pursued.

This issues in consultation with the Finance Directorate of the Ministry of Railways.

Please acknowledge receipt.

(Vivek Sena)
Exec. Director (Station Dev. Engg.)
Railway Board

(B. Prashanth Kumar)
Exec. Director (Passenger Marketing)
Railway Board

DA: 29 pages
No. 2018/LM (PA) 3/66
New Delhi, dt. 09.04.2018

Copy forwarded for information to the FA&CAOs, all Indian Railways
Dy. Controller & Auditor General of India, Room no. 224, Rail Bhawan, New Delhi.

For Financial Commissioner / Railways

Copy to: (i) ED/EEM, ED (T&C), ED/Works, Railway Board
(ii) F(X) I, F(X) II, TG-III, TG-IV, LMPA, Electrical (G) Branches, Railway Board
(iii) MD/IRCON, MD/RVNL, MD/RITES
Government of India  
Ministry of Railways  
(Railway Board)

No.2013/W-l/Genl./0/30 Pt.II  
New Delhi dated 12.05.2017

The Chief Administrative Officer (C) and  
Principal Chief Engineers,  
All Indian Railways.

Sub: Provision of Fixed structures in New Line/Gauge Conversion Projects and Setting of Gate Lodges, station buildings etc. alongside the existing track.

In New Line and Gauge Conversion Works, sometimes station building, Gate huts and other permanent structures are being provided without provision of future doubling and associated changes in the yards. This results into dismantling of these structures during execution of doubling and a long period of Pre-NI and NI working.

It is, therefore, decided that yard plans in case of New Lines and Gauge Conversion projects shall be planned with future doubling in mind. Proposed tracks for doubling shall be shown on the plan in broken lines and permanent structures located accordingly.

In case of manning of unmanned level crossing, it is noticed that sometimes gate lodges are being constructed near the track without provision of additional line, which are required to be dismantled at the time of doubling/3rd line to accommodate the additional track.

Therefore it has been decided that whenever a new gate lodge or station building or any other structure is being constructed either as a replacement or as a new structure, these shall be constructed at adequate set back distance to accommodate the new doubling/3rd line. Further, new gate lodges should be provided in staggered manner on alternate side of track.

The above instructions will be applicable for those projects where ESP have not been prepared. Wherever it is not possible to adhere to the above instructions, approval of PCE or CAO(C) shall be obtained.

This is issued with the approval of Member Engineering.

(S.C. Jain)  
Executive Director/Works  
Railway Board
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

No.2017/29/CE-III/BR/Br 588/ECoR

New Delhi, dt 03/08/2017

Principal Chief Engineers,
All Zonal Railways.

Chief Administrative Officers (Construction)
All Zonal Railways.

Sub: Construction of bridges during doubling

On Indian Railways, large no. of works of doubling/3rd line etc. are being executed requiring construction of new bridges parallel to existing bridges. Bridges are to be planned, designed and constructed as per prevailing codal provisions and policy instructions issued time to time. While deciding GAD of the bridge being planned for doubling/3rd line etc., the following may be ensured by railways in order to avoid the excessive scour:

(i) The piers of new bridge are in alignment of the piers of existing bridge. The span arrangement should be decided in such a way that there is free flow of water through spans of old bridge and there is no staggering of piers in water flow area.

(ii) There should be adequate distance between new bridge and old bridge.

(A.K.Singhal)
Executive Director Civil Engg./B&S
Railway Board

Copy for information and necessary action to:

1. CMD/RVNL, RITES, KRCL, IRCON, DFCCIL
2. CBEs/All zonal railways
The Chief Admin. Officer (Con.),
Northern Railway,
Kashmere Gate,
Delhi.

Sub: Removal of unmanned and non-interlocked level crossings by way of construction of RUB/LHS.

Ref: Northern Railway (Construction)’s letter No. 260-WO/W.SPL/ROB, RUB & LC/Pt.III dt. 25.08.2015

Vide Railway Board’s letter No. 2006/CE-IV/LX/WP/1 dt. 09.01.2012 and Railway Board’s letter of even no dated 18/06/2013 guidelines have been issued on elimination of level crossings while executing New Lines, Gauge Conversion and doubling projects. Railways were advised to plan elimination of manned/unmanned level crossings keeping the most cost effective option of providing, to the maximum extent possible, Road Under Bridges (RUB)/LHS. However, removal of unmanned and non-interlocked level crossing assumes importance in doubling projects as retention of the same has safety implication and is definitely an avoidable safety hazard.

Doubling of a section is planned only where the rail traffic is anticipated to increase; therefore, attempts should be made to remove unmanned and non-interlocked level crossings by way of construction of RUB/LHS and charge to respective doubling estimates. In terms of Para No 5 (v) of Railway Board’s letter dated 09/01/2012, this shall not amount to material modification. As regard removal of remaining level crossings, same may be planned by proposing new works under PH-29 & PH-30.

[Signature]
(Anjum Parvez)
Executive Director (Proj. Monitoring)
Tel./Fax: 011-2338 8236

Copy to:
Chief Administrative Officer (Construction), All Indian Railways.
The General Managers,
All Indian Railways.

Sub: Platform length at Railway Stations for new line, gauge conversion & doubling projects.

References have been received in Board regarding provision of high level platforms in New Line, Gauge Conversion & Doubling Projects.

The matter has been considered in Board’s office and following has been approved by Board (ME, MT & CRB):

(i) For all New Line, Gauge Conversion projects, high level platforms should be restricted to the length of longest stopping coaching train, proposed on that New Line/Gauge Converted Line and the remaining portion of the platform should be at rail level to accommodate a 26 coach train.

(ii) For all doubling, 3rd and 4th line projects, high level platforms should be restricted to the length of the longest stopping coaching train at that station and the remaining portion of the platform should be at rail level to accommodate a 26 coach train.

(iii) All loop lines should be of full length of required CSR and the rail level platform provided for 26 coach length should have the required technical clearance for upgradation to high level as and when required.

Zonal Railways should take necessary action accordingly.

[Signature]
(B. K. Gupta)
Executive Director (Proj.M.)
Railway Board
CHAPTER- 4
TENDER PLANNING, CONTRACT & CONTRACT MANAGEMENT

4.1 Tender Planning:

Tender planning includes the following:-

i) Sanction of work.

ii) Scope of work.

iii) Site availability.

iv) Availability of Funds.

v) Availability of Drawing/ESP/GAD

vi) Proper Assessment of quantities.

vii) Bifurcation of zone work.

viii) Sequence of floating of tender.

4.1.1 Sanction of work:

Before inviting any tender for a work, it shall be ensured that work is sanctioned by the competent authority. Tender cannot be floated unless work is sanctioned. If the work is not sanctioned, tender can only be floated with the approval of competent authority i.e. PHOD. If the Detailed Estimate of work which are not sanctioned by competent authority, tender can be floated, in case of emergency, with the approval of CAO/C in terms of para 5.0 of Railway Board's letter No.2017/Trans/01/Policy dated 08-02-2018. (Annexure 4.01). However, their letter of acceptance shall be issued only after sanction of detailed estimate.

4.1.2 Scope of work:

The scope of work shall be in accordance to the sanctioned work.

4.1.3 Site Availability:

At the time of inviting the tenders it shall be ensured the site is available from all encumbrances. In case of New Line/Double Line, Railway should not enter into contractual liabilities unless 70% land has been acquired before the start of work and as stipulated vide Railway Board’s letter No.98/W-I/Genl./O/30/Pt-I dated 03-07-2013. (Annexure 4.02).

4.1.4 Availability of Fund:

Before the process of inviting the tender it shall be ensured that sufficient fund is available for execution of work so that work may not hampered due to paucity of funds. In case of availability of insufficient fund for a particular works, demands for funds shall be raised timely through re-appropriation of funds.
4.1.5 Availability of Drawings:

General Arrangement Drawings shall be approved/ available at the time of seeking approval from Chief Engineer to float the tender and a certificate has to be endorsed in this regard. All the other drawings shall also be available before the start of work.

4.1.6 Assessment in Quantities:

4.1.6.1 Quantities of items involved for the execution shall be worked out carefully.

4.1.6.2 To have proper assessment, the team involved in the preparation/execution of work shall visit the route of construction. The team shall be up to CDM level.

4.1.6.3 The vary purpose to include every member to get acquainted with the site condition.

4.1.6.4 Due care taken at this stage help in reduce number of Addendum/ Corrigendum & need to introduce NS items during execution of work.

4.1.6.5 Delay in the payment is one of the major reasons for the failure of the contract as well as grant of extension of time.

4.1.6.6 Litigation problems can be reduced by prompt decisions.

4.1.7 Bifurcation of zone and work:

Bifurcation of Zone depends upon the length/quantum of work /cost of the work involved. It should be assessed whether sufficient agencies are available which increases the chance of fair competition in the tender process.

4.1.8 Sequence of floating of tender:

1. Tender shall be planned and invited based on priority/Stage & time involved in the completion of work.

2. The scheme for execution of project shall be prepared by Dy.CE/C and got approval from concerned CE/C.

3. The scheme shall include number of tenders, completion period and time schedule.

4. Approval to float the tender shall be taken from the CE/C irrespective to the tender value. Guidelines have been issued from the HQ vide letter No. 74-W/O/WA/Pt-.IXdated 14.2.14 (Annexure 4.03).

5. Tenders can be invited as per the detail given below in the descending order of priority/time involvement.

6. Earthwork including Minor Bridges and Blanketing. Shifting of utilities i.e. Electrical/S&T/Civil etc. be included in this tender.

7. Major Bridges.

8. Misc. Civil Works of platform, circulating area & other passenger amenities work.

9. Station Building and Quarters.


12. P. Way linking work including Welding Work.

4.2 Inviting Tender & formulation of Contract Agreement:

Preparation of tender schedule including N.S. Items

- Type/form of Tender to be invited.
- Notice Period.
- Tender Document.
- Approval to invite tender.
- Publication of Notice in Newspaper & On web site.
- Opening of tender.
- Tender Committee Minutes on IREPS e-portal.
- Negotiation is to be conducted on IREPS e-portal.
- Issue of acceptance letter on IREPS e-portal.

4.2.1 Preparation of tender schedule N.S. Items:

- Preparation of tender schedule is one of the important activities.
- Half job of contract management is over if the tender schedule is prepared carefully & tender conditions are incorporated based on the site requirement.
- Due care be taken while incorporating NS items in the tender schedule. Standard schedule of various works are available in the construction organization.
- NS directory of various items be prepared, which have been introduced during the execution of work.
- Tender Schedule of other units, where work of similar nature has/have been executed shall be studied before finalization of tender schedule. The possibility of introducing the Non schedule item during the execution of work can be minimized to a great extent.
- While preparing the tender schedule it shall be ensured that the average of LARs of similar type of works under similar condition and geographical proximity has been considered.
- Introduction of any item, at the later stage, has to pass through many stages viz. getting Administrative approval, technical check of items, finance vetting, its sanction & incorporating in Addendum/Corrigendum. Lot of time & energy is consumed in these activities which ultimately delay the work.
4.2.2 Type/form of Tender to be invited:
Tender can be open/special limited / limited / single tender based on the works specific requirement. In Construction Organization, in general, open tenders are invited.

4.2.3 Notice Period:
Sufficient notice should be given for the submission of tenders, which in the case of large works should not be less than 21 days. The above prescribed tender notice period may be reduced from 21 days in the exceptional circumstances in consultation with the Principal Financial Adviser. However, for tenders valued upto and including Rs.2 crore invited through e-tendering, the tender notice period can be reduced upto 14 days in consultation with associate finance vide Railway Board’s letter No.2018/Trans. Cell/S&T/NIT Period dated 26-07-2018(Annexure 4.04).

4.2.4 Tender Document:
It shall include:
- Check List of Documents and Covering Note
- Instructions to the Tenderer
- Site data and specification
- Special conditions and GCC
- Tender schedule & Forms of tender
- Scope of work as defined in the tender documents/drawings.

4.2.5 Approval to invite tender:
Approval of Chief Engineer shall be taken before inviting the tender. Proposal for inviting the tender shall be in accordance to the check list issued by the HQ vide letter No. 74-W/O/WA/Pt-V/CP dated 12.03.2012 (Annexure 4.05).

4.2.6 Publication of Notice in Newspaper & On web site:

4.2.6.1 Tender Notice shall be published in the leading newspaper.

4.2.6.2 Tender notice should be crisp and clear in accordance to the HQ letter No. 74-W/O/WA/Pt-IX/internet CPRO dt. 20.01.2015(Annexure 4.06) and Railway Board letter No. 2014/CE-I/CT/O/X/TN dt. 18.06.2014(Annexure 4.07).

4.2.6.3 Tender notice and document shall also be uploaded on www.nr.indianrailways.gov.in

4.2.7 Opening of Tender:
Tender shall be opened on the schedule date time and place as mentioned in the tender document. Tender opening committee consisting two members one each from executive and finance department as nominated. Perspective bidders or their authorized representative can witness the tender opening. Sealed tender box is open by opening committee. Rate of various item of the tender schedule along with technical details and commercial conditions, if any, is read by the opening and also recorded in the register duly signed by the tender opening committee.
4.2.8 Briefing note & Comparative Statement:

Railway Board vide para 2.0 of letter No.2017/Trans/01/Policy dated 08-02-2018(Annexure 4.01) has dispensed with vetting of Briefing Note and Comparative Statement. It has now been decided that all system generated statements from IREPS website, post tender opening are directly seen by tender committee and vetting of CS and vetting of BN is not required for tender committee proceedings.

4.2.9 Tender Committee Minutes:

1. Tender shall be finalized within shortest possible time.
2. Time saved at this stage is time gained for execution of work.
3. Draft tender committee are initiated by Convener member on IREPS e-portal and is communicated among the tender committee members and are finalized on IREPS e-portal only.
4. While finalization the Tender Committee minutes it should be ensured that average of LARs be taken instead of single LAR.
5. Guidelines issued by Vigilance have been circulated vide HQ letter No. 74-W/O/Misc. Corr/WA/CP dt. 9.02.12.(Annexure 4.08)
6. On IREPS e-portal all pages are auto generated machined numbered.
7. Up to date validity of offer shall be mentioned in the top sheet of the TC minutes. Validity of the offer shall be got extended timely if any required.
8. Tender Committee Minutes are discussed on IREPS e-portal among the members and if it is considered that negotiation is to be conducted with the lowest tenderer then letter of offer of Negotiation is also issued on IREPS e-portal only.

4.2.10 Issue of Acceptance letter:

Letter of acceptance is e-generated and issued on IREPS portal. Restriction for increase and decrease in quantity or banning of rates shall also be mentioned in the e-generated acceptance letter. The hard copy of LOA is also taken out for information of all concern.

With the issue of acceptance letter, Tender now termed as CONTRACT.

4.2.11 DOs and DON'Ts on Tender Handling

4.2.11.1 Change in scope of work through Corrigendum/Addendum should be done with adequate notice period to avoid complaints.

4.2.11.2 Tender schedules should be made with great clarity and care, ensuring that

4.2.11.3 Quantity of items to be executed/ supplied or activities/ works for which payments are required to be made are clearly shown along with unit of measurements.

4.2.11.4 Penalty clause, wherever applicable, should be unambiguous about quantum of penalty to be levied for non-performance.
4.2.11.5 While indicating estimated values for NS items based on rate analysis/ LARs, the description of NS items should be unambiguous and if the values/estimated cost arrived at is on the basis of LARs, care may be taken to ensure that no changes in description have been made that gives undue advantage to the bidders.

4.2.11.6 Technical specifications should have clarity and should not limit the competition while ensuring at the same time that the quality is not compromised by relaxing the accepted benchmarks/technical approval.

4.2.11.7 All pages of Master Tender Document should be signed by Tender calling authority and placed on Tender file so that in case of any dispute during execution, particularly with reference to description of work, special conditions of contract, inspection and payment clauses, penalties leviable etc. the same can be referred to.

4.2.11.8 Introduction of any new parameter for evaluation of offers at tender committee stage should be scrupulously avoided.

4.2.11.9 An offer beyond validity is not available. Extension of validity shall be taken well before the stage arrived. In fact finalization of tenders within validity has been reiterated time and again.

4.2.11.10 Deviation from Tender Conditions should be scrupulously avoided while considering offers, both in case of technical and financial eligibility criteria.

4.2.11.11 Eligibility of an offer/Tender should be decided based on the credentials and Constitution of the firm submitted at the time of tender under evaluation and noting the basis of credential supplied by the same tenderer afterwards and/or submitted in some other tender.

4.3 Contract Management:

4.3.1 Kick off Meeting:

Immediately after award of contract, kick off meeting shall be held with the contractor. Detailed Programme shall be charted out in the meeting regarding deployment of men & machinery for the timely completion of project.

4.3.2 Bar Chart Programme:

Bar Chart, QAP & Site Infrastructure including test laboratory and deployment of site engineer as per tender condition shall be insured. Age, shall be asked to submit the Methodology statement.

4.3.3 Quantity variation:

1. Instruction of Acceptance letter shall be closely observed during the execution of work.

2. Quantity of all the items, to be executed, shall be reassessed and variation in quantity and requirement of any new NS item, if any shall be processed immediately so that these may not be the reason of delay in execution of work as well as payment to the contractor.
3. Detailed check list for finance proposal have been circulated from HQ vide letter No. 74-W/WA/24/CP/Feedback dated 23.3.2015(Annexure 4.09). Proposal shall be submitted in the HQ in accordance to the checklist issued as above.

4. Standard proforma for submission of proposal for seeking administrative approval for holding negotiations for quantity enhancement has been issued from the HQ vide letter No. 74-W/O/WA/Pt- X/CP dt. 15.9.2011 (Annexure 4.10) and vide letter No. 74-W/O/WA/24/CP/feedback dt. 14.02.12(Annexure 4.11). Proposal shall be submitted in the HQ compiling the standard proforma.

4.3.4 Introduction of NS item in running contract:

1. NS items, if any required, shall be processed with due care. Care taken while preparing the NS item helps to clear the proposal from finance quickly.

2. It is observed that observation made during technical check is more or less are similar. Requirement of NS items, more or less, remains the same in the similar type of work.

3. While preparing the NS items, already sanctioned NS item of similar nature shall be kept in mind and processed accordingly.

4. Before operating the NS items, administrative approval of Chief Engineer shall be taken.

5. Standard proforma for submission of proposal for seeking administrative approval for sanction of new NS items, holding negotiations for quantity enhancement has been issued from the HQ vide letter No. 74-W/O/WA/Pt.-X/CP dt. 15.9.2011. (Annexure 4.10) Proposal shall be submitted in the HQ compiling the standard proforma.

4.3.5 Performance Guarantee:

1. In case of extension in the date of completion of the work, performance guarantee as submitted at the time of tender shall also be got extended.

2. In case of variation in cost increases beyond 25% of the contract amount, additional performance guarantee amounting equal to 5% for excess value of the original contract shall be deposited by the contractor in term of Clause No. 16(4) d of GCC 2014.

4.3.6 Release of performance guarantee:

1. The performance guarantee shall be released after the physical completion of the work based on the completion certificate issued by the competent authority stating that the work has been completed.

2. The competent authority, to release the performance guarantee shall normally with the authority who is competent to sign this contract but not more than JAG officers.

3. The certificate, inter alia, should mention that work has been completed in all respect and all the contractual obligation have been fulfilled by the contractor and there is no due from the contractor to Railway against the contract concern.

4.3.7 Final Bill & Security Deposit:
1. Final Bill shall be recorded immediately after the completion of work.

2. Final Bill shall be passed after sanctioned final Addendum/Corrigendum duly vetted by the finance.

3. While preparing the PVC bill, care shall be taken to deduct the payment if indices have been decreased from the base period index.

4. At the time of final bill supplementary agreement shall be got signed and no claim certificate shall be taken from the contractor.

5. Security deposit shall be released only after the expiry of maintenance period and after passing of final bill based on the No Claim Certificate.

6. An unconditional and unequivocal no claim certificate shall be obtained from the contractor before release of security deposit.

4.3.8 **DOs and DON'Ts on Contract Management:**

1. It should be ensured that all documents required to be submitted by the Contractor, before starting of work as mentioned in the Tender Document, have been submitted.

2. Copy of Contract Agreement should be available with the site-in-charge/supervisor of the work so as to ensure that work is executed as per the specification of the contract.

3. Initial ground levels should be measured jointly with the contractor before commencing of earth work and recorded in the machine numbered level books. Dates of recording initial and final ground level should be clearly mentioned in the level book.

4. Approval of Competent authority should be taken for variation beyond quantity mentioned in agreement before processing Bill for the same.

5. Final Bill should be prepared on actual measurement of work done at site and not on lump-sum basis.

6. Measurement Book should be properly maintained. It should clearly mention that location of site and items executed.

7. Item/location test checked and date of test check should be clearly mentioned in the Measurement Book. Instructions issued vide R.B. letter No. 97/CE-I/CT/42 dated 04.7.1997 (Annexure-4.12)should be followed. However, for works costing more than Rs. 5 Crores, the condition of Contractors Measurement is made mandatory in terms of para 10.0 of Railway Board’s letter No. 2017/Trans/01/Policy dated 08-02-2018 (Annexure -4.01).

8. Tender clause regarding availability of ‘Completion Certificate’ and ‘No claim Certificate’ should be verified before payment of Final Bill.

9. The ‘exceptional and unavoidable’ circumstances leading to variation of quantity in excess to the Agreemental quantity should be brought on record before processing the contract for variation.

10. Final Bill should not be passed without the sanctioned corrigendum/Addendum.

4.4 **What is EPC:**
ENGINEERING, PROCUREMENT & CONSTRUCTION:

**Engineering** – FLS, Geotechnical Survey, collecting & verifying field data & details, ESP, L-sections, drawings, GADs, structural designs etc.

**Procurement** – Supply of track material, Fittings, S&T and Electrical equipment’s, Cables, Rails, Sleepers etc.

**Construction** – Bridges, Building, Formation, Platforms, Track, Yard work, RUB/ROB etc.

4.5 *Salient Features of EPC:*

1. EPC is design and build contract.

2. Form of Lumpsum contract.

3. Only indicative project cost is given instead of schedule of quantities (BOQ).

4. Pro-ratabased payments.

5. Liberty to contractor for planning & design.

6. Construction risks largely on Contractor instead of Railways.

7. Milestone based targets.

4.6 *Special Advantages of EPC tendering:*

1. No time and cost overruns due to delays in Designs and Drawings.

2. Project risks (commercial & technical) due to design and drawing on contractor’s account.

3. Milestone based payment.

4. Higher defect liability period of two years.

5. Single window monitoring by Railway’s Engineer.

6. Flexibility in efficient designs without compromising on quality and the safety.

7. Delay damages to be paid by both railway and contractor.

8. Special provision for sub-contracting.

4.7 *Railway Board’s milestones on EPC Tendering:*

1. Receiving queries after advertisement (up to 25 days from the date of NIT).

2. 1st Pre-bid meeting (25 days from the date of NIT).
3. Railways Response to queries (30 days from the date of NIT).

4. 2nd Pre-bid meeting (45 days from the date of NIT).

5. Railways Response to queries (60 days from the date of NIT).

6. Last date of request for bid documents (120 days from the date of NIT).

7. Bid due date (120 days from the date of NIT).

8. Physical submission of document (125 days from the date of NIT).

9. Opening of technical bids (127 days from the date of NIT).

10. Declaration of qualified bidders (will be intimated during bidding process.)

11. Opening of Financial bids (will be intimated during bidding process.)

12. Return of signed duplicate copy of LOA (within 7 days of LOA issue).

13. Validity of bid (180 days from bid due date).

14. Submission of performance security (within 30 days of issue of LOA).

15. Signing of Agreement (within 60 days of receipt of LOA).

4.8 Railway Board’s Instructions on EPC tendering circulated vide letter dated 30.12.2019 (Annexure -4.13).

1. New lines, GC works, Doublings, Large colonies, workshops and important bridges should be in EPC mode.

2. In case of deviation from EPC mode for above works personal approval of GM to be taken.

3. In case of major yards, the decision of its exclusion from EPC can be taken by CAO/C.

4. Value of EPC tenders should be more that Rs.100 crore.

5. Scope of work/items to be included in EPC tender to be approved by CAO/C.

   a) Pre-requisites as per Railway Board’s instructions on EPC tendering circulated vide letter dated 30.12.2019.

      i) Approved Drawings/Documents before inviting EPC tenders:-

         • Alignment and longitudinal section of the project.

         • General arrangements Drawings of Important bridges/ Major Bridges/Minor Bridges/ROBs/RUBs/LHSs/FOBs.

         • Design Basis Report for Important Bridges.

         • Engineering Scale Plans (ESPs).

         • Signal Interlocking Plans (SIPs) and Cable Route Plans.
• Layout Plans for Buildings etc.

ii) Shifting of all the utilities through separate agency before calling EPC tender to the extent possible.

iii) Procedure & Timeline for approval of ESPs & SIPs:

• Executing Agencies will request ADRM for proposing Divisional requirements to be incorporated in the Proposed/Existing Yard.

• ADRM will indicate the Divisional requirements in the yards to the Executing agencies within 10 days of receipt of requisition from Executing Agency.

• Division should approve the ESPs within 15 days of submission of ESPs by the Executing agency.

• Zonal Headquarter should approve ESPs within 15 days of submission by Division office.

• Zonal Headquarter should finalize and approve SIPs within 21 days of approval of ESPs.

• For the approval of ESPs/SIPs ADRM will be coordinator at Divisional level and AGM at the Headquarters level.

iv) Method Statement: In case of Doubling /3rd line/4th line, Method Statement and Sequence of working including yard Remodeling should be prepared and got approved from Zonal Railway Head quarter before calling of EPC Tender. AGM of railway will coordinate.

b) Important points to be kept in mind while customising the EPC Tender document.

• DPR should be realistic and if required should be updated duly considering all soft costs applicable to EPC type of contracts. A few such costs are as under:

• Activities related to Estimation of BOQ on the basis of field survey and geo-technical investigations by bidders,

• Design & drawings of all structures involved in the project,

• Supervision of complete work including QA & QC measures and various testing,

• Ensuring various insurances during work and Bank Guarantee,

• Contractor’s funds blocked during execution of work due to various milestones of payment, liabilities including of extended defect liabilities duration,
• Preparation of CRS papers, Completion drawings

• AMC, if any, and

• Contingencies

• Methodology adopted by Railway PSUs i.e. RVNL/IRCON/ROITES for framing DPRs/tenders for execution of Railway works on EPC basis may also be referred.

• The scope of the project needs to be stated holistically and realistically in Schedule ‘B’ and ‘C’ as the same will be the deciding factor for total project cost and subsequent variations leading to change of scope as per Article 13 of EPC Agreement, which is restricted to 10% of the bid price. Effective consultation with concerned departments will therefore be essential.

• For the purpose of price adjustment as per Clause 17.8 of the agreement, the relative percentages of various components of individual activities to be prescribed in the table of Clause 17.8.4(e),(h) and (k) need to be determined carefully and diligently on the basis of past experience and also considering special features of the project.

• The contract price weightage for various activities to be prescribed in Schedule ‘G’ should be determined realistically on the basis of detailed estimate of the project prepared with proper due diligence.

• The agreement provides for damages for delays on account of Authority i.e. Railways @ 0.2% of the performance security for each day of delay as per Clause 10.2.6, it is, therefore, essential to sensitise concerned officers and staff about time-bound decisions/processing of case related to EPC contract and establish an effective Management Control System to ensure timely clearances.

• Attention is also drawn to Clause 10.2.7© where in certain timeline has been stipulated to be observed by railways officials while reviewing the drawings submitted by the contractor. These should be adhered to.

• Tender should be invited only when no major impediment is anticipated in acquiring the balance land and associated permits. LOA should be issued only when land acquisition is 90% complete and corresponding essential clearances have been obtained so as to eliminate/minimize damage on this account and ensure timely completion of the project.

• Approved Engineering scale plans (ESP), approved GAD of stations/other service/residential buildings should be ready for all the stations before inviting the tender. The plans are to be attached with Bid document.
• Project specific bidding document should be prepared in consultation with concerned department and associate finance.

• In case of Doubling/3rd line/4th line, Method statement and sequence of working including Yard Remodeling should be prepared and got approved from Zonal Railway headquarter before calling EPC tender. In case of RE projects, provision of traffic blocks should be jointly agreed to by the concerned DRM and CPM/RE through an MOU/Joint Note.

• Clear Do’s and Don’ts should be notified while issuing RFP to avoid inadvertent mistakes by bidders.

4.9 A brief about RFP:

4.9.1 Preparatory arrangements for RFP documents:
1. Foot to foot Survey of section for collecting all field details.
2. All GADs & Drawings of existing major and minor bridges.
3. Land availability in full or partial width to be assessed.
4. Fixing of alignment of additional line in block sections after detailed survey.
5. Land acquisition of addition land if required.
6. To obtain Forest & Environmental clearances.
8. Planning for construction for important and major bridges.
10. NOCs for LCs to be eliminated by LHSs/RUBs to be obtained.
11. Identification of scope and Planning for track works.
15. Identification of scope and Planning for Electric works.

4.9.2 Survey, detailed investigation and preparation of Plans/GADs by fixing an agency:
1. A contract may be awarded for Detailed survey, investigation and preparation of Plans/ GADs etc. as detailed under:
2. Geotechnical investigation to ascertain soil property.
3. Preparation of Project Feasibility Report by the Consultant.
4. Land Boundary posts have been erected to demarcate the land.
5. Centre line pillars marked to indicate the alignment.

4.9.3 Preparations of plans and specifications
1. Preparation of tentative GA Plans of ROBs, RUBs, LHS, Major Bridges (on irrigation canal) and approvals from State/Railway authorities.
2. Preparation of L-Sections, GADs of important Major/Minor Bridges (Approvals within Railway).
3. Preparation and approval of yard plans by division & CTPM to freeze the main scope of yard remodeling work.
4. Preliminary drawings for stations, service buildings, residential building and circulating area.
5. Detailing and specifications of buildings, structures & track.

4.9.4 Other pre-requisites for preparation of RFP document
1. Aggregate traffic block hours.
2. Hiring charges for various track machines.
3. Project facilities and manpower.
4. Project Milestones for payment.
5. Detailed Project costing and break-up into sub-items as per schedule-G of EPC document.
6. Updation of Standard RFP, MCA to meet the Specific requirements of the Project.

4.10 A brief about EPC agreement:

4.10.1 Schedules of EPC agreement:

Schedule-A: Defines existing details of land, structures, track, yards, facilities etc. Details include:
1. Site, land details
2. Details of existing structures, facilities
3. Permanent way details, yard details
4. Bridges – Important, Major, Minor
5. Provide GADs & Drawings for guidance
6. Grade Separator – LC, ROB, RUB, flyover
7. Existing facilities at station i.e. platform, FOBs, lines etc
8. Electrical details & UG crossings
9. Details of signalling infrastructure
10. Details of Telecom Infrastructure

Schedule – B : Description of Railway Project
11. Operational requirement
12. Geometric designs & features
13. Bridges – Track, RUB, LCs etc.
14. Specifications & working requirement
15. Material – Rail & sleepers to be provided by railways/Contractor
16. Earthwork – Methodology specification etc
17. NI working at yards
18. Building works
19. Road & Pathways damage & sewerage system
20. Platform & facilities at stations
21. Electrical works
22. S&T works

Schedule – C: Project Facility
23. Office setup of contractor
24. Office setup for Railways
25. Resting facility
26. Furnishing requirement
27. Deployment of personnel
28. Requirement of equipment's
Schedule – D: Specification & Standards

29. Manuals of specification & standard for EPC contract 2014 issued by Railway Board


31. Reference to all codes manual, specifications, guidelines & circulars & important letters.

32. Reference of drawings & designs

33. Time schedule for review of various drawings, ESP, GADs etc.

34. SIP, cable route plan etc.

35. LOPs of yard etc.

Schedule – E : Applicable Permits

36. Permission of the State Government for extraction of boulders for quarry and crusher setting up.

37. Licence for use of explosives.

38. Permission of the State Government for drawing water from river/reservoir and bore holes.

39. Licence from inspector of factories or other competent Authority for setting up batching plant;

40. Obtaining STP (short term permits) for earth pits & borrow area for earth work.

41. Taking connection of Electric supply and water supply for construction work.

42. Permit to dispose cut spoils & debris out of Railway boundary.

Schedule – F – Format of bank guarantees

Schedule – G : Schedule of % payment at various stages of various structures

43. Earthwork at stages like up to earth fill top subgrade, blanket, protection works etc.
   - Unit is linear length
   - Payment of each stage on prorata basis for 500 M length.

44. Major Bridges at stages like
   - Foundation
   - Substructure
   - Super structure
• Payment of each stage on prorata basis of total linear water way of Major/Imp bridge

45. Minor Bridges
• On completion
• On prorata of linear length of minor bridges

46. RUBs
• On completion
• On prorata of total barrel length of RUBs

47. LCs
• On completion
• On prorata of total nos. of LCs

48. Platforms
• On completion
• On prorata of total square meter of area

49. Buildings
• On prorata basis on completion of plinth area in square meters.
• Boundary wall, fencing road etc.

50. FOBs
• On completion
• Unit is on completion linear length of all FOBs

Schedule – H

51. Drawings to be prepared by contractor and given to Railway
• General map of country
• Index Plan, Index Map

52. GADs of structures
• Details of LCs, RUB,ROBs
• Schematic plans of station yards
• Yard diagram
• Track structure & component
• All SIP
• SWR, GWR
• Cable route plan
• Location/function boxes etc.
• Details like curve abstract
• Bridge abstract
• LC abstract
• Gradient abstract etc.

Schedule – I
53. Project Completion Schedule (say 900 days)
54. Four milestones in schedule completion period (days)
55. Milestone I 240 days
56. Stage payment statement for >=10% of contract price
57. Milestone II 480 days
58. Stage payment statement for >=35% of contract price
59. Milestone III 700 days
60. Stage payment statement for >=70% of contract price
61. Schedule completion for completion of project

4.10.2 Penal Clauses:

<table>
<thead>
<tr>
<th>S.N</th>
<th>Activity</th>
<th>Defaulter</th>
<th>Quantum</th>
</tr>
</thead>
</table>
| 1.  | Damages for delay in handing over the site which includes:  

The Right of way for not less than 90% of the total length.  
All environmental & forest clearances. NOCs for ROBs and LHSs from State | Authority | Amount of Damages per day per m, as prescribed in tender documents. |
2. Authority doesn't provide any machinery and equipment at the designed time

| Authority | Amount equal to twice at which machinery or equipment was to be given to the contractor on hire. |

3. Delay in shifting of obstructing utilities beyond a period of 180 days from the date of notice by the Contractor

| Authority | Amount of Damages per day per m |

4. Failure to provide Traffic blocks or power blocks:

| Authority | If any default in compensating the Authority shall pay to the Contractor Damages at the specified per days, per hour. |

5. Approval of engineering scale plan, signalling interlocking plan and route control chart

| Authority | 0.2% of the Performance Security for each day of delay |

6. Delayed authorization by CRS etc.

| Authority | Payment due towards testing and commissioning will be paid with the interest of Bank Rate +3%. |

7. Timely Payment

| Authority | Case of delay in payments, the delayed payment will accrue an interest of Bank Rate + 3% |

4.10.3 Damages statement:

<table>
<thead>
<tr>
<th>S.N</th>
<th>Activity</th>
<th>Defaulter</th>
<th>Quantum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Performance Security</td>
<td>Contractor</td>
<td>For delay in submitting PG, damages @0.05% of contract price per day shall be levied.</td>
</tr>
<tr>
<td>2.</td>
<td>Retention money</td>
<td>Contractor</td>
<td>Authority shall deduction 6% from each bill subject to maximum of 5% of contract value.</td>
</tr>
</tbody>
</table>
### 3. Project milestone completion and project scheduled completion

| Contractor | For each day of delay in achieving milestone, a recovery of 0.05% per day of the contract price. |

### 4. Completion of Punch List (deficiency) items

| Contractor | Damages @ lower of (a) 0.1% of the Performance Security, and (b) 0.2% of the cost of completing such items as estimated by the Authority's Engineer. |

### 5. Removing of the contractor’s equipment, material, debris and temporary work from site within 15 days after work

| Contractor | An amount equal to 120% (one hundred and twenty per cent) of the actual cost of removal incurred by the Authority. |

### 6. Contractor’s failure to rectify Defects.

| Contractor | In case contractor does not rectify defects in time advised, railway shall rectify the defects and recover damages @ 120% of the cost incurred. |

### 7. Traffic Blocks and Power Blocks

| Contractor | In case, total duration of blocks specified in the document is exceeded by more than 20% damages @ specified per hour will be recovered. |

### 4.11 Important clauses in RFP:

#### 4.11.1 Pre-qualification:

1. Clause 2.2.2.1-

2. To be eligible for pre-qualification and short-listing, an Applicant, shall fulfill the following conditions of eligibility:

3. (A) Technical Capacity: For demonstrating technical capacity and experience (the “Technical Capacity”), the Applicant shall over the past 5 (five) financial years preceding the Application Due Date,

4. (i) have received payments for construction of Eligible Project(s), or has undertaken construction works by itself in a PPP project, such that the sum total thereof is more than 2.5 times the Estimated Project Cost (the “Threshold Technical Capacity”):

5. [Provided that at least half of the Threshold Technical Capacity shall be from the Eligible Projects in Category 1 and/ or Category 3]
6. (ii) undertaken at least one Eligible Project of value of not less than 35 per cent of the Estimated Project Cost and have received payments for not less than 75 (seventy-five) per cent value of such project.

7. For composite works:

8. Involving Electrification work: Either bidder should have undertaken at least one Electrification work of value of not less than 35 per cent of the Electrification Cost and have received payments for not less than 75 (seventy-five) per cent value of such project.

9. Involving S&T work: Either bidder should have undertaken at least one S&T work of value of not less than 35 per cent of the S&T Cost and have received payments for not less than 75 (seventy-five) per cent value of such project.

10. Clause 2.2.2.3 In case of a Consortium/joint venture, the Technical Capacity is to be satisfied by any member of Consortium/Joint Venture having minimum 26% share holding in Consortium/Joint Venture.

11. Clause 2.2.2.2 Financial Capacity: The Bidder shall have a minimum “Net Worth” (the “Financial Capacity”) of 10% of the Estimated Project Cost at the close of the preceding financial year.

4.11.2 Eligible project category:

1. Clause 2.2.2.4 –

Following categories of experience would qualify as Technical Capacity and eligible experience

Category 1: Project experience on Eligible Projects in Railways sector.

Category 2: Project experience on Eligible Projects in core sector.

Category 3: Construction experience on Eligible Projects in Railways sector.

Category 4: Construction experience on Eligible projects in core sector.

4.11.3 Eligible Project

1. (a) For project to qualify as Eligible Project in Cat 1 & 2:

The entity claiming experience should have held, in the company owning the Eligible Project, a minimum of 26% equity during the entire year for which Eligible Experience

The capital cost of the project should be more than 10% (ten per cent) of the Estimated Project Cost.

2. (b) For a project to qualify as an Eligible Project under Categories 3 and 4:

The Applicant should have received cumulative payments for construction works executed, fully or partially, during the 5 (five) financial years immediately preceding the Application Due Date.

However, receipts of less than 10% of the Estimated Project Cost shall not be reckoned as receipts for Eligible Projects.
4.11.4 Types of Works considered

For New lines, Gauge Conversion, Doubling, 3rd line, 4th line, including composite works with electrification and/or Signalling and Tele-communication etc. works-

**Railways sector** - would be deemed to include railways, metro rails, LRT, monorail, high speed rail, highways, expressways, bridges (road/railways) and tunnels (road/railways)

**Core sector** - would be deemed to include hydroelectric dams, barrage, ports, airports, thermal/steel/cement plants, oil and gas pipelines, irrigation canals, water supply (pipelines/treatment plants), sewerage (pipelines/treatment plants), power transmission lines, civil works in power sector/commercial set ups (SEZs etc)/industrial parks/Logistics parks and real estate development.

For **Railway Electrification**-

**Railways sector** - would be deemed to include overhead equipment system of railway electrification for railway system, metro system, suburban transit system, monorail, high speed railways, substation and transmission lines.

**Core sector** - would be deemed to include railways, power, telecom, ports, airports, metro rails, oil and gas pipelines and highways.

4.12 A brief about RFP:

4.12.1 Summary

➢ Define scope in schedules of EPC agreement.

➢ Define schedule of bidding process.

➢ Pre-bid conferences.

➢ Authority’s response to queries and C &A if required.

➢ Validity of bid - 180 days.

➢ Define Bid Security and performance security.

➢ Bidder to quote only Bid Price.

4.12.2 DOs & DON'Ts in EPC Contracts

**DOs:**

1. Preparation of realistic DPR.

2. Minimum 90% land must be available.

3. All tentative GADs including ESPs, SIPs etc. should be got approved before calling tenders.

4. All utilities to be shifted before tendering to the extent possible.
5. Method statement to be frozen before calling tenders.

6. Commitments made by Railway in regard to funds, cautions, blocks, track machines etc. to be strictly adhered to, to avoid penalties on Railway.

**DON'Ts:**

1. No new requirements to be added during execution.

2. No alterations to be made in approved drawings during execution.

### 4.13 Conclusions:

1. Bigger players have been staying away from Indian Railways because of unilateral contract conditions. EPC contracts have reciprocal responsibility and it is Railway's policy to adopt it for speedier execution.

2. Pre-requisites to be ensured by Railways to safeguard Railway's interest.

### 4.14 Annexures:

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<thead>
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<th>4.14 Annexures:</th>
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No. 2017/Trans/01/Policy

New Delhi, dated: 08-02-2018

The General Manager, All Indian Railways/PLUs, NF(Con), CORE

The DG/RSO & NAI

CAOs, DMW/Patiala, WPO/Patna, COFMOW/NDLs, RWP/Bela


Ref: Railway Board’s letter no Trans/01/policy dated 17.11.2017

In order to expedite decision making and execution of works, following changes have been approved by the Board (ME, FC & CRB).

1.0 Handling Vitiation during Variation in Contract Quantities

In partial modification of existing instructions, it has been decided that as a result of variations, a contract shall be considered “vitiated” only when, the following percentage variation in contract value between tenderers are noticed to have been exceeded.

<table>
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<tr>
<th>Sn</th>
<th>Value of Contract</th>
<th>Percentage difference between present Contractor and new L-1 as a result of variation. (percentage shall be calculated with base as the revised contract quantities multiplied by the rates of the present contractor)</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Small value contracts (Tender Value less than Rs. 50 lakhs)</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Other than small value contracts (Tender Value equal to or more than Rs. 50 lakhs)</td>
<td>5</td>
</tr>
</tbody>
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1.1 When the percentage difference between present Contractor and new L-1 is noticed as becoming beyond the values specified above, the following action shall be taken.

The Railway administration should immediately examine whether it is practicable to bring in a new agency to carry out the extra quantity of work keeping in view the progress of the work in accordance with the original contract and the nature and lay-out of the work. If it is found that there will be no serious practical difficulty in meeting the additional quantity of work done by another agency, then fresh tenders for the extra quantity may be invited otherwise negotiating the rate with the existing contractor for arriving at a reasonable rate for the additional quantities of work, may be adopted.

1.2 The above shall be regulated as under:

a) The case shall be decided by the tender accepting authority (competent for the revised quantity) and shall not be treated as a case of single tender. The provisions of Railway Board letter no. 2007/GE.ICT/18/PT. XII dated 31.12.2010 hereby gets superseded.

b) These instructions will be similarly applicable to earning contracts with H-1,H-2 substituted for L-1, L-2 and so on.

c) Executives while executing the work shall make all efforts to ensure that no vitiation takes place in normal circumstances. Vitiation should be an exception rather than a...
routine affair. Efforts should be made to invite bids on the basis of percentage above/below/at par.

d) Vitiation should always be computed with respect to the items, rates, quantities and conditions as available at the time of Tender Opening and subsequent changes/additions by way of new items will not be counted for computing Vitiation.

2.0 Dispense with Vetting of Brief Notes & size of TC Recommendation

2.1 It has been decided that all system generated statements from IREPS website, post tender-opening are directly seen by the Tender Committee and vetting of the comparative statement and vetting of brief note is not required for Tender Committee proceedings.

2.2 The Tender Committee proceedings are made brief and crisp.

3.0 System of Verification of Tenderer’s credentials:

3.1 For the works tenders, it has been decided to adopt the affidavit-based system of credential verification. The tenderer shall submit along with the tender document, documents in support of his/her claim to fulfill the eligibility criteria as mentioned in the tender document. Each page of the copy of documents/certificates in support of credentials, submitted by the tenderer, shall be self-attested/digitally signed by the tenderer or authorized representative of the tendering firm. Self-attestation shall include signature, stamp and date (on each page). Only those documents which are declared explicitly by the tenderer as "documents supporting the claim of qualifying the laid down eligibility criteria", will be considered for evaluating his/her tender. The system shall be applicable once it is made operational in IREPS. This system is already being followed by some of Railway PSUs.

3.2 In all works tender documents, following para may be added in the section describing the qualification and eligibility criteria.

"The tenderers shall submit a notarized affidavit on a non-judicial stamp paper stating that they are not liable to be disqualified and all their statements/documents submitted along with bid are true and factual. Standard format of the affidavit to be submitted by the bidder is enclosed as annexure-A. Non submission of an affidavit by the bidder shall result in summary rejection of his/her bid. And it shall be mandatory Incumbent upon the tenderer to identify, state and submit the supporting documents duly self attested by which they/he is qualifying the Qualifying Criteria mentioned in the Tender Document. It will not be obligatory on the part of Tender Committee to scrutinize beyond the submitted document of tenderer as far as his qualification for the tenderer is concerned."

With the submission of the affidavit as mentioned above, the practice of verification of tenderer’s documents by the Railways may be dispensed with. Following clause may also be added to the Instructions to Bidders.

a) The Railway reserves the right to verify all statements, information and documents submitted by the bidder in his tender offer, and the bidder shall, when so required by the Railway, make available all such information, evidence and documents as may be necessary for such verification. Any such verification or lack of such verification, by the railway shall not relieve the bidder of its obligations or liabilities hereunder nor will it affect any rights of the railway thereunder.

b) In case of any wrong information submitted by tenderer, the contract shall be terminated, Earnest Money Deposit (EMD), Performance Guarantee (PG) and Security Deposit (SD) of contract forfeited and agency barred for doing business on entire Indian Railways for 5 (five) years.

Signature

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c) With such a system of self-certification of credentials, tender finalization should also be speeded up. It has accordingly been decided that the tender validity period should be reduced to 45 days for single packet and 60 days for two packet system of tendering (in place of the present limits of 90 days and 120 days) for tenders having affidavit based system of credential verification.

4.0 Tender Invitation at short notice period

In continuation of existing instructions, for tenders called with short notice period of 21 days, tender validity period would be 30 days and for tenders called with 14 days notice period, the tender validity would be 20 days only. This would in fact justify the urgency of work.

5.0 Calling tenders pending sanction of detailed estimates

In cases of urgency, open tenders may be called, before sanction of detailed estimates, with the approval DRM/P_HOD/CHOD. However, the letter of acceptance shall be issued only after the sanction of detailed estimate.

6.0 Multiple L-1

In case of more than one L-1 bidders, tender may be awarded to tenderer having higher Bid Capacity. In case Bid Capacity is also the same, tenderer having done more value of similar work in last three previous financial years and the current financial year up to the date of opening of the tender, may be selected for the award. Instructions with respect to Bid Capacity will follow.

7.0 Discharge of tenders

Before discharging a tender due to higher rates etc., the TC and TAA may examine the possibility of a cartel formation, getting lower rates as a result of retendering, loss of transparency in re-invited tender, the opportunity cost for delay in the execution of the work and the cost of retendering. Each zonal Railway may workout a model cost estimate for the process of tendering which may be kept in view by the TC and TAA while examining the tender.

8.0 Price variation Clause (PVC)

Price variation Clause (PVC) in Works Contract is dealt with in accordance with provisions of item 46A of GCC-July 2014. In order to simplify and enhance the pace of the works, it has been decided to remove the PVC clause in all works contract tenders having value less than Rs 5 Crore.

9.0 Project Management Consultancy (PMC)

In partial modification to Railway Board's letter no 2007/CE.1/CT/18 dated 05.07.2010, and 14.09.2017, it has been decided to extend the scope of PMC services for all works contracts costing more than Rs 10 Crore in open line, Construction and RE organization while ensuring the following:

a) Personal approval of DRM/P_HOD/CHOD would be required on case to case basis.

b) The proposal to engage PMC services for any project/contract shall be governed as per instructions contained in Railway Boards letters mentioned above (and amended from time to time). These instructions will also be applicable for all the works approved for PMC by DRM/P_HOD/CHOD.

c) The word Deputy CE or its equivalent mentioned in the instructions above shall mean Equivalent Branch Officer of the Division/Railway Electrification (RE).

d) The expenditure incurred on PMCs should be within the D&G charges as per extant instructions.

[Signature]

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10.0 Contractor’s Measurements

In partial modification to Railway Board’s letter no 2016/CE-LCT/14 Measurement/1 dated 21.09.2017, and 2016/CE-LCT/14 Measurement/3 dated 21.09.2017, it has now been decided to extend the scope of Contractors Measurement for all works costing more than Rs 5 Crore in Divisions, Construction and RE organization, subject to following condition:

a) Approval of DRM/POD/CHOD, without finance concurrence.

b) The proposal to have works measurements by Contractors for any project/contract shall be governed in accordance with the instructions contained in Railway Board’s letters mentioned above (amended from time to time). Such instructions are applicable for all the works approved for Contractors Measurement by DRM/POD/CHOD.

c) The word Deputy CE or its equivalent mentioned in the instructions above shall mean equivalent Branch Officer of the division/RE organization. XEN/AXEN shall mean their equivalent counterparts in Division/RE organization.

11.0 Deposit Works

These works are defined in accordance with para 1843 of IR Code of Engineering Department. The method of execution is also defined therein. The limit of variation by 20% due to reasons other than escalation etc may not be applicable for Deposit Works. Sanction, execution and variations in these works shall be made by the Railway administration in consultation with the sponsoring authority bearing the cost of the deposit works, within the broad guidelines provided in IR Code of Engineering Department and Model SOP-October 2017. Revised detailed estimate should however be within the powers of the sanctioning authority.

12.0 This issues with the concurrence of Associate Finance of Transformation Cell Railway Board.

Kindly acknowledge the receipt and ensure compliance.

(T. K. Pandey)
Executive Director, Transformation

Sangita Kumar
Executive Director (Accounts), Transformation
Copy to:

1. The Director, Indian Railway Institute of Civil Engineering, Pune.
2. The Director, Indian Railway Institute of Mechanical and Electrical Engineering, Jamalpur.
3. The Director, Indian Railway Institute of Signal Engineering and Telecommunications, Secunderabad.
4. The Director, Indian Railway Institute of Electrical Engineering, Nasik.
5. The Executive Director, Indian Railways Centre for Advanced Maintenance Technology, Gwalior.
6. The Director, Indian Railway Institute of Transport Management, Lucknow.
7. The Registrar, Railway Claims Tribunal, Delhi.
8. The General Secretary, IRCG, New Delhi.
10. The Secretary, Railway Rates Tribunal, Chennai.
12. CMD/MD of all railway PSUs

Copy to:

1. The Genl. Secy., AIRF, Room No. 248, & NFIR Room No. 256-C, Rail Bhavan
2. The Secy. Genl., IRPOF, Room No. 268, FroA, Room No. 255-D & AIRPFA, Room No. 256-D Rail Bhavan

Copy to:

1. PS to MR, MOS(S), MOS(G)
2. CBP, FC, ME, MTR, MRS, MS, MT, SECY, DG (RHS), DG (RPF), DG (Stores), DG (Pers), DG (S&T)
3. All AMs, Principal Executive Director & Executive Directors of Railway Board

(T. K. Pandey)

Executive Director, Transformation
The Chief Admin. Officers (Const.)
All Indian Railways
Chairman-cum-Managing Director,
Rail Vikas Nigam Limited,
New Delhi

Sub:- Entering into contractual liabilities before land acquisition.

Instructions have been issued by the Board from time to time that Railways should not enter into contractual liabilities unless land has been acquired, the site is clear of all obstructions and all other formalities like finalization of plans and drawings have been completed. However, incidents have come to the notice of the Board wherein on some Zonal Railways, tenders for Earthwork and Bridges for New Lines projects have been awarded much before the physical possession of land. This reflects poor planning on the part of the Railways and lead to arbitration/litigation.

In view of the above, Board has decided that henceforth, the Railways should not enter into contractual liabilities in case of the New Line Projects unless the land required for completion/commissioning of project/identified section of the project over atleast 70% of the linear alignment has been acquired.

This has been issued in consultation with Finance.

Kindly acknowledge the receipt of this letter.

(V.P. Dudeja)
Executive Director (Works)
Tel/Fax: 011-2338 2102
Annexure 4.03

NORTHERN RAILWAY
(Construction Organization)

Headquarters Office,
Kashmere Gate,
Delhi
Dated: 14-02-2014

No.74-W/O/WA/Pt.IX

Addressed to:--
As per mailing list.

Subj: Invitation of Tenders

In supersession to this office letter No. 74-W/O/WA/Pt.VIII dt. 23.03.93 and all other instructions on the subject, the following procedure shall be adopted for invitation of tenders.

(i) On sanction of a project, the scheme of execution of project should be made out by the Dy. CE/C and the same be got approved from the CE/C concerned. This should include number of tenders, completion period and the time schedule. Invitation of tenders should be approved by CE/C concerned irrespective of tender value.

(ii) Normally no tender should be invited for work costing below Rs. 20 lakhs. However if exigency of service requires to do so, tender may be invited by the field unit after approval of CE/C concerned.

(iii) The tender schedule and tender documents should be approved by Dy. CE/C concerned for tender to be invited by field unit and by CE/C concerned for tender to be invited at HQ level.

(iv) All tenders beyond Rs. 25 lakhs shall be opened in CAO/C's office as well as in the concerned field unit simultaneously. However, tenders related to Lucknow field unit will be opened in CAO/C's office only irrespective of tender value.

(v) Whenever a tender document is received by the convenor of tender committee, he may advice other two members about the receipt of the tender documents and the tender should be finalized as per model schedule laid down for finalization of contract.

This issues with the concurrence of finance and approval of C.A.O/Const.

(Pardeep Kumar)
Dy.CE/Const./T&C

For Chief Admn. Officer/Const.
Annexure 4.04

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

No. 2018/Trans.Cell/S&T/NIT Period

The General Manager, All Indian Railways/Pla. NF(Cmn), CORE
The DG/RDSO/ Lucknow, DG/NAIR/Vadodara
CAOs, DMW/Patna, WPO/Patna, COFMOW/NDLS, RWP/Beda, CAO/ROAF

Sub: Tender Notice Period-Works Contracts.

(2) ECR’s letter no. ECR/ADM/AMSOP Modification/Note ‘10’ Para 05/Part ‘A’/Works Matter dated 21.06.2018.

New Delhi, dated: 26.07.2018

With reference to ECR’s letter under reference (2) above and in supersession of Board’s letter at (1) above, Board (ME, FC & CEB) have approved the following:

1. The changes in existing para 1238 of Engineering Code as:

   1238. Tender Notice: Sufficient notice should be given for the submission of tenders, which in the case of large works should not be less than 21 days. The above prescribed tender notice period may be reduced from 21 days in the exceptional circumstances in consultation with the Principal Financial Adviser.

   However,

   (i) For tenders valued upto and including Rs 2 crore invited through e-tendering, the tender notice period can be reduced upto 14 days in consultation with associate finance.

2. For works in remote locations or of specialized nature or amount higher than Rs 50 crore, adequate tender notice period (not less than 21 days) should be given for preparation to the potential bidders in order to ensure competitive and well informed bidding.

3. The tender validity period shall be kept three times the tender notice period. However, the tender validity period in case of self certification of credentials will continue as per railway board’s letter no. 2017/Trans/01/Policy dated 08.02.2018.

4. The minimum tender notice period shall be reckoned from the date the tender is published on the e-tendering website. The publication in newspaper will continue as per the present practice and the effective date of tender notice will be the date of uploading on e-tendering website.

This issues with the concurrence of Associate Finance of Transformation Cell of Railway Board.

(Ramesh Balondo)
Executive Director/S&T
Transformation Cell

No. 2018/Trans.Cell/S&T/NIT Period

1. PF/As, All Indian Railways & Production Units
2. The ADAI (Railways), New Delhi
3. The Director of Audit, All Indian Railways

Sanjeeb Kumar
Executive Director Accounts
Transformation Cell
No. 2018/Trans.Cell/S&T/NIT Period

New Delhi, dated: 26.07.2018

Copy to:
1. The Genl. Secy., AIRF, Room No. 248, & NFIR Room No. 256-C, Rail Bhavan
2. The Secy. Genl., IRPOF, Room No. 268, FIFOA, Room No. 256-19 & AIRFFA, Room No. 256-D Rail Bhavan, New Delhi

Copy to:
1. PS to MR, MOS(S), MOS(G)
2. CRB, FC, ME, MTR, MRS, MS, MT, SECY, DG(S&T), DG (RHS), DG (RPF), DG (Stors), DG(Pers)
3. All AMs, Principal Executive Director & Executive Directors of Railway Board

(Unmesh Balanda)
Executive Director/S&T
Transformation Cell
No. 2018/Trans.Cell/S&T/NIT Period

New Delhi, dated: 26.07.2018

Copy to:
1. The ADAI (Railways), New Delhi
2. The Director of Audit, All Indian Railways
3. The Director, Indian Railway Institute of Civil Engineering, Pune.
4. The Director, Indian Railway Institute of Mechanical and Electrical Engineering, Janakpur.
5. The Director, Indian Railway Institute of Signal Engineering and Telecommunications, Secunderabad.
6. The Director, Indian Railway Institute of Electrical Engineering, Nasik.
7. The Executive Director, Indian Railways Centre for Advanced Maintenance Technology, Gwalior.
8. The Director, Indian Railway Institute of Transport Management, Lucknow.
9. The Registrar, Railway Claims Tribunal, Delhi.
10. The General Secretary, IRC, New Delhi.
12. The Secretary, Railway Rates Tribunal, Chennai.
14. Managing Director, CRIS, Chunakypuri, New Delhi

Copy to:
1. The Genl. Secy., AIRF, Room No. 248, & NFIR Room No. 256-C, Rail Bhavan
2. The Secy. Genl., RPOF, Room No. 268, FROA, Room No. 256-D & AIRPFA, Room No. 256-D Rail Bhavan

Copy to:
4. PS to MR, MOS(S), MOS(G)
5. CRB, FC, ME, MTR, MRS, MS, MT, SECY, DG(S&T), DG (RHS), DG (RPF), DG (Stores), DG(Pers)
6. All AMs, Principal Executive Director & Executive Directors of Railway Board

(Umesh Bafunda)
Executive Director/S&T
Transformation
Northern Railway
(Construction Organization)

HEADQUARTER OFFICE,
KASHMERE GATE, DELHI

No.74-W/O/WA/Pt.V/CP

Addressed to
As per mailing list attached

Dated: - 12.03.2012

Sub: Mandatory pre-requisites to be complied before calling of tenders.

I have been observed that many a times tenders are being called and awarded even before approval of Site Plans/GAD, availability of adequate land etc. This often results in avoidable & complex situations such as prolongation of contracts, higher PVC payments, fore closure and time cost overruns besides leading to audit objections litigations & arbitrations.

To avoid above situations, it has been decided by Competent Authority that mandatory pre-requisites as enclosed herewith as Annexure-I must be complied with before calling of tenders so as to ensure timely and smooth execution of contracts especially in new lines, doublings, GC and Bridge works. Accordingly, the check list for calling tender has also been revised and enclosed herewith for strict compliance in TC minutes also, a Para should be added mentioning that the technical member has certified that all the pre-requisite for calling of tenders issued vide HQ letter No. 74-W/O/WA/Pt.V/CP dated 12.03.2012 have been complied with.

This issues with the approval of CAO/C

DA: As above

-Sd-
(Pradeep Kumar)
Dy.Chief Engineer/C/T&C
For Chief Admv. Officer/Const.
Sub: Short Tender Notice

Ref: Railway Board’s letter No.2014/CE-I/CT/O/10/TN dated 18-06-2014

The Ministry of Railways, Railway Board vide above referred letter has issued instructions for Tender Notices publication in newspapers (copy enclosed). Accordingly, existing Tender Notice for publication has been modified and a Format of revised tender notice to be sent to CPRO for publication in Newspapers is enclosed herewith for implementation in all future tenders in Construction Organization with immediate effect.

This has approval of CAO/C

DA: As above

(Praeep Kumar)
Dy. Chief Engineer/Const/T&C. for Chief Admn. Officer/C

Copy to:
The CPRO, Publication Office, State Entry Road, New Delhi, for information please.

DA: Format of revised tender notice.
Annexure-4.07

Government of India
Ministry of Railways
(Railway Board)

No. 2014/CE-I/CT/0/10/TN
New Delhi,
dated 18.06.2014

To,
As per list attached.

Sub: Short Tender Notice
Ref: Board’s circular no. 2008/CE-I/CT/21. Dated 05.03.2009.

Vide circular under reference, instructions were issued that Tender Notices published in newspapers should be crisp and clear: Tender Notices should not be lengthy and should furnish only such details as are mentioned in circular under reference.

2. However, it is observed that Zonal Railways etc. are not strictly following instructions contained in circular under reference. The matter has been reviewed and it has now been decided by Board (CRB) that only following items need to be included in Tender Notices published in newspaper:

(i) Name of Work with its Location and Completion Period.

(ii) Approx. Cost of the work.

(iii) Earnest Money to be deposited

(iv) Date & Time for submission of tender and opening of tender

(v) Website particulars, Notice Board Location where complete details of tender can be seen and Address of the Office from where the tender form can be Purchased etc.

The detailed terms and conditions should not be a part of the advertisement and should be available on Railway website: The tabulation work should also not form part of the Tender Notice.

3. Tender Notices appearing in the Press should not be needlessly long. Unnecessarily long Tender Notices, apart from causing loss of revenue to the Railway, also tend to lose the clarity of the subject. Due care should be exercised by the concerned authority who approves the “Notice Inviting Tender” (NIT) to ensure that these do not have unnecessary repetitions and ambiguity.

The purpose of publishing Tender Notices in newspapers is to draw the attention of the eligible contractors to the proposed work. Since the complete details are available in the Tender Notices, posted on the Railway website and also placed on the Notice Board of the concerned office, there is no need to give exhaustive details about the work in the Tender Notices being published in the newspapers.

4. The Railways need to be cautious while issuing notices and corrigendum/addendum which should invariably be published in all the concerned newspapers.
besides posting the same in the website/ Notice Board of the office etc., where the original notice was pasted. The Website should also specify of date upto which tenderers may note updates/corrigendum/revised date of opening.

The Railways may also arrange to have all the notices including Tenders Notices published on a fixed day in a week. For this, since the space requirement in newspapers will be in bulk, the Railway may negotiate for considerable reduction in the advertisement charges with the newspapers concerned.

5. This is in supersession to Board’s circular under reference.

6. This issues with the concurrence of the Finance Directorate of the Ministry of Railways.

7. Please acknowledge receipt.

-Sd-
(Alok Kumar)
Executive Director/Civil Engg. (G)RB
(Phone: 030-44803 (Rly.):011-23383379 (MTNL) 09910487302(CUG Mobile)

No. 2014/CE-I/CT/0/10/TN New Delhi, dated 18.06.2014

Copy forwarded for information to :
(i) FA&CAO, All Indian Railways.
(ii) Dy. Comptroller and Auditor General of India (Railways), Room no. 224, Rail Bhawan, New Delhi (with 46 spare copies).

-Sd-
For Financial Commissioner/Railways
Northern Railway  
(Construction Organisation)  

Headquarter Office,  
Kashmere Gate,  
Delhi-110008  

No. 74-W/0/Misc.Corr./WA/CP  
Dated: 09.02.2012  

Addressed to :-  
[As per mailing list Attached]  

Sub: Consideration of single LAR leading to awarding of high rates in Works Contract.  

Enclosed please find herewith a photo-copy of letter No.VIG/CT/2010/12/045/G/UMB/Engg. dated 07-02-2012 received from Dy.CVO/Engg., NR, Baroda House, New Delhi along with a photo-copy of Rly Bd.'s letter No.94/CE-I/ICT/4 Dt. 17-9-97 as referred therein for your information and further necessary action as directed therein for strict compliance.  

DA/As above  

(Pradeep Kumar)  
Dy. Chief Engineer/C/T&C  
for Chief Admn. Officer/Const.  

Copy for information to:-  

No.74- W/O/WA/24/CP/Feed Back
Dated: - 23.03.2015

Addressed as per mailing list attached.

Sub: - Detailed Check List for Finance proposals.

The competent authority i.e Chief Administrative Officer/Const N Rly Kashmere Gate, Delhi in consultation with FA&CAO/C has decided that the check list for various proposals/estimates may be complied with while forwarding the proposals to Accounts Department. The requisite formats of the check list are enclosed here with for necessary compliance please.

However, it is advised that the time limit for vetting/concurrence of proposal as given in the instructions is maximum and efforts should be made to finalize the cases much earlier.

This is for information and necessary action please.

DA:- As above

-Sd-

(Pradeep Kumar)
Dy. Chief Engineer/C/T&C
For Chief Admv. Officer/Const.
Annexure-4.10

Northern Railway
(Construction Organization)

HEADQUARTER OFFICE,
KASHMERE GATE, DELHI

No.74-W/0/WA/PL/CP

Dated: - 15.09.2011

Dy. Chief Engineer/Const.,
Northern Railway
TKJ, SERD, SSB, CSB, CSB-II, NDWCS/SERD, Secy to CAO/C
UMB, CDG-I, II & III, DJAT, PTK, JUC, MB, LKO-I & II.

Sub: - Standard Proforma for submission of proposals seeking “Administrative Approval” for sanction of new NS items, holding negotiations for quantity enhancement and contract variations (i.e. addendum/corrigendum).

Enclosed please find herewith the following standard Proforma to be annexed with various proposals to be submitted to Headquarter office: -


2. Standard Proforma for submission of proposal for contract variations (i.e. addendum/corrigendum).

3. Standard Proforma for submission of proposal for holding negotiations for enhancement of quantities of items beyond +25% / 100% (major value/minor value)

All the fields Dy. HODs are advised to submit the above proposals only in the prescribed Proforma henceforth to avoid delay in processing and approvals at Headquarter level.

The above issues with the concurrence of FA&CAO/C and approval of CAO/C.

DA/As above.

-Sd-

(Pradeep Kumar)
Dy. Chief Engineer/C/T&C
For Chief Admv. Officer/Const.
Sub:- Procedure for dealing with variation in quantities involving execution of work in running contract where negotiations are to be done as per codal provisions.

Ref:-
(2) CAO/C/P&P’s note dated 13.01.2008.

In partial modification to the instructions issued by CAO/C/P&P vide his note dated 13.01.2008, the following procedure shall henceforth be adopted in cases involving enhancement of quantities beyond +25%+100% of the original awarded quantity:

i) The proposal for enhancement of item quantities beyond +25%/+100% of the originally awarded quantity (major value item/minor value item), thus requiring negotiations, should be submitted to the contract signing authority as per the Standard Proforma circulated vide this office letter of even no. dated 15.9.2011.

ii) After examining the proposal, the contract signing authority will forward the same for finance vetting.

iii) After vetting from the associate finance, the proposal will be put up to the Tender Accepting Authority for according Administrative approval for holding negotiations for enhanced quantities.

iv) The TC will hold negotiations with the existing contractor and put up its recommendations to the Tender Accepting Authority as per the SOP. After acceptance, the acceptance letter will be issued.

v) The supplementary agreement for the consequent contract variation will be signed by the “Contract Signing Authority” as defined in the SOP for the revised value of the contract, after endorsement by the Associate Finance.

These issues with the concurrence of FA&CAO/C and approval of CAO/Const.

(Signed)
(Pradeep Kumar)
Dy. CE/C/IT&C
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

New Delhi, dated 7.7.97

Addressed to:

As per list attached.

Sub: Test check on works and instructions regarding.

...

In the course of test check on works conducted by the Vigilance Directorate of Railway Board, on the Railways, it was noticed that in several cases test check on works are done by the officers in a very casual manner. The irregularities committed by the officers while conducting test checks only came to light when a vigilance investigation is carried out. In such a situation anybody can give a certificate blindly to the effect that test check has been conducted without actually conducting any such check.

CVG in such a case where grave irregularities in the conduct of test check have been noticed made some observations which are reproduced below:--

"The system failure mentioned by the department also needs to be corrected forthwith. When an officer is expected to conduct test-check of works, and when he certifies that he had done the test-checking, it should be incumbent upon him to specify clearly the relevant particulars/details of the area which has been so subjected to test-checking by him. Otherwise, anybody can blindly give a certificate without actually conducting any such checking. This would defeat the very purpose of test checking. Further, in such a situation, his accountability also gets blurred and it becomes next to impossible to take his task for not conducting any check and/or for conducting the check in a perfunctory manner. The Commission, would, therefore, advise the department to issue necessary instructions at once making it obligatory/incumbent upon officers of all levels to furnish all relevant particulars about test-checking done by them."

Board have taken a serious view of the matter and desire that when officers give certificate after conducting test-check, he should specify clearly the relevant particulars/details of the area which has been test checked by him to avoid any hazy/skeptical conduct in test checking."

The above instructions should be strictly adhered to.

Receipt of this letter may please be acknowledged.

(V.K. Behlwan)---30 July
Exec. Director, Civil Engg. (G)
Railway Board.
As per Mailing List

Sub: Standard EPC Contract Document for single stage two packet system of tender.

*****
The documents for Request for Participation (RFP) and Standard Engineering Procurement Contract (EPC) for Single Stage Two Packet System of Tendering, duly approved, were uploaded on IR website www.indianrailways.gov.in/railwayboard>>"About Indian railways" >>"Railway Board Directorate" >>"Civil Engineering" >>"Policy Matters" >>"EPC Tender documents (Single Stage)", vide Railway Board letter No. 2018/CE-I/CT/36-EPC Contract Policy dated 29.10.2019 & 15.11.2019.

Important points to be kept in mind while customizing the EPC tender documents is available on IR website www.indianrailways.gov.in/railwayboard>>"About Indian railways" >>"Railway Board Directorate" >>"Civil Engineering" >>"Policy Matters" >>"Important points for EPC tenders" for guidance and further necessary action please.

-Sd-
(P.S. Gupta)
Executive Director/CE (G)
CHAPTER- 5

FORMATION DESIGN AND BLANKETING

5.1 Design of Formation:

5.1.1 Formation collectively refers to layers comprising of blanket, subgrade/top layer of formation and embankment fill. It is the platform over which track foundation comprising of ballast/sub ballast and track structure is laid.

Since thickness of ballast cushion and track structure is fixed, performance of track is predominantly dependent on laying of track to correct geometric design and constructing formation that is structurally sound so as not to fail under its own load and live loads and settlement due to consolidation of subgrade is within permissible limits.

Aim of formation design is to construct formation that gives trouble free service under the most adverse conditions of loading, maintenance and weather.

5.1.2 Design of formation is governed by two broad factors. One is related to geometric design involving design of horizontal and vertical curves, L section, formation width, track centre etc and other is regarding design of soil and blanket layer, design of slopes, drainage arrangements etc.

Various design criteria/aspect considered in design of formation are as under:

GEOMETRIC DESIGN:

5.2 Horizontal alignment – Curve design

5.2.1 Speed potential in sections gets restricted if curves are not properly designed. Maximum speed, which can be permitted, on a curve takes into account radius of curve, actual cant, cant deficiency and length of transition curve.

5.2.2 Maximum permissible speed on transitioned curve is

\[ V = 0.27 \sqrt{R} (C_a + C_d) \]

Where \( R \) = Radius of curve

\( C_a \) = Actual cant in mm. (165mm max.)

Note: Maximum cant of 185 mm. may be assumed for the purpose of locating all permanent structures etc., by the side of the curves on new constructions and doubling on group ‘A’ routes having potential for increasing the speed in future. The transition length should also be provided on the basis of 185 mm. cant for the purpose of planning and layout of the curve.

\( C_d \) = Cant deficiency in mm (100mm for speed in excess of 100Kmph for nominated rolling stock and routes with CE approval. Otherwise 75mm.)

5.2.3 Speed worked out above is required to be restricted if transition length of adequate length is not provided. In such cases, safe speed is worked out on the basis of actual cant/cant deficiency, which can be provided taking into consideration the limiting value of cant/cant deficiency gradient and rate of change of cant/cant deficiency.
5.2.4 Desirable length of transition shall be maximum of following (Para 407 of IRPWM):

(a) \[ L = 0.008 \text{ Ca} \times \text{Vm} \]
(b) \[ L = 0.008 \text{ Cd} \times \text{Vm} \]
(c) \[ L = 0.72 \text{ Ca} \]

(a) & (b) are based on Desirable Rate of change of cant/ cant deficiency of 35mm/sec.

(c) is based on Cant/ cant deficiency gradient of 1 in 720.

(d) In exceptional cases where room is not available for providing sufficiently long transitions in accordance with the above, the length may be reduced to a minimum of 2/3 of the desirable length as worked out on the basis of formula (a) and (b) above or 0.36 Ca (in metres ) whichever is greater. This is based on the assumption that a rate of change of cant/cant deficiency will not exceed 55 mm. per second and the maximum cant gradient will be limited to 2.8 mm. per metre or 1 in 360. This relaxation shall apply to Broad Gauge only.

5.2.5 At locations where desirable length of transition is restricted and therefore, may be inadequate to permit same maximum speed as calculated for circular curve, it will be necessary to lower the cant/ cant deficiency which will reduce speed on circular curve but increase speed on transition curve. Cant in such cases is to be selected to permit highest speed on curve as a whole.

5.2.6 For the purpose of designing future layouts of curve, future higher speeds (such as 160 km./h. for Group 'A' routes and 130 km./h. for Group 'B' routes) may be taken into account for calculating the length of transitions.

5.2.7 Laying transition and Shift

Offset in cm from straight to any point on transition is calculated as:

\[ Y \text{ in cm} = 16.7 \times X^2 / LR \]

Where \( X \) = distance from commencement of transition in meter. \( L \) & \( R \) are length of transition and radius of curve in meter.

Shift is inward shift of circular curve to accommodate cubic parabola transition curve. It is calculated as

\[ S \text{ in cm} = 4.2 \times L^2 / R \]

5.2.8 Length of transition in case of compound curve is calculated as

(i) \[ L = 0.008 \left( \text{Ca}1 - \text{Ca}2 \right) \times \text{Vm} \]

(ii) \[ L = 0.008 \left( \text{Cd}1 - \text{Cd}2 \right) \times \text{Vm} \] Whichever is greater where \( \text{Ca}1 \) and \( \text{Cd}1 \) are cant and cant deficiency for curve No. 1 in mm. \( \text{Ca}2 \) and \( \text{Cd}2 \) are cant and cant deficiency for curve No. 2 is mm., \( L \) is length of transition in metres., \( \text{Vm} \) is the Maximum permissible speed in Km. p. h.

Cant gradient should be within the permissible limits as stated in Para 407(1) of IRPWM. Common transition may be provided when the length of common transition as worked out above is more than the length of virtual transition as specified in Para 406 (1) (b) of IRPWM.
In case of reverse curves, common transition curve may be provided between circular curves. The total length of common transition, i.e., from circular curve to circular curve, may be obtained from –

(i) \( L = 0.008 \ (C_{st} + C_{dt}) \times V_m \) or

(ii) \( L = 0.008 \ (C_{st} + C_{dt}) \) \( V_m \) whichever is greater, where \( C_{st} \) and \( C_{dt} \) are cant and cant - deficiency of curve No. 1 in mm, \( C_{st} \) and \( C_{dt} \) cant and cant deficiency of curve No. 2 in mm.

5.2.9 For high speed in group A & B routes, a straight of minimum 50m should be provided between transitions of reverse curves. In case, it is not possible to provide 50m straight, then straight may be eliminated by suitably extending the transition lengths. Rate of change of cant and versine to be kept same in the extended transition.

5.2.10 Turnouts on curves

Curves of contrary flexure - The cant of the main line (which is the negative super-elevation on the turn-out) should be calculated from the formula given in the Schedule of Dimension and the permissible speed on the main line determined from the allowable cant deficiency and cant on the main line. The speed so determined shall be subject to limitations governed by the standard of interlocking and the sectional speed.

Curves of similar flexure - (1) Not followed by reverse curve immediately the turnout curve shall have the same cant as the main line curve.

(2) Followed by reverse curves - A change of cant on the turn-out may be permitted starting behind the crossing and being run out at a rate not steeper than 2.8 mm, per metre and subject to the maximum cant on the main line turn-out being limited to 65 mm.

The permissible speed on the main line is then determined from the allowable cant-deficiency and subject to limitations governed by the standard of interlocking and the safe speed limit.

5.2.11 There should not be any change of super elevation over turnouts for 20m from toe of switch and upto 20m beyond ANC. Normally turnouts not to be taken from transition. If reqd. in exceptional cases, approval of CE is required.

5.2.12 Cross over with curves – On curves on double line connected by cross over road, the speed and the cant for both roads are governed by the inner road to which the cross over road is a curve of contrary flexure. On the outer road, it is a curve of similar flexure. The permissible speed and the necessary cant on the inner road shall be calculated in accordance with Para 413. The same speed and the same cant shall be allowed on the outer road.

The outer track shall be raised so that both roads lie in the same inclined plane in order to avoid change in cross-level on the cross over road. Where this is not possible, both main line and the turn-out should be laid without cant and suitable speed restriction imposed.

5.3 Vertical alignment – L section and vertical curves

5.3.1 Obligatory points – L section for doubling projects is finalized considering various
obligatory points such as yards, level crossings and bridges. In doubling works, cross overs connecting existing line and doubling line are to be kept at same level and same plane.

5.3.2 Level of track at level crossing for new as well as existing line to be kept same. Variation, if any, shall not be excessive.

5.3.3 As per para 4.9 of substructure code, free board from HFL/FSL to formation level to be 1m or atleast as available in existing/adjoining bridge.

5.3.4 Maximum steepest gradient in station yards:
   (i) For new works & Alteration to Existing works-
       (a) Recommended: 1 in 1200 (0.083 %)
       (b) Maximum (Steepest): 1 in 400 (0.25 %)
   (ii) For existing works: 1 in 400 (0.25 %)
       (a) Recommended dimension is generally the good practice, the adoption of which will lead to desirable uniformity on Indian Railways; but it is not to be treated as standard, a departure from which requires sanction.
       (b) (b) In case, it is not possible to provide recommended gradient of 1 in 1200 (0.083%) in yard even after making efforts to provide grades as flat as possible, reason for deviation from recommended gradient and up to the specified maximum (steepest) gradient of 1 in 400 (0.25%) shall be recorded by the zonal Railway.
       (c) No station yard shall be constructed nor shall any siding join a passenger line on a steeper grade than 1 in 260, except where it is unavoidable and then also only with the previous sanction of the Railway Board, obtained through the Commissioner of Railway Safety, when a slip siding or other arrangement is made sufficient to prevent accident.
       (d) The power of condonation for gradient steeper than the specified standard maximum gradient of 1 in 400(0.25%) shall be as under
           (i) Steeper than 1 in 400 (0.25%) and up to 1 in 260 (0.38%): Commissioner of Railway Safety
           (ii) Steeper than 1 in 260 (0.38%): Railway Board through Chief Commissioner of Railway Safety.

5.3.5 Keeping these obligatory points, eliminate sags & humps while keeping flatter possible gradient.

5.3.6 Vertical curves – Whenever algebraic difference in grades at the junction of grades is more than 0.4%, vertical curve shall be provided. Minimum prescribed radius of vertical curve is 4000m for Group A routes, 3000m for group B routes and 2500m for others.

5.3.7 Compensation for curvature should be given in all cases where existing gradient when added to curve compensation exceeds ruling gradient. Compensation to be allowed is 70/R percent (0.04 percent per degree of curve).

5.4 Formation Width and Cross Slope

5.4.1 Para 263 of IRPWM specifies Ballast Profiles/ Sections/ Depth of Cushions. Vide Advanced Correction Slip no. 135, formation width has been increased from 6.85
m to 7.85 m for single line B.G. track for 350 mm ballast cushion and 1.5:1 ballast slope. This will facilitate 900mm cess width.

5.4.2 Now with 5.30 m track centre and 7.85 m bank width for single line B.G track, width of double line bank will be 13.15 m. With 6.0 m track centre, width of double line bank will be 13.85 m.

5.4.3 Formation width for 50m length in approaches of major/important bridges shall be kept as 10m. On high banks also, formation width is to be increased.

5.4.4 Additional width of formation will have to be provided to cater for increase in extra ballast on out-side of curves and extra clearance required on double line on account of super-elevation etc.

5.4.5 Adequate drainage must be ensured for the worst in service conditions. The top of formation should have cross slope of 1 in 30 from centre of track towards both sides for single line and from one end towards cess/drain side (Single slope) in multiple lines.

5.5 Minimum Distance centre to centre on straight tracks

5.5.1 Minimum distance centre to centre on straight tracks should be kept as 5300mm for new works/addition to existing works.

In case new OHE masts/signal posts are required to be provided in between tracks under unavoidable circumstances, the clearance of 5300 mm shall be increased by equal to the width of such provisions/structures/foundations, as the case may be.

5.5.2 Survey of all minor/major bridges should be done before deciding track centre. Track centre can be increased from minimum 5300 mm if increase in track centre facilitates for elimination of reverse curves, ensures minimum degree of reverse curves in approach of Important/Major bridges, minimum dismantling of wing walls and return walls of existing minor bridges and saving of portals of existing OHE.

5.5.3 Drainage arrangements between tracks to be kept in mind while planning track centre more than 6.10m.

5.5.4 While planning doubling works, no new reverse curves to be provided. If increase in track centre for construction of bridge becomes inescapable than reverse curve may be avoided by adjusting apex/tangent length of curves on either side thereby providing required track centre between two curves on either end of bridge.

5.6 Design of formation and blanketing layer


With the aim to construct the formation for future needs, it was decided in 2009, that the formation on Indian Railways will be constructed for 25 T axle load. Underlying principle/requirement for design of formation are as under:
1. With increased axle load, induced stresses now extend considerably below ballast layer.

2. Rehabilitation of formation during service has serious safety and cost implications.

3. Formation to be safe against shear failure and plastic deformation.

4. Deficit bearing capacity result in cess and crib heaving, mud pumping, slope failure etc. Large deformation is due to poor compaction, shrinkage/ swelling.

5.7 Soil Exploration and Soil Classification for formation design:

5.7.1 As formation design will primarily depend upon the type of soil being used in construction, it is essential that soil exploration is done properly for soil classification as laid down in RDSO GE: G-1 Para 3.0. The results of soil exploration shall be reviewed and finally approved at the level of CAO/C and equivalent officers in PSUs as this will be the basis of further design.

5.7.2 Exploratory bore holes are undertaken at 200/300m interval along the alignment. Bore holes are drilled upto 1.5/2m below existing ground level or twice the height of bank ht. (whichever is more). Bore logs are prepared from disturbed samples and particle size distribution; soil classification and index properties of soil are determined.

5.7.3 Soil is classified as per IS: 1498-1970 as per which soils are classified primarily on the basis of dominant particle size and its plasticity characteristics. Soil particles consist of mainly following four size fractions:

Gravel : 80 - 4.75mm
Sand : 4.75mm - 0.075mm
Silt : 75 – 2 micron
Clay : less than 2 micron

Particle size distribution is determined by a combination of sieving and sedimentation analysis and its plasticity characteristics as per Liquid Limit and plasticity limit.

5.7.4 As per IS 1498, symbols assigned to various soil consist of two letters. First letter signifies dominant particle and second letter signifies grading/plasticity as per following:

<table>
<thead>
<tr>
<th>Primary letter</th>
<th>Secondary letter</th>
</tr>
</thead>
<tbody>
<tr>
<td>G: Gravel</td>
<td>W: Well graded</td>
</tr>
<tr>
<td>S: Sand</td>
<td>P: Poorly graded</td>
</tr>
<tr>
<td>M: Silt</td>
<td>M: With non-plastic fines</td>
</tr>
<tr>
<td>C: Clay</td>
<td>C: with plastic fines</td>
</tr>
<tr>
<td>O: Organic soil</td>
<td>L: of low plasticity</td>
</tr>
<tr>
<td>P: Peat</td>
<td>I: of medium plasticity</td>
</tr>
<tr>
<td></td>
<td>H: of high plasticity</td>
</tr>
</tbody>
</table>

In case of sand and clay, dual symbols are used if fines are 5-12% or plasticity index is 4<Pl<7. Brief details of soil classification are available at annex-I of GE-1/2003.

5.7.5 In case of soft clay and sensitive clays, in-situ vane shear tests should be conducted to determine its strength and depth of underlying compressible clay layer. Free soil index should also be carried out for expansive soil and for organic soils; organic content is also to be determined.
5.7.6 Various soil groups have been combined together in table-1 based on % age fines to formulate the thickness of blanket layer.

**Table-1** Description of soil quality class

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Description w.r.t % age fines (size&lt;75 micron)</th>
<th>Soil as per IS classification confirming to referred soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ 1</td>
<td>Soil containing fines&gt;50% CL, ML,, CL-ML, CI, MI,CH,MH</td>
<td></td>
</tr>
<tr>
<td>SQ 2</td>
<td>Soil containing fines from 12% TO 50% GM, GC, SM,SC, GM-GC,SM-SC</td>
<td></td>
</tr>
<tr>
<td>SQ 3</td>
<td>Soil containing fines&lt;12% GW, GP,SW, SP,GW-GM, GW-GC, SW-SM, GP-GM, GP-GC,SP-SM,SP-SC</td>
<td></td>
</tr>
</tbody>
</table>

5.8 **Design of cuttings;**

5.8.1 Cutting natural ground for formation is required due to fact that railway formations maintain much easier gradient than prevailing slopes. Top width of formation in Railway cutting is also to be kept as 6.85m wide with side drains on both sides and a suitable slope. Cut profile may pass through soil or rock or combination of both and nature of soil through which it is made governs parameters of design such as slopes of sides, drainage, need for breast wall, pitching, retaining wall etc.

5.8.2 Construction of cuttings is done from top to bottom but design is done from bottom to top. Cut section has three components: Bottom width, side slopes and top which incorporate catch water drains, spoil bank and slope stabilization for terrain. Revised profile sketch has been shown in Annex 2/11 to 2/13 of Para 263 of IRPWM of 2019.

5.8.3 Slope in cuttings is generally kept as 1:1 as against 2:1 in normal embankment as a result slope stability is very critical for cutting sections. Failure in soil slopes is circular in homogenous material and planer or non-circular in non-homogenous soils or if there are discontinuities in the slope.

5.9 **SLOPE STABILITY:**

Stability of any slope is governed by number of factors such as nature of material comprising formation, movement of water and steepness of slope. Tendency of instability occurs when stress due to self-weight of soil forming slope and external loads such as structure on crest of slope, water pressure, earthquake etc is more than the shear strength of soil or layer comprising slope. In stable slope, there is no continuous surface along which average shear strength is less than shear stress. Shear strength can be mobilized by permeability characteristics and extant of drainage changes that can take place. Infiltration of water due to rainfall, external changes near slope such as deforestation, construction of reservoir raises pore pressure and reduces shear strength. Detailed procedure of slope stability analysis along with solved example is given as annex-III of RDSO-GE: G-I/2003.

5.10 **Drainage Arrangements in Banks and Cuttings:**

5.10.1 Drainage is the most important factor in the stability of bank/cutting in railway construction. Effective drainage of the rainwater in the monsoon season is very important to safeguard bank/cutting from failure. Railway formation is designed for fully saturated condition of soil. However, flow of water should not be allowed
among the track as it not only contaminates ballast but also erodes formation. Therefore, drainage system should be efficient enough to prevent stagnation and allow quick flow of water.

5.10.2 Drainage in Embankment: In bank cross slope is provided from centre towards end to drain out surface water. Therefore, normally there is no need of side drains in case of embankment. However, there are situations where height of bank is such that blanket layer goes below normal ground level. In such cases side drains may require to be constructed along the track at suitable distance so that track alignment does not become channel for flow of ground surface water.

In case of double line construction, central drain between the track should be avoided to extent possible as it is not only difficult to construct but difficult to maintain also due to continuous vibration of moving traffic and due to difficulty in curing of concrete. Only in very rare situations, when drainage of water is not possible without construction of drain, suitable arrangement for construction of drain with precast concrete channel/ subsoil drains along with proper outfall should be made. If distance adjacent tracks is large enough, suitable slope should be provided in ground to make rain water flow in natural manner. Wherever there is level difference between two adjacent tracks, suitable non-load bearing dwarf wall may be constructed to retain earth.

5.10.3 Drainage in Cuttings:

Ingress of moisture is the principle triggering factor for slope instability and landslides. It is the water pressure and not the quantity of water, which matter in stability. For effective control of slides, water presence and its flow needs to be taken care of. Improvement in drainage surface/subsurface increases strength and stability and at much lesser cost. Often large failure cannot be controlled without some form of drainage.

**Side drains:** In case of cutting, properly designed side drains of required water carrying capacity are to be provided. If the height of cutting is less (say upto 4m), normally only side drains on both side of track are to be provided. In case of deep cuttings, catch water drains of adequate water carrying capacity are also required along with side drains. A typical sketch of side drains and catch water drains is given in Sketch E in GE: G-1/2003. A typical side drain is minimum 300mm deep with 1200mm width at top and 600mm at the bottom. Top of the drain is kept at or higher than bottom of blanketing layer.

**Catch water drain:** When natural topography is having one side slope and surface runoff has a tendency to flow into the cutting, network of drain on top of cutting is provided to intercept water heading towards cutting and dispose off at proper discharge locations. Catch water drain should be made pucca with joints sealed with bituminous compound. These drains should have section enough to carry 50% more discharge than required to account for any blockage. These drains should have enough slope to develop self-cleansing velocity and shall have well designed discharge points.

5.11 Erosion control for Banks and Cuttings

Slopes in soft rock or soil are prone to serious erosion during heavy rain. Vegetation cover is certainly the best form of protection of particularly soil slopes. A grass mat covering slope not only binds the surface material together but also tend to inhibit entry of moisture into slope. Erosion control measures adopted are classified in following categories:

a) **Conventional non-agronomical system** – Adopted for banks subjected to wave action and includes pitching, asphalting and cement stabilization etc.
b) **Bio technical solutions** – Vegetation is provided on slope surface and is effectively used in soils with some clay. Method consist of preparing slopes area by grading it for sowing seeds or plant strips of locally available creeping plants. Its roots go 50-75mm in slope and anchors it. This include, doob, vetiver, bacharum, sarkanda etc.

c) **Engineering system** – This system has three methods. Geo-jute is suitable for high erosion areas. Geo jute is eco-friendly material made of jute yarn and is biologically degradable. In this top 50-75mm soil is made free from clods and surface is evenly dressed. Seeding is done by distributing uniformly over the slope. Folded geo-jute is buried at critical slippage of top layer and then unfolded loosely. Watering facility is required during initial period along with protection from cattle grazing. Once established, no maintenance is required.

d) **Hydro-seeding system**: This is non-conventional and innovative system of vegetation development. This system can be tried on mountainous slopes and steep banks/cuttings. Verdyl Mulch solution @ 100-150gm/sqm is sprinkled on surface for germination of vegetation depending upon local soil and climate conditions.

e) **Polymer Geogrids**: Under unfavourable soil and rainfall conditions where vegetative growth is difficult or is considered inadequate, a synthetic root reinforcement vegetation system using Geogrid should be provided. Geogrids are flexible, non-biodegradable, resistant to chemical effects and are stable over a temperature of 60-100 degree centigrade.

5.12 **Embankment design:**

5.12.1 In order to construct a formation that gives trouble free service under most adverse conditions of loading, maintenance and weather, it is necessary that:

a) Subgrade in bank or cutting is structurally sound so as not to fail in shear strength under its own load and live load. Deficient shear strength will lead to ballast heaving in cess and crib, mud pumping and slope failure.

b) Secondly, any settlement due to the compaction and consolidation in subgrade/subsoil is within the permissible limits. This happens due to poor compaction during construction and consolidation (primary and secondary) of subgrade and sub soil.

5.12.2 Construction of embankment is to be carried out normally with soil available in nearby area but unsuitable soil such as organic clay, organic silt, peat, chalks, dispersive soils, poorly graded gravel and sand having Cu<2 are normally avoided. Clay and silt of high plasticity (CH & MH) should not be used in top 3m of embankment.

Different type of fill materials, if used should be deposited in such a way that all parts of site receive roughly equal amount of given material in roughly same sequence to get approximately homogenous character of sub grade. Fly ash generated by power plants, residue of brick kilns can be effectively used as intermediate layers in case of major fill.

In situations where soil for construction consists of cobbles, boulders, rocks fragments, largest size of material should not be more than 2/3rd of loose layer thickness. It should also be ensured that after up to 3m of such construction, a 30cm layer of properly compacted soil is provided. In case cobbles, boulders are of size bigger than 2/3rd of layer, these may be placed on toe of embankment instead of using as subgrade material.

5.13 **Blanketing –Design and Provision:**
5.13.1 To avoid failure of track formation due to inadequate bearing strength and to safeguard against swelling and shrinkage, adequate blanket thickness must be provided in all cases at the time of construction of new line/doubling. Improvement in formation subsequent to opening of section is very costly and have serious safety implications and therefore required provision should be kept while constructing formation.

5.13.2 The instructions given in Specification NO. RDSO/2018/GE:IRS-0004 (D) Part-IV for “Rationalisation of Formation Layer Thickness on Indian Railway Track” issued in July 2019 regarding thickness of formation layers supersedes instructions given in all earlier guidelines of RDSO and RDSO letter no. RS/G/108/Heavy Axle Load dated 26.10.2016 and these guidelines are to be followed for blanketing design and provision.

5.13.3 Requirement of Blanket Layer:

a. The provision of blanket layer shall not be needed when formation/earth fill embankment have:
   (i) Rocky beds except those, which are very susceptible to weathering e.g. rocks consisting of shales and other soft rocks, which become muddy after coming into contact with water.
   (ii) Soils conforming to specifications of Blanket material.

b. For other conditions, the system of layered construction of embankment consisting of blanket layer/prepared sub-grade/sub-grade shall normally be followed.

5.13.4 Specification and thickness of Formation layers:

Thickness of Prepared sub-grade and blanket layer has been rationalized based on UIC-719 R calculation for ballast cushion as 350 mm

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Soil type category in sub-grade</th>
<th>Prepared Sub-grade Soil Type</th>
<th>Recommended Blanket thickness (mm)</th>
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<td>SQ2</td>
<td>SQ3</td>
<td>300</td>
<td>Two layer</td>
</tr>
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5.13.5 Height of Embankment and Formation Layer thickness:

(i) Minimum height of embankment above ground level or highest flood level (HFL) whichever is higher should not be less than one meter to ensure proper drainage and avoid trespassing.

(ii) Total thickness of formation layers of 1.5 m (minimum) should be provided of blanket, prepared sub-grade & subgrade embankment fill uniformly in embankment/cutting for effective stress dispersal.

(iii) The specification of soil strata below the ground level (GL) must be decided from the results of soil exploration.

5.13.6 For providing uniform total thickness of formation layer of 1.5 m:

a. For Embankment: If the specification of sub-soil meets the required specification of prepared subgrade upto required depth and below that specification of sub-soil meets the required specification of subgrade upto required depth then there will be no need of excavation, else the excavations will be done as per the requirement. For more clarification a

<table>
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<tr>
<th>S.N.</th>
<th>Soil type category in sub-grade</th>
<th>Prepared Subgrade</th>
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<tr>
<td>6</td>
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<td>SQ3*</td>
<td>..-</td>
<td>450</td>
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sample case has been explained as Annexure-II in Specification NO. RDSO/2018/GE:IRS-0004 (D) Part-IV issued in July 2019.

b. **For Cutting:** If the specification of the sub-soil meets the required specifications of blanket up to the specified depth, then below it the specification of sub-soil meets the specification of prepared subgrade up to specified depth and below that if the specification of sub-soil meet the specification of subgrade up to specified depth then there will be no need of excavation, else the excavations will be done as per the requirement. For more clarification a sample case has been explained as Annexure-II in Specification NO. RDSO/2018/GE:IRS-0004 (D) Part-IV issued in July 2019.

5.13.7 The reduction in thickness of formation layer, if required, will be done first in lower fill, then in top layer of subgrade then in prepared subgrade and then in blanket.

5.13.8 In case of cutting, blanketing shall be provided as per para 5.13.4 based on type of soil and their CBR values just below the blanket.

5.13.9 Production of Blanketing Material: It is difficult to get natural blanket material. Normally, the blanket material shall be produced mechanically by crushing the stones and/or by mixing, naturally available materials using suitable equipment/plants like pug mill, wet mix plant, crusher etc. (Ref. Appendix-C of GE:G-14). However, if naturally available material conforms to the specifications, the same can also be used. The type of blanket material to be used whether natural or manufactured (mechanical crushing and/or blending) may be indicated clearly before start of the work and should be indicated in tender document.

Decision to use of natural blanket material or manufactured blanket material shall be taken on the basis of site conditions or final location survey report.

5.13.10 **Specifications of Blanketing material** (Table 4-7 of Specification NO. RDSO/2018/GE:IRS-0004 (D) Part-IV issued in July 2019):

   (in respective tables)

   (i) Cu>7 and Cc between 1 and 3.

   (ii) Fines (passing 75 microns): 3% to 10%.

   (iii) Los Angeles Abrasion value < 40 %.

   (iv) Minimum soaked CBR value >=25

   (v) Field compaction: Min 100 % of MDD in field trial.

   (v) Size gradation-within specified range (as table 8 of above specification) or should lie more or less within enveloping curves.

   (vi) Filter criteria with subgrade layer and Minimum Ev2 to be satisfied as given of RDSO specification of July 2019.

5.13.11 **Unsuitable soil for construction of embankment:***

   (i) Soils to be normally avoided are:
a) Organic clays, organic silts, peat, chalks, dispersive soils, poorly graded gravel and sand with uniformity coefficient (Cu)< 2,

(b) Clays and silts of high plasticity (CH & MH) in top 3 m of embankment.

(ii) Some typical situations, as given below, may arise when in construction of formation such unsuitable types of soils (para 6.6.1) are not possible to be avoided for economical or any other reason, then Railway may consult RDSO to decide special investigations and other measures to formulate suitable scheme of construction.

a) Cuttings passing through unsuitable soils, shales and soft rocks which become muddy after coming into contact with water,

b) Construction of embankment on sub-soil of unsuitable types of soils.

c) Use of CH & MH type of soils even in top 3 m of embankment.

5.14 Use of Geosynthetics in Railway Embankment

5.14.1 The decision on use of geosynthetics shall be taken based on the techno-economic considerations for every site of work, with the approval of PHOD in Open Line and Construction departments of Zonal Railways and equivalent officer in PSUs.

5.14.2 Regarding use of Geogrid in Formation Rehabilitation in existing lines, where track parameters get disturbed frequently, it is recommended to use Geogrid as per RDSO specification for CBR of sub-grade 4 to 8. For sub-grade of CBR less than 4 the cases to be sent to RDSO for approval. Generally, Geogrid will not be required for subgrade having CBR more than 8. However, if it is required, cases to be referred to RDSO for approval. Non-woven Geotextile just below Geogrid at the bottom of ballast may be used where no blanket is available and SQ1 or SQ2 soil exists at the top of formation, to prevent the upward migration of the fine particles from top of formation to the ballast so that clean ballast may not be contaminated.

5.14.3 To reduce the thickness of the Blanket Layer (which is costly granular material obtained by quarrying or mining) in case of new constructions, on techno-economic considerations and/or to reduce the adverse impact on environment due to quarrying/mining geogrid can be used as a stabilisation element to form a mechanically stabilised layer.
5.14.4 Regarding geo-grid for use below blanket in new lines for reduction in specified thickness of blanket layer, use of Geo-grid shall be considered at places where it is economical to use it in combination with blanket as it reduces the requirement of thickness of blanket. Zonal Railways and Construction units must submit the design of reinforced formation layer along with design methodology for use and selection of Geo-grid for approval by RDSO. Zonal Railways and Construction units should consider only those firms which have successfully used the same proposed product in similar application (reduction in bedding layers thickness) at minimum 3 locations ,with minimum 3 years’ experience at one of the location in India/International, with supporting documents as an evidence for satisfactory performance.

5.14.5 To prevent upward migration of fines from prepared sub-grade/sub-grade causing contamination of layer on top of it (which reduces the strength & drainage capacity of this layer of better quality material) and also to prevent penetration of coarse particles of layer on top of prepared sub-grade/sub-grade into soft/ fine grained particles of prepared sub grade/sub-grade a suitable non-woven Geo-textile layer may be used as “separator layer” in the following cases.

(a) Below blanket layer if SQ2 soil is used in prepared sub grade in two layer system.

(b) Below blanket layer if SQ1 or SQ2 soil is used in sub grade in single layer system.
CHAPTER-6

EARTHWORK IN CONSTRUCTION PROJECTS

6.1 EXECUTION OF EARTHWORK IN FORMATION:

Before taking up actual execution of work, detailed drawings need to be prepared for the entire length of the project to give alignment, formation levels, formation width at ground level, cross sections of catch water drains & side drains, cross section and levels of subgrade, blanket levels etc. to facilitate smooth execution at site. Execution of work has to be carried out in systematic manner so as to construct formation of satisfactory quality.

6.1.1 Preliminary works:

(i) Site Clearances: Full formation width at ground level plus additional extra width of 1 m on both sides should be cleared of all obstructions viz. vegetation, trees, bushes, building, fences, abandoned structures etc. and thereafter it should be dressed and leveled. Depressions if any, should be filled with suitable soil duly compacted. Finally, leveled surface should be properly compacted by mechanical means to get leveled and uniform ground surface.

(ii) Setting out of Construction Limits: Centre line of alignment @200 m c/c or so and full construction width should be demarcated with reference pegs/dug belling about 90 cm away from proposed toe of the bank. Care should be taken not to disturb the pegs during construction. Pegs should be preferably painted for identification.

(iii) Selection of Borrow Area: Borrow area should be selected sufficiently away from the alignment, as far as possible at the extreme of Railway land but normally not less than 3 m plus height of bank to prevent base failure. Borrow area should be selected for soil suitable to the construction.

(iv) Selection of fill materials: Except for unsuitable soil as explained in Para 5.1 of GE:G-1, 2003, any type of locally available soil can be used as a construction material. OMC and MDD of the selected fill material should be tested in the laboratory as per laid down frequency.

6.1.2 General aspects:

A field trial for compaction on a test section shall be conducted on fill material to assess the optimum thickness of layer and optimum number of passes for the type of roller planned to be used to arrive at desired density. If the soil has less than required moisture content, necessary amount of water shall be added either in borrow pits or after the soil has been spread loosely on the embankment. If the soil is too wet, it should be allowed to dry till moisture content reaches to accepted level required for the compaction. Clods or hard lumps of soil of borrow area shall be broken to 75 mm or lesser size before placing on embankment. Each layer should be compacted with recommended type of roller upto required level of compaction commencing from the sides, before putting next upper layer.

6.1.3 Compaction of earthwork:

Definition-Compaction is the process of increasing the density of soil by mechanical means by packing the soil particle closer together with reduction in air voids. Compaction helps soil to acquire increase in shear and bearing strength.

6.1.3.1 Factors affecting compaction:

Compaction is affected by a) moisture content b) compacting effort and c) soil
6.1.3.2 **Methods of compaction** are of four types kneading compaction, static compaction, dynamic compaction and vibratory compaction. Different types of action are effective for different type of soils.

(i) Sandy and gravely soils are compacted using vibratory rollers and if fines are less, these can be compacted with minimum no. of passes of vibratory rollers without strict control of OMC. With higher percentage of fines such soils are to be brought to OMC before compaction. Since top layer of sandy layer remains loose, in final passes roller should move smoothly without vibration.

(ii) Silty soils are fine grained and can be plastic or non-plastic depending on clay content. These can be compacted near OMC with smooth rollers or vibratory rollers. Vibratory rollers will impart higher energy and higher degree of compaction.

(iii) **Compaction of Clays:** Water content plays very important role in clay. Main objective is to achieve uniform mass with no voids. If moisture content is too high, roller tends to sink in layer but if it is too low then chunks will not yield to rolling. Appropriate water content is plastic limit + 2%. Such soils can be best compacted with sheep foot rollers. Padfoot vibratory roller is also very effective and for better results after initial rolling with static pad foot roller, rolling with vibratory rollers is to be done.

6.1.3.3 Suitable thickness of layer is necessary for uniform compaction. It depends on type of soil and type of rollers. Normally 200-300mm thickness of loose soil is used. Density also depends on number of passes but after optimum passes, increase in density is insignificant. It is better to prepare test bed of varying thickness, moisture and compacting effort to arrive at most optimum thickness and number of passes of given soil and roller used.

6.1.4 **Placement of Back-Fills on Bridge Approaches and Similar Locations:**

The back fills resting on natural ground may settle in spite of heavy compaction and may cause differential settlements, vis-a-vis, abutments, which rest on comparatively much stiffer base. To avoid such differential settlements, while on one hand it is essential to compact the back fill in the properly laid layers of soil, on other hand, the back fill should be designed carefully to keep:

i) Settlement within tolerable limits.

ii) Coefficient of subgrade reaction should have gradual change from approach to the bridge.

Back fill on bridge approaches should be shall be placed in accordance to para 605 of Indian Railway Bridge Manual 1998. Fill material being granular and sandy type, therefore, need to be placed in 150 mm or lesser thick layers and compacted with plate compactors. While placing backfill material benching should be made in approach embankment to provide proper bonding.

6.1.5 **Drainage Arrangement in Embankment/Cutting:**

Drainage is the most important factor in the stability of bank/cutting in railway construction. Effective drainage of the rainwater in the monsoon season is very important to safeguard bank/cutting from failure. Railway formation is designed for fully saturated condition of soil. However, flow of water should not be allowed
6.2.1 Erosion control of slopes on banks & cuttings:

Exposed sloping surface of bank/cutting experiences surficial erosion caused due to the action of exogenous wind and water resulting into loss of soil, leading to development of cuts, rills/gullies adversely affecting the cess width, soil matrix, steepening of slopes etc which depends on type of soil, climatic conditions, topography of area, length of slope etc. Detailed guidelines for erosion control are given in Para 5.11.

6.1.6 Other Aspects of Construction of Earthwork:

a) The spreading of material in layers of desired thickness over the entire width of embankment should be done by mechanical means and finished by a motor grader. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the slope and grade.

b) Thickness of layer is decided based on field compaction trials as per annexe no. IV. However, as a good practice thickness of layer should be generally kept as 300 mm for fill material and 250 mm for blanket material in loose state before compaction.

c) If natural moisture content (NMC) of the soil is less than the OMC, calculated amount of water based on the difference between OMC & NMC and quantity of earthwork being done at a time, should be added with sprinkler attached to water tanker and mixed with soil by motor grader or by other means for obtaining uniform moisture content. When soil is too wet, it is required to be dried by aeration to reduce moisture content near to OMC. Efforts should be made to keep moisture content level of the soil in the range of OMC ± 2% at the time of compaction.

d) The rolling for compaction of fill material shall commence from edges towards centre with minimum overlap of 200 mm between each run of roller.

e) Extra bank width of 500 mm on either side shall be rolled to ensure proper compaction at the edges. The extra soil would be cut and dressed to avoid any loose earth at the slopes.

f) Top of formation should be finished to cross slope of 1 in 30 from one end to another towards cess/drain in multiple lines and from centre of formation to both sides in single line.

6.2 QUALITY ASSURANCE OF EARTHWORK:

6.2.1 Setting up of GE Lab at Construction/Rehabilitation Site:

A well-equipped GE Field Laboratory shall be set up at all construction projects connected with new lines, doubling and gauge conversion works as well as, where rehabilitation of failing formation is being undertaken. Number of such GE labs to be established on a particular project/work site would depend on the pace and length of work being executed at a particular site and the output of the lab so that all quality control checks can be performed effectively.
6.2.2 **Quality Check of Earthwork:**

Quality of execution of formation earthwork shall be controlled through exercise of checks on the borrow material, blanket material, compaction process, drainage system and longitudinal & cross-sectional profiles of the embankment.

6.2.3 **Quality Control Checks on Finished Earthwork:**

Degree of compaction of each layer of compacted soil should be ascertained by measurement of dry density/Relative Density of soil at locations selected in specified pattern.

6.2.4 **Frequency of Tests:**

Density check would be done for every layer of compacted fill/blanket material as per following minimum frequency:

1. **At least one density check for every 30m length for blanket layers and top one meter of prepared sub-grade/subgrade along the alignment in a staggered pattern of each compacted layer.**
2. **At least one density check for layer other than as specified in i.) above, every 500 sqm or 75m c/c whichever occurs earlier along the alignment in a staggered pattern of each compacted layer.**
3. **In case of important bridge approaches (100m length on either side), at least on density check for every 25m length shall be adopted.**
4. **Second cycle plate load test: Ev2 measurement at top of each finished sub-grade/prepared subgrade/Blanket layer to be determined at the frequency of one test per Km.**
5. **Type of soil is checked for every 5000 cum in case of embankment fill, for every 2000 cum in case of subgrade and for every 500 cum in case of blanket material.**

6.2.5 **Method of In-situ Dry Density Measurement:**

Any of the following methods could be used for dry density measurement as per requirement at site(Detailed guidelines in this regard are given in table of para 7.2.2.1 (c) of GE: G-1/2003):

1. **Core cutter method** is most commonly used for in-situ dry density measurement due to faster results with minimum apparatus requirement. In some of the coarse- grained soils (with little fines) taking core cutter samples is difficult.
2. **Sand replacement method** may be used for density measurement in all type of soils and specially in coarse grained soils (with little fines).
3. **Nuclear Moisture density gauge** is very handy and is very suitable where large number of tests are required for railway embankment. Besides, bulk density it provides moisture content and degree of compaction. (These augers utilize radioactive materials that may be hazardous to the health of the users unless proper precautions are taken. Users of these gauges must become familiar with applicable safety procedures and government regulations).

**Note:** Density check of compacted layer is indirect method of checking strength of soil. It is always desirable to have direct test providing
6.3.1 Strength parameters required for designed loads. When bearing capacity is insufficient, application of repeated axle loads shall result in plastic settlement of embankment resulting in track settlement and degradation. Conventional CBR method is one of such laboratory test.

6.2.6 Acceptance Criteria:

(i) Coarse grained soils which contains fines passing 75 micron IS Sieve, upto 5% should have the Density Index (Relative Density) a minimum of 70% as obtained in accordance with IS: 2720 (Part 14)-1983.

(ii) For other soils, field dry density should not be less than maximum attainable dry density obtained in field compaction trial. However, in field compaction trial, the max attainable dry density should not be less than 98% of MDD values.

In case, there are difficulties in achieving 98% of the MDD values as obtained by the laboratory test, in the field trials, the same may be relaxed upto 95% of MDD with the specific approval of Chief Engineer/ Const, recording reasons of such relaxations.

6.2.7 Finished Tolerances:

Formation Level: Finished top of sub-grade level may have variation from design level by ±25 mm and finished top of blanket layer may also be permitted to have variation from design level by plus 25 mm. The ballast should be placed only on level formation without ruts or low pockets.

Cross Slope: Cross slope should be within 1 in 28 to 1 in 30.

Side Slopes: Side slope should be 2H : 1V or flatter as per design.

Formation Width: Formation width should not be less than the specified width.

Speed of Section during Opening: Design and quality of construction should be such, so as to ensure opening of new lines, gauge conversions and doublings at full sectional speed and the same can be maintained throughout the service life from geo-technical considerations.

6.3 MAINTENANCE OF RECORDS:

At work site, details of works along with materials being used are to be properly recorded so that work of satisfactory quality can be achieved which can also be verified at later stage. Records are also required to be maintained to develop completion drawings and other details, which would become permanent records of the section and could be helpful in future to plan developmental activities and remedial measures if need be. Some of important records to be maintained are as follows:

6.3.1 Quality Control Records:

At least, following records of quality control as per proformas given in GE:G-1/2004, needs to be maintained.

i) Characteristics of borrow materials as per Proforma I of Annexure – 6.01.

ii) Field compaction trial details as per Annexure – 6.02.

iii) Quality of compaction of earthwork as per Proforma No. 3 for core cuttermethod &4 of Annexure – 6.01 for sand replacement method.
iv) List of equipment for field lab as per Annexure-6.03.

6.3.2 Permanent Records:

It would be desirable to prepare completion drawing of embankments and cuttings indicating details of special construction features like toe-walls, breast wall, catch and side drains, cross section of embankment/cutting, type of soil in subgrade and depth of blanketing material, geological features etc. These permanent records need to be handed over to open line at the time of handing over section of the section for maintenance.

6.4 Annexures:

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<thead>
<tr>
<th>6.4</th>
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<tbody>
<tr>
<td>(i)</td>
<td>Annexure - 6.01- Details of Borrow soil/ Formation subgrade</td>
</tr>
<tr>
<td>(ii)</td>
<td>Annexure- 6.02- Field compaction Trial</td>
</tr>
<tr>
<td>(iii)</td>
<td>Annexure- 6.03- List of Equipment for Field Lab</td>
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## Details of Borrow soil/ Formation subgrade

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Performa for field compaction record

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<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

Note: In case of compaction of blanket material, percentage of fines should be mentioned in column. The above format is taken from Appendix A (page 8) of IS: 2720 Pt.29-197
Performa for field compaction record

Performa No. 4

Chainage / km from: ..............to: ..............

\( y' \) max from lab: ..............

Soil Classification: ..................

\( y' \) min from lab: ..............

Height of bank: ..................

### Sand Replacement method

<table>
<thead>
<tr>
<th>Location</th>
<th>Bulk density of sand ( y_s ) (gm/cc)</th>
<th>Wt. of soil from hole ( W_w ) (gm)</th>
<th>Wt. of Cylinder + sand before pouring ( W_1 ) (gm)</th>
<th>Wt. of sand + Cylinder after pouring ( W_2 ) (gm)</th>
<th>Mean weight of sand in cone ( W_s ) (gm)</th>
<th>Wt. of sand in hole ( W_0 = W_1 - W_2 - W_s )</th>
<th>Bulk density of soil ( y_b = (W_s/W_0) \cdot y_s )</th>
<th>Moisture content (w), %</th>
<th>Dry density of soil ( y_d = y_b (1 + w) )</th>
<th>Relative density Io</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

Sig. and name of Railway officer

Sig. and name of contractor

Remarks

| 12 | 13 | 14 |
Field compaction Trial

1 General:
Field compaction trial is carried out to optimize compaction efforts of earthwork while achieving desired level of density based on Lab tests (Heavy compaction test, IS:2720 (Part-8) and Relative Density Test, IS:2720 Part -14). Type of roller to be used for compaction has to be decided depending on type of soil to be compacted in execution of earthwork.

2 Determination of compaction efficiency:
The increasing trend of density with increase in number of passes of a compactor tends to diminish gradually and a ‘diminishing return stage’ is reached. This will determine the type of compactor, optimum thickness of layer, corresponding water contents and number of rollers passes.

3 Methodology for conducting field compaction trial includes following steps:

Step 1: Construct a test ramp about 30m long, 10m wide & 0.15m thick on one end & 0.55m on other end, preferably at the construction site, over a level ground surface clear of bushes, depressions etc under nearly identical conditions (Fig. – K1).

Step 2: Divide the ramp equally into desired number, say, four segments, longitudinally of about 2.5m width (more than width of roller). Each strip will be used for conducting trial at specific moisture content, viz. OMC (Lab test value), OMC ±4% and (PL - 2%) etc. Specifications for Railway Formation 23 of 169 Note: Experience shows that most suitable water content falls within a small range of 3% below to 1% above the OMC for most of the soil.

Step 3: Start compaction trial on first segment at a particular moisture content (Step 2).

Step 4: Fix four number sampling points on this strip at locations where layer thickness of about 0.225, 0.30, 0.375 & 0.450m are to be obtained after rolling.

Step 5: Collect samples around the sampling points (Step 4). Determine moisture content by any suitable standard method.
Step 6: Compare the moisture content with that of the relevant desired moisture content (Step-3).

Step 7: Wait for natural drying if moisture content is on higher side or sprinkle appropriate amount of water uniformly followed by ploughing etc. and leave for 5 to 30 minutes depending on type of soil, in case the moisture content is on lower side (Step 3).

Step 8: Determine moisture content once again at sampling points before rolling. Observations of determination of moisture content are recorded as per (Table – K2).

Step 9: Roll the strip and measure the dry density (by any standard method) of the soil after every two passes commencing from four roller passes. The observations are recorded as per Table-K3. Note: Measurement of dry density and moisture content are taken after removing top 5 cm layer of earth with least possible disturbance. If the layer thickness is small, density ring should be used.

Step 10: Carry out testing on each strip at different specific moisture content as for first strip explained above. Compile the results of trial of all strips as per (Table – K2).

Step 11: From these test results, two sets of graphs are plotted: First set of graphs - Dry density vs number of rollers passes for each water content and layer thickness. For each layer, there would be four (depending on range of moisture content chosen) curves for different moisture content.

Second set of graphs: Maximum dry density vs moisture content for each layer thickness.

Step 12: Second set of graphs will give field moisture content, maximum attainable field dry density and optimum layer thickness. From these field values minimum no. of passes of particular roller are read from first set of graphs. Relevant proforma are placed at Appendix – K.
Compaction Equipment Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Roller-1</th>
<th>Roller-2</th>
<th>Roller-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of roller</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drum dimension</td>
<td>Width (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Roller type)</td>
<td>Diameter (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot (Sheep Foot type)</td>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Length (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Area (mm²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact Area (cm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Sheep Foot/ Pneumatic tyre/Vibratory Plate type)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tyre inflammation pressure (kg/cm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal Amplitude (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic force (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Speed (kmph)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static linear loads (kg/cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact Pressure (kg/cm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

List of Equipment for Field Trial/Monitoring

<table>
<thead>
<tr>
<th>SN</th>
<th>Equipment</th>
<th>Required</th>
<th>Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pan balance with weights (5kg 500g)</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Physical balance with weights (1mg to 100mg)</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Core cutter with Dolly and Hammer</td>
<td>4 set</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Spatula</td>
<td>4 set</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Flying Pan</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Containers plastic (about 500g capacity)</td>
<td>8 nos</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Enamel plates (1cm dia)</td>
<td>16 nos</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Uniform clean sand (Ottawa sand)</td>
<td>10 nos</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Measuring Tape (2.0m)</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Measuring Tape (15m/30m)</td>
<td>1 no</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Kerosene oil stove</td>
<td>1 no</td>
<td></td>
</tr>
</tbody>
</table>

Signature of Monitoring Official:  
Signature of Project Official:  
Name:  
Designation:  
Name:  
Designation:
Table 1: Field compaction trial observation

<table>
<thead>
<tr>
<th>Strip no.</th>
<th>Location on the ramp</th>
<th>Moisture content before watering</th>
<th>Moisture content after adding the water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Container no.</td>
<td>Wt. of wet soil (gm)</td>
<td>Wt. of dry soil (gm)</td>
</tr>
<tr>
<td>1</td>
<td>J</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>J</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>3</td>
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<td></td>
</tr>
<tr>
<td>K</td>
<td>4</td>
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<td>L</td>
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<td>L</td>
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<td>3</td>
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<td></td>
</tr>
<tr>
<td>L</td>
<td>4</td>
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<td></td>
</tr>
<tr>
<td>M</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>2</td>
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<td>3</td>
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<td></td>
</tr>
<tr>
<td>M</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Signature of monitoring official: .................................................................
Signature of project official: .................................................................
Name: ..........................................................................................................
Name: ..........................................................................................................
Designation: .............................................................................................
Designation: .............................................................................................
Date: ........................................
Date: ........................................
## Table 2: Field compaction trial observation

<table>
<thead>
<tr>
<th>Strip no.</th>
<th>Location on the ramp</th>
<th>Core cutter no</th>
<th>Moisture content before watering</th>
<th>Moisture content after adding water</th>
<th>Dry density of soil</th>
<th>% of MDD</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wt. of empty core cutter (gm)</td>
<td>Wt. of wet soil with core cutter (gm)</td>
<td>Bulk density of soil (gm/cc)</td>
<td>Wt. of wet soil (gm)</td>
<td>Wt. of dry soil (gm)</td>
</tr>
<tr>
<td>J</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>K</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>L</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>M</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Signature of monitoring official: ___________________________  Signature of project official: ___________________________
Name: ___________________________  Name: ___________________________
Designation: ___________________________  Designation: ___________________________
Date: ___________________________  Date: ___________________________

---

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### Table-3: Field Compaction Trial- Computation Sheet

<table>
<thead>
<tr>
<th>SN</th>
<th>Lift thickness (mm)</th>
<th>Moisture content (%)</th>
<th>Dry density of soil (gm/cc)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nos of the roller passes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>225</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>375</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>450</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>525</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Computed by ...........................................  Checked by ..........................................
Name .............................................  Name .............................................
Designation ......................................  Designation ......................................
Date ...............................................  Date ...............................................
Project .............................................  Location ........................................
RAMP OF EARTH FOR COMPACTION TRAILS IN THE FIELD

* SAMPLING
  - J, K, L, M

* MOISTURE CONTENT (%)
  (WITH VARIATIONS OF +2%)
  - OMC-4, OMC, OMC+4, PL-2

* SAMPLING POINTS
  - J1, J2, J3, J4, K1, K2, K3, K4, L1, L2, L3, L4, M1, M2, M3, M4

* THICKNESS IN MM.
  - 225, 300, 375 & 450

* NO. OF TIMES FOR OBSERVATIONS
  - 6 (SIX), (AFTER INTERVAL OF 4, 8, 12, 16 & 14 PASSES OF ROLLER)

* TOTAL NO. OF OBSERVATIONS
  - 4 x 4 x 5 = 96
<table>
<thead>
<tr>
<th>NAME OF PROJECT</th>
<th>LIFT</th>
<th>NOTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION</td>
<td>225mm</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td>300mm</td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>375mm</td>
<td>△</td>
</tr>
<tr>
<td></td>
<td>450mm</td>
<td>▲</td>
</tr>
</tbody>
</table>

### MOISTURE CONTENT vs MAX. DRY DENSITY FOR VARIOUS LIFT THICKNESS

<table>
<thead>
<tr>
<th>MAX. DRY DENSITY (g/m³)</th>
<th>MOISTURE CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.20</td>
<td>8</td>
</tr>
<tr>
<td>1.30</td>
<td>10</td>
</tr>
<tr>
<td>1.40</td>
<td>12</td>
</tr>
<tr>
<td>1.50</td>
<td>14</td>
</tr>
<tr>
<td>1.60</td>
<td>16</td>
</tr>
<tr>
<td>1.70</td>
<td>18</td>
</tr>
<tr>
<td>1.80</td>
<td>20</td>
</tr>
<tr>
<td>1.90</td>
<td>22</td>
</tr>
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</table>

### OFFICIALS IN CHARGE

<table>
<thead>
<tr>
<th>SIGNATURE</th>
<th>NAME OF OFFICER</th>
<th>DESIGNATION</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

### QUALITY CONTROL OFFICIALS

<table>
<thead>
<tr>
<th>SIGNATURE</th>
<th>NAME OF OFFICER</th>
<th>DESIGNATION</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
List of Equipment for Field Lab

New line/Doubling/GC works are to be executed in close association with the GE Cell on Railways to ensure proper quality of earthwork.

**LIST OF EQUIPMENTS FOR FIELD LAB**

*Table-G1*

<table>
<thead>
<tr>
<th>SN</th>
<th>Description of Equipments</th>
<th>Preference of code (latest version to be used)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IS set of sieves with base &amp; top lid 20mm, 19mm, 10mm, 4.75mm, 2 mm 600mic, 425mic, 212mic, 75mic,.</td>
<td>IS-460</td>
<td>2 sets</td>
</tr>
<tr>
<td>2</td>
<td>Hand operated sieve shaker for above sieves.</td>
<td></td>
<td>1 no.</td>
</tr>
<tr>
<td>3</td>
<td>BALANCE i) Pan balance - 10 kg capacity (with 1.0 gm Least Count) ii) Electronic balance - 500 gm capacity (with 0.1 gm Least Count)</td>
<td></td>
<td>1 no.</td>
</tr>
<tr>
<td>4</td>
<td>Field density apparatus complete. a) sand replacement b) core cutter with dolly</td>
<td>2720-1974 part-XXVIII 2720-1975 part-XXIX 2720 part-8-1983</td>
<td>2 sets 5 sets 2 sets</td>
</tr>
<tr>
<td>5</td>
<td>Modified heavy Proctor density apparatus full unit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Liquid Limit apparatus hand operated with counter &amp; grooving tools.</td>
<td>2720 part-V-1985</td>
<td>2 sets</td>
</tr>
<tr>
<td>7</td>
<td>Shrinkage limit apparatus</td>
<td></td>
<td>1 no.</td>
</tr>
<tr>
<td>8</td>
<td>Stainless steel spatula - 25cm long</td>
<td></td>
<td>2 no.</td>
</tr>
<tr>
<td>9</td>
<td>Porcelain bowl for LL - 15cm dia.</td>
<td></td>
<td>3 no.</td>
</tr>
<tr>
<td>10</td>
<td>Aluminium dish with lid - 5cm dia.</td>
<td></td>
<td>4 no.</td>
</tr>
<tr>
<td>11</td>
<td>Wash bottle - 1 lit. capacity 500ml capacity</td>
<td></td>
<td>5 no.</td>
</tr>
<tr>
<td>12</td>
<td>Glass plate 10mm thick 50x50 cm</td>
<td></td>
<td>2 no.</td>
</tr>
<tr>
<td>13</td>
<td>Ground glass 5mm thick 50x50 cm</td>
<td></td>
<td>2 no.</td>
</tr>
<tr>
<td>14</td>
<td>Enamed trays 45x30cm 20x20cm</td>
<td></td>
<td>3 no. 3 no.</td>
</tr>
<tr>
<td>15</td>
<td>Enamelled plates 6inch dia</td>
<td></td>
<td>10 no.</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Frying pans</td>
<td>9 no.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Stove janta</td>
<td>10 no.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Straight edge 300mm long</td>
<td>3 no.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Grain size analyser of fines</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Hydrometer</td>
<td>2 no.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Thermometer 0 to 50 c c</td>
<td>2 no.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glass cylinder 1000cc capacity with 60mm dia.</td>
<td>5 no.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Desiccators as IS –6128</td>
<td>2 no.</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Can of 10 litre capacity for distilled water</td>
<td>3 no.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wooden mortar and pestle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Specific gravity test apparatus.</td>
<td>1 no.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Density bottle-50ml capacity</td>
<td>2 no.</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Glass cylinder 100 cc capacity (for Free Swell index test)</td>
<td>2 no.</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Oven- thermostatically controlled to maintain a temperature 105-110c</td>
<td>1 no.</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td><strong>Consumable Item</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Sieve brush</td>
<td></td>
<td></td>
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<tr>
<td>27</td>
<td>Wire brush</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Sodium carbonate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Sodium hexa meta phosphate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Kerosene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Mercury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td><strong>Additional Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Hand auger 150mm dia with extension rod</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Sampling tube 100mm dia. And 450mm length</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IS-2720 part-4-1985**
CHAPTER-7

PLANNING FOR BALLAST PROCUREMENT

7.1 Introduction:
Ballast is the granular material usually crushed stone placed and packed below and around the sleepers to transmit load (due to the wheels of the train) from sleepers, to formation and at the same time allowing drainage of the track. It provides a suitable foundation for the sleepers and also hold the sleepers in their correct level and position, preventing their displacement by lateral or longitudinal thrusts. The lateral stability of a track depends on the ballast.

7.2 Minimum depth of ballast cushion:

As per Para 263(2) of IRPWM advance correction slip no. 126 dt 21.06.11 for Broad gauge-

<table>
<thead>
<tr>
<th>In Case of</th>
<th>Min depth of all BG routes (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track Renewals (Complete Track Renewals and Through Sleeper Renewals)</td>
<td>300*</td>
</tr>
<tr>
<td>All Doubling, Gauge conversions and new line construction works</td>
<td>350</td>
</tr>
<tr>
<td>Loop line</td>
<td>250</td>
</tr>
</tbody>
</table>

*Where possible a depth of 350mm may be provided

7.3 Calculation of Quantity of Ballast per meter in track:

As per Annexure -2.11 B para 263 of IRPWM & as per ACS155 dated09.1.2020 of IRPWM (Annexure-7.01)

* For Broad Gauge, PRC sleepers

<table>
<thead>
<tr>
<th>Depth of cushion</th>
<th>Quantity of Ballast per meter in cum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Straighttrack</td>
</tr>
<tr>
<td>200 mm</td>
<td>2.030</td>
</tr>
<tr>
<td>300 mm</td>
<td>2.304</td>
</tr>
<tr>
<td>350 mm</td>
<td>2.585</td>
</tr>
</tbody>
</table>
7.4 Specification of track ballast:

As per RDSO Specifications for Track ballast IRS-GE-1 (Up to CS-4 dt 10.5.2016)

General

7.4.1 Basic quality–

Ballast should be hard durable and as far as possible angular edges/corners free from weathered portions of parent rock, organic impurities and inorganic residues.

7.4.2 Particle shape –

Ballast should be cubical in shape as far as possible individual pieces should not be flaky and should have generally flat faces not more than two rounded/sub rounded faces.

7.4.3 Mode of manufacture–

To ensure uniformity of supply, Machine crushed ballast should be preferred for Broad Gauge.

7.4.4 Physical Properties-

Ballast sample should satisfy the following physical properties in accordance with IS: 2386 Pt IV 1963 when tested as per procedure given in (Annexure-7.03) RDSO Specifications for Track ballast IRS-GE-1 (Up-to CS-4 dt 10.5.2016).

Aggregate Abrasion value - 30% Max* (BG)
Aggregate Impact value - 20% Max* (BG)

*Relax up to 35% & 25% respectively on techno-economic grounds by CTE/CE.

7.4.5 Water absorption–

tested as per IS 2386 Pt III-1963, following the procedure given in Annexure III should not be more than 1% as per RDSO Specifications for Track ballast IRS-GE-1 (Up-to CS-4 dt 10.5.2016) (Annex.7.03).

The power of relaxing for water absorption limit should be delegated to CTE in open line/CAO on construction for specified areas. However, maximum water absorption in any case should not be allowed more than 2.5% as per the Para 2.2.3.1 of the RDSO ‘Specifications for Track Ballast’ IRS-GE-1, 2004 (Up-to CS-4 dt 10.5.2016)

7.4.6 Size and gradation-

Ballast should satisfy the following size gradation
(a) Retained on 65 MM Sq. mesh sieve - 5% Maximum
(b) Retained on 40 MM Sq. mesh sieve - 40% to 60% (*For machine crushed)
(c) Retained on 20 MM Sq. mesh sieve - Not less than 98% (For machine crushed)

• Oversize ballast :

i) In case ballast retained on 65mm sieve is at variance from 7.4.6 (a) specified above the stack can be accepted with reduced payment as under:
A Max of 5% ballast retained on 65 mm sieve shall be allowed without deduction in payment. In case ballast retained on 65 mm sieve exceeds 5% but does not exceed 10%, payment as 5% deduction in contract rate shall be made for the full stack. Stacks having more than 10% retention of ballast on 65 mm sieve shall be rejected.

# As per the RDSO ’Specifications for Track Ballast’ IRS-GE-1, 2004, corrected up to CS No.4. (Annexure-7.03)

ii) In case ballast retained on 40mm square mesh sieve is above 60% limit prescribed in 7.4.6 (b) above, payment at following reduced rates shall be made for the full stack in addition to reduction worked out at (i) above.

- 5% reduction in contracted rates if retention on 40mm square mesh sieve is between 60% (excluding) and 65% (including).
- 10% reduction in contracted rates if retention on 40mm sq. mesh sieve is between 65% (excluding) and 70% (including).

iii) In case retention on 40mm sq mesh sieve exceeds 70% the stacks shall be rejected.

- **Under size ballast:**
  The ballast shall be treated as under sized and shall be rejected if –

  i) Retention on 40mm square mesh sieve is less than 40%.

  ii) Retention on 20mm square mesh sieve is less than 98% (for machine crushed).

### 7.5 Method of sieve analysis:

i) The screen for sieving of ballast will be of square mesh and shall not be less than 100 cm in length, 70cm in breadth and 10cm in height on sides. The test sieves used for sieve analysis shall conform to the specification given in (Annexure -7.03)RDSO Specifications for Track ballast IRS-GE-1 (Up-to CS-4 dt 10.5.2016).

ii) While carrying out sieve analysis the screen shall not kept inclined, but held horizontally and shaken vigorously. The piece of ballast retained on the screen shall not be pushed through the screen openings.

iii) The percentage passing through or retained on the sieve shall be weight only.

iv) Least count of weighing machine should not be more than 100gms (Correction Slip No.4 RDSO Specifications for Track ballast IRS-GE-1 (Up-to CS-4 dt 10.5.2016)

### 7.6 Condition for submission of Tender:

7.6.1 Each tenderer at the time of tendering shall submit the test report of Impact value, Abrasion value, Water Absorption Value from approved Laboratories and the list of these laboratories shall be mentioned in the tender documents.

7.6.2 The tenderer shall also furnish an undertaking in incorporated in the tender document that the ballast supply at all times will conform to Specifications for Track Ballast as specified by Railway.
7.7 Measurement:

7.7.1 Stack Measurement:
Stacking shall be done on a neat plain and firm ground with good drainage. The height of stack shall not be less than 1 m except hilly areas where it may be 0.50 m and the height shall not be more than 2.0 m. Top of stack shall be kept parallel to the ground plane. The side slope of stack should not be flatter than 1.5:1 (Horizontal:Vertical). Cubical content of each stack shall normally be not less than 30 cum in plain areas and 15 cum in hilly areas.

7.7.2 Wagon Measurement:
In case of ballast taken by directly into wagons, a continuous white line should be painted inside the wagon to indicate the level to which ballast should be loaded the cubical content in cubic metre corresponding to white line should also be painted on both sides outside the wagon.

7.7.3 Shrinkage Allowance:
Payment shall be made for the gross measurement either in stack or in wagon without any deduction of shrinkage / voids. However, when ballast supply is made in wagons, shrinkage up to 8% shall be permitted at destination while verifying the booked quantity by the consignee as per the RDSO 'Specifications for Track Ballast' IRS-GE-1, 2004.

7.7.4 Sampling and Testing:

7.7.4.1 General

7.7.4.1.1 The sample shall be drawn with due diligence and adequate precautions so that they represent the true nature and condition of the ballast.

7.7.4.1.2 Being a heterogeneous material, the gradation of ballast loaded in wagon and/or dumped/inserted in the track may not remain same as that initially checked in stacks due to lifting, loading, transportation, unloading etc. Similarly, in case of direct loading in wagon, the gradation of ballast at destination may not remain same as that at source, due to loading, transportation etc. Therefore, the sample from wagon and track are not representative samples as far as gradation is concerned. Even in the same track, results of two checks may not be same.

7.7.4.1.3 The samples from a stack taken after lapse of a long period of stacking are not representative samples of the ballast supplied in the stack, due to settle down of smaller size of particles in voids underneath, dirt/dust getting accumulated in the stack, rains etc.

7.8 Sampling Frequency:

In order to ensure supply of uniform quality of ballast, the following norms shall be followed in respect of sampling testing and acceptance.
7.8.1 On supply of the first 100cum, the tests for Size & Gradation, Abrasion Value, Impact Value, and Water Absorption (if prescribed) shall be carried out by Railway. Further supply shall be accepted only after this ballast satisfies the specification for these tests. Railway reserve the right to terminate the contract as per GCC at this stage itself in case the ballast supply fails to confirm with any of these specifications.

7.8.2 Subsequent tests shall be carried out as follows:

<table>
<thead>
<tr>
<th>S N</th>
<th>TEST</th>
<th>Supply in Stacks</th>
<th>Supply in Wagons</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Size &amp; Gradation</td>
<td>One for each 100 cum or part thereof in any stack</td>
<td>One for each 100 cum or part thereof for quantity to be loaded in wagons.</td>
</tr>
<tr>
<td>b)</td>
<td>Abrasion Value, Impact Value, &amp; Water Absorption Value (*)</td>
<td>One test for every 2000 cum</td>
<td></td>
</tr>
</tbody>
</table>

(*) These tests shall be done for the purpose of monitoring quality during supply. In case of the test results not being as per the prescribed specification at any stage, further supplies shall be suspended till suitable corrective action is taken and supplies ensured as per specifications.

- The above tests may be carried out more frequently if warranted at the discretion of Railway.

7.9 Supply of ballast in Stacks:

1. Sampling Procedure

   (i) At the time of formation of stacks, sufficient care should be taken to ensure that there is sufficient space around the stack to facilitate movement of JCB/Power Equipment. The length and width of each stack shall be kept in such a way that every part of the stack is accessible to the JCB or Power Equipment, to be deployed for drawing “Samples”.

   (ii) In case of ballast supply in stacks, three “Samples” each of 0.3 - 0.5 cum volume, one, sample each from two sides and one sample from top after removing outer layer (150-200 mm) should be collected from stack for every 100 cum or part thereof, by JCB or other suitable Power Equipment.

   (iii) The location (in plan) and depths of sampling points shall be varied for different “Samples” and different stacks in a lot.

   (iv) Gross “Sample” should be prepared by thoroughly mixing the three “Samples” collected as in (ii) above, using JCB bucket or any other suitable Power Equipment, on a clean, flat and hard surface.
(v) A “Test Sample” of volume 0.027 cum shall be drawn from each of the “Gross sample, by the method described in para 5.3.1 of (vii) RDSO Specifications for Track ballast IRS-GE-1 (Up-to CS-4 dt 10.5.2016) for carrying out Size and Gradation tests.

(vi) Method of drawing “Test Samples”. The ballast in “Gross Sample” shall be scooped into a cone shaped pile by taking care to drop each scoop full exactly over the same spot. After the cone is formed, it shall be flattened by pressing the top of the cone with a smooth surface. Then it is cut into quarters by two lines which intersect at right angles at the centre of the cone. The bulk of the samples is reduced by rejecting any two diagonally opposite quarters. The remaining ballast shall be mixed and “test sample” shall be drawn for testing. After drawing “test samples”, the left over ballast of “Gross Samples” shall be dumped back in the stack.

(vii) In case clean, flat and hard surface is not available then a tarpaulin or any other suitable sheet may be used on a flat surface for mixing, drawing and sieve analysis of samples.

(viii) In case of stacks of volume more than 100 cum, more than one “Test Samples” will be tested for size and gradation. In such cases the sieve analysis results of all the “Test Samples” shall individually conform to following gradation, for acceptance/rejection of the whole stack:

(a) Retention on 20mm Sq. Mesh Sieve shall not be less than 98% for machine crushed ballast (not less than 95% for hand broken ballast).

(b) Retention on 40mm Sq. Mesh Sieve shall be between 40 to 70%.

(c) Retention on 65mm Sq. Mesh Sieve shall not be more than 10%.

The full payment/reduced payment for the whole stack, as given in Para 2.3 of the “Specifications for Track Ballast (IRS-GE-1, June-2004), shall be decided based on the average of the sieve analysis results of all the “Test Samples” for a stack.

7.10 Supply of ballast in Heaps for Loading directly in Wagons:

7.10.1 Sampling Procedure

(i) Samples of ballast shall be collected from heaps of ballast proposed to be loaded in to the wagons. For this, the contractor shall inform ADEN in-charge in writing sufficiently in advance before placement of rake, about the location of ballast heaps from where it is to be loaded into wagons. ADEN in-charge shall decide the location of heaps from which sampling is to be done, judiciously covering the entire quantity of ballast to be loaded in the rake.

<table>
<thead>
<tr>
<th>Type of Tests</th>
<th>Supply of Stacks</th>
<th>Supply in Wagons</th>
<th>Size of Test sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### i) Size and Gradation Test

<table>
<thead>
<tr>
<th></th>
<th>One for each 100 cum or part thereof, in any stack</th>
<th>One for each 100 cum or part thereof for quantity to be loaded in wagons</th>
<th>0.027 cum for every 100 cum or part, thereof</th>
</tr>
</thead>
</table>

### ii) Abrasive Value, Impact Value and Water Absorption Value

- One Test for every 2000 cum
- (Based on IS:2386 Part-III & IV of 1963)

---

**ii)** As per the RDSO 'Specifications for Track Ballast' IRS-GE-1, 2004, corrected upto CS No.4.

The above tests may be carried out more frequently if warranted at the discretion of Railway.

**iii)** Based on the approx. quantity of ballast to be loaded in the rake, methodology for sampling of ballast to be followed shall be the same as in Para-5.3.1 and 5.3.2 of RDSO Specifications for Track ballast IRS-GE-1 upto CS-4 dt 10.5.2016.

### 7.11 Checklist:

1. **(i)** Location of ballast supply should be fixed and marked in ballast supply chart & location shall be within minimum lead as well as possible.
2. **(ii)** Ballast should be Angular & Homogeneous.
3. **(iii)** Before supply, a sample of ballast be checked by authorized Laboratory by Const. Organization.
4. **(iv)** Ballast sample should satisfy the physical properties in accordance as per CEs Circular No 231(P-Way) Annexure 7.02.
5. **(v)** Where supply is required, a Register of Plots be maintained and in Register, AXEN/XEN should certify i.e. Plot is level and dimension of plot must be mentioned.
6. **(vi)** Side slope of ballast stake should not be flatter them 1.5: 1.
7. **(vii)** Height of stake shall not be less than 1.0 meter.
8. **(viii)** Each stack shall not be less than 30 cum.
9. **(ix)** Register of ballast supply should be maintained by SSE/JE/C/P way as per Para 4.10 of CE/circular 257.
10. **(x)** No measurement should be done for part stacks. After Measurement of stack, the Stack shall not be disturbed except for training out (Para 4.11 of CE/circular 257).
11. **(xi)** Ballast Putting/training out permission will be taken from Dy. CE/Const after 15 day of Measurements or 7days after passing of bill, whichever is later.
### 7.12 Annexures:

<table>
<thead>
<tr>
<th></th>
<th>Annexures:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Annexure - 7.01 - Correction Slip no. 155 to the Indian Railways Permanent Way Manual</td>
</tr>
<tr>
<td>(ii)</td>
<td>Annexure - 7.02 - C.E.’s Circular No. 231 (P.Way) : Specifications of Track Ballast</td>
</tr>
<tr>
<td>(iii)</td>
<td>Annexure - 7.03 - Specifications of Track Ballast IRS-GE-1 June 2004</td>
</tr>
</tbody>
</table>
No. 2019/CE-II/CS/1/Pt.

New Delhi, dated 09.01.2020

The General Managers (Engrs.-) CR, ER, ECR, ECoR, NR, NCR, NER, NFR, NWR, SR, SCR, SER, SECER, SWR, WR, WCR and Metro Railway/Kolkata.
The General Manager (Const.), N.F. Railway, Guwahati.
The General Manager/CORE/Allahabad.

Principal Financial Advisor, All Indian Railways
The CAO/Const. All Indian Railways.
The General Managers (Engrs.) - ICF/Chennai, RCF/Kapurthla, DLW/Varanasi, CLW/Chitrakoot, Rail Wheel Factory, Yelahanka, Bangalore & DMW/Patiala.

The Director General (Track), RDSO/Alambagh, Lucknow.
Chief Commissioner of Railway Safety, Lucknow.

Managing Director, IRCON, New Delhi.
Managing Director, RITES, RITES (rites bhawan) NII, Sector-29 Gurgaon-122001.
Managing Director, DMRC, Metro Bhawan, Barakhamba lane, New Delhi.
Managing Director, CONCOR, New Delhi.
Managing Director, RVNCL, August Kranti Bhawan, Bhikaji Cama Place, New Delhi.
Managing Director, DFCCIL, Pragati Maidan, Metro Station, New Delhi.
Managing Director, PIPAVAV Railway Corp. Ltd., 14th Floor, B-Wing, Statesman House 148, Barakhamba Road, Connaught Place New Delhi Central Delhi
Managing Director, MRVC, Church Gate station Building 2nd Floor, Mumbai - 400020.
Managing Director, RLDA, IRCON Office Compound, Next to Safdarjung Rly. station, Motibagh-I, New Delhi.
Managing Director, Konkan Railway Corporation Ltd, Belapur Bhawan, Sector-11, CBD Belapur, Mumbai. Pin - 400614.

Director, IRICON, Pune.
Director, RIEEN, Nasik.
Director, IRISET, Secunderabad.
Director, IRIMEE, Jamalpur.
Director, IRITM, Vill. Kakanad, Hardoi, Manik Nagar, Lucknow.
Director General, Railway Staff College, Vadodara.
Genl. Secretaries, AIRF, NFIR, IRPOF, FROA, AIRPFA, DAI (Railways) Rail Bhawan, New Delhi.


*****

Ministry of Railways (Railway Board) has decided that correction/addition as indicated in the enclosed Correction Slip No.155 dated 09.01.2020, to relevant para of the IRPWM, be made.

Receipt of this letter may please be acknowledged.

(Pradeep Nagar)
Director Civil Engrg.(P)
Railway Board

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No. 2019/CE-JCS/1/Pl.

Copy to:-

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AM(CE), AM(Works), AM(Budget), AM(Eng.), AM(Fin.), AM(Sig.), AM(Plg.),
AM(Staff), AM(Mech. Engg.), AM(PU.), AM(Tele.), AM(TT), PED(Bridge),
PED(Vigilance), PED(Stn.Dev.Engg.) PED(Safety), AM(C&S), AM(T&C), AM(Comm.),
PEDCE(P), EDTK(MC), EDCE(G), PED(Bridge), ED(L&A)R, ED(Works), EDV(E),
ED(Project Monitoring), ED(Safety), EDFXI, EDF(XII),
DTK(MC), DTK(M), DTK(P), DCE(B&S), DCE(I&S)II, Dir(Works)-I, Dir(Works)-II,
Dir.Works(Plg.), DVE-I & DVE-II,

ED/C&S - for uploading on Railway Board website.

******

New Delhi, dated. 09.01.2020
1. The existing Annexure-2/11 (Sketch and Table) and Annexure-2/13 (Sketch) of Para 263 of IRPWM shall be replaced by new Annexure-2/11 (Sketch and Table) and Annexure-2/13 (Sketch and table) of Para 263 as attached.

Annexure-2/11 Para 263

(A) BALLAST PROFILE FOR LWR TRACK (SINGLE LINE B.G.)

IF NECESSARY IN A CUTTING SUITABLE

DWARF WALL SHALL BE

PROVIDED FOR RETAINING

BALLAST.

F (FOR CUTTING)

F (FOR EMBANKMENT)

| G Gauge | Type of Sleepers | A | B | C' | D | E' | F | FI | H | Quantity of Ballast per meter in | Remarks |
|---------|------------------|---|---|----|---|----|---|----|---| Straight Track (m³) | Curved Track (m³) |
| Steel Trough | 250 | 350 | 500 | 2,280 | 2,430 | 6,850 | 6,250 | 550 | 1,762 | 1,827 |
| 1676 mm | 300 | 400 | 550 | 2,270 | 2,420 | 6,850 | 6,250 | 590 | 1,782 | 1,853 |
| 2 Block | 250 | 350 | 500 | 2,360 | 2,510 | 6,850 | 6,220 | 630 | 2,110 | 2,193 |
| 1 block | 300 | 400 | 550 | 2,350 | 2,500 | 6,850 | 6,220 | 680 | 2,314 | 2,405 |

1. The Minimum Clean Stone Ballast cushion below the bottom of sleeper i.e., A=250 mm.
2. For routes where increase in speeds are to be more than 120 Kmph. A=300 mm or 200 mm, along with 150 mm of sub-ballast.
3. Suitable dwarf walls shall be provided in case of cuttings, if necessary for retaining ballast.
4. *On outer side of curves only.
5. *Cuts may be widened where required depending on local conditions and outside of curves.
6. All dimensions are in mm.
7. * 200 over 150 sub-ballast.
(B) BALLAST PROFILE FOR LWR TRACK (SINGLE LINE B.G.)
(FOR PRC SLEEPERS)

![Diagram of ballast profile]

<table>
<thead>
<tr>
<th>G</th>
<th>Type of Sleeper</th>
<th>A</th>
<th>B</th>
<th>C*</th>
<th>D</th>
<th>E*</th>
<th>F</th>
<th>F1</th>
<th>H</th>
<th>Quantity of Ballast per Meter</th>
<th>Straight Track (M³)</th>
<th>Curved Track (M³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1676 mm</td>
<td>PRC</td>
<td>250</td>
<td>350</td>
<td>500</td>
<td>2692</td>
<td>2851</td>
<td>7850</td>
<td>7850</td>
<td>646</td>
<td>2.030</td>
<td>2.120</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>350</td>
<td>350</td>
<td>500</td>
<td>2772</td>
<td>2930</td>
<td>7850</td>
<td>7850</td>
<td>698</td>
<td>2.304</td>
<td>2.401</td>
<td></td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>350</td>
<td>500</td>
<td>500</td>
<td>2851</td>
<td>3099</td>
<td>7850</td>
<td>7850</td>
<td>751</td>
<td>2.585</td>
<td>2.690</td>
<td></td>
</tr>
</tbody>
</table>

Remarks:
1. Depth of ballast cushion should be provided as per Para 263(2)(a) of IRPWM.
2. Cross-Slope of 1 in 30 shall be provided for New Works.
3. Suitable dwarf walls shall be provided in case of cuttings, if necessary for retaining ballast.
4. *On outer side of curves only.
5. Super-elevation has not been considered in calculation of ballast quantity for curved track.
6. The cess width on existing track is to be increased on programmed basis wherever required so that minimum cess width as per side slope given above is ensured.
7. All dimensions are in mm.

[Signature] 09/10/2020
<table>
<thead>
<tr>
<th>S. No.</th>
<th>In case of</th>
<th>Recommended Depth of Ballast Cushion (mm)</th>
<th>Quantity of Ballast per Meter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>On Straight and Curves of Radius flatter than 600M</td>
<td>Curves of Radius sharper than 600M</td>
</tr>
<tr>
<td>1</td>
<td>Loop line</td>
<td>250 mm</td>
<td>1.769 M³</td>
</tr>
<tr>
<td>2</td>
<td>Track renewal</td>
<td>300 mm</td>
<td>2.022 M³</td>
</tr>
<tr>
<td>3</td>
<td>All gauge conversion &amp; new work</td>
<td>350 mm</td>
<td>2.282 M³</td>
</tr>
</tbody>
</table>

**Note:**

1. In the case of ordinary fish plated track: * To be increased on the outside of curves to 400 mm in the case of curves sharper than 600 M radius.
2. In short welded panel Track* To be increased to 400 mm on outside of all curves, flatter than 875m radius and to 450 mm, in the case of curves sharper than 875M radius.
3. * To be increased to 550 mm on the outside of turn in curves of turn-outs in passenger yards.
4. Depth of Ballast cushion should be provided as per Para 263(2)(a) of IRP/M.
5. The cess width on existing track is to be increased on programmed basis wherever required so that minimum cess width as per side slope given above is ensured.

[Signature]  
[Date: 09/01/2020]
C.E.'s Circular No. 231 (P. Way)

Sub: Specifications of Track ballast

1. This is supersession to C.E.'s Circular No. 170. Instructions issued by RDSO on the subject in May '95 shall now be followed. Copy of the same is enclosed.

2. Wherever the approval of Chief Engineer has been mentioned in those instructions, if please be read as Chief/Chief track Engineer.

Sd/-
For Chief Engineer

SPECIFICATION FOR TRACK BALLAST

1. SCOPE: These specifications will be applicable for stone ballast to be used for all types of sleepers on normal track, turnouts, tunnels and deck slabs etc. on routes.

2. DETAILED SPECIFICATION

2.1 GENERAL

2.1.1 Basic quality: Ballast should be hard, durable and as far as possible angular edges/corners, free from weathered portions of parent rock, organic impurities and inorganic residues.

2.1.2 Particle Shape: Ballast should be cubical in shape as far as possible. Individual pieces should not be flaky and should have generally flat faces with not more than two rounded/sub-rounded faces.

2.1.3 Mode of Manufacture: To ensure uniformity of supply, machine crushed ballast should be preferred for Broad gauge and Metre gauge routes. Procurements of hand broken ballast shall be resorted to only with the prior personal approval of CTE/CE. CTE/CE should record reasons while granting such approval before calling off tender in each case for ballast supply on Broad Gauge and metre Gauge routes.

However, no such approval need be taken for supply on Narrow gauge routes.

2.2 PHYSICAL PROPERTIES

2.2.1 Ballast sample should satisfy the following physical properties in accordance with IS: 2386 Pt. IV-1983 when tested as per the procedure given in Annexure-1 & 2.

<table>
<thead>
<tr>
<th>Ballast Grade (BG &amp; MG)</th>
<th>Aggregate Abrasion value</th>
<th>Aggregate Impact value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30% Max.*</td>
<td>20% Max.*</td>
</tr>
</tbody>
</table>

* Relaxable upto 35% & 25% respectively on technoeconomic grounds by CTE/CE

2.2.2 The shape parameter "Flatness Index" as determined in accordance with IS: 2386 Pt. 1-1983 following the procedure given in Annexure-3 should not be more than 50%. This test may be dispensed with for ballast supply on Narrow gauge routes.
2.2.3 The water absorption test as per IS: 2386 Pt. III-1963, following the procedure given in Annexure 4 should not be more than 1%.

This test may be dispensed with for ballast supply on Narrow gauge routes.

2.3 SIZE AND GRADATION:

2.3.1 Ballast should satisfy the following size gradation :-

(a) Retained on 65MM. Sq. mesh sieve - Nil

(b) Retained on 405MM. Sq. mesh sieve - 40% to 60%

(c) Retained on 20MM. Sq. mesh sieve - Not less than 98% for machine crushed. Not less than 95% for hand broken.

2.3.2 Oversize ballast:

i) In case ballast retained on 65mm square mesh sieve is at variance from 2.3.1 (a) specified above, the stack shall be rejected.

ii) In case ballast retained on 40mm square mesh sieve is between 60% limit prescribed in 2.3.1 (b) above, payment at following reduced rates shall be made for the full stack :-

- 95% of quoted rates if retention on 40mm mesh sieve is between 60% (excluding) and 65% (including).
- 90% of quoted rates if retention on 40mm sq mesh sieve between 60% (excluding) and 65% (including).

iii) In case retention on 40mm sq. mesh sieve exceeds 70% the stacks shall be rejected.

2.3.2 Undersize ballast:

The ballast shall be treated as undersized and shall be rejected if-

i) Retention on 40mm square mesh sieve is less than 40%

ii) Retention on 20mm square mesh sieve is less than 98% (for machine crushed) or 95% (for hand broken)

2.3.4 Method of Sieve Analysis:

i) The screens for sieving of ballast be of square mesh and shall not be less than 100cm in length, 70 cm in breadth and 10 cm in height on sides.

ii) While carrying out sieve analysis, the screen shall not be kept inclined, but held horizontally and shaken vigorously. The piece of ballast retained on the screen shall not be pushed through the screen openings.)
iii) The percentage passing through or retained on the sieve shall be determined by weight only.

3.1 Each tenderer at the time of tendering shall submit the following:

(a) Three samples of ballast in sealed transparent jars containing three kg each.

(c) Test report of impact value, abrasion value, flakiness index and water absorption value from reputed laboratory/institution.

(d) The above samples received from the tenderer shall be signed by the tender opening members. Lable as per the following format be pasted by the tenderer on all the above four sample containers.

---

(Tender No. :
Name of the work :
Name of the tenderer :
is the test certificate enclosed. Yes/No
Date
Signature of Tender
Opening Officials
Date

The tenderers shall also furnish an under taking that the ballast supply at all times will conform to specifications for Track ballast as specified by Railway.

3.3 Railway reserves the right to retest the ballast sample of any or all tenderers, before finalisation of tender at Railway's cost.

4. METHOD OF MEASUREMENT.

Stacking shall be done on a neat, plain and firm ground, with good drainage. The height of stack shall not be less than 1m except in hilly areas where it may be 0.5m. Top width of stack shall not be less than 1.0m. Top of stack shall be kept parallel to the ground plane. The side slopes of stack should not be flatter than 1:5:1 (Horizontal: Vertical). Cubical content of each stack shall normally be not less than 30 cum in plain areas and 15cum in hilly areas.

4.2 WAGON MEASUREMENT:

4.2.1 In case of Ballast supply taken by direct loading into wagons, a continuous white line should be painted inside the wagon to indicate the level to which ballast should be loaded, the cubical content in cubic metre corresponding to white line should also be painted on both sides outside the wagon.
4.2.2 In addition to painted, mentioned in para 4.2.1, short pieces of flats (cut pieces of tie bars or otherwise) with the cubical contents punched, shall be welded at the centre of all the four sides as shown below as permanent reference.

**Welded flat**

<table>
<thead>
<tr>
<th>CUM</th>
<th>White line</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.85</td>
<td></td>
</tr>
</tbody>
</table>

4.3 **SHRINKAGE ALLOWANCE**: Payment shall be made for the gross measurements either in stacks or in wagons without any deduction for shrinkage voids.

5. **SAMPLING AND TESTING**:

5.1 On acceptance of tender, three samples in sealed Jars submitted by the successful tenderer as per clause 3.1 will be kept one each in Divisional Dy. Chief Engineer’s (C) Office, Assistant Engineer’s Office and PWI’s Office. This will provide visual guidance to check uniformity of supply. However, fulfillment of size, gradation, shape and physical properties shall be the criteria for acceptance of supply in the field. Rest of the samples submitted at the time of tender can be disposed off after finalisation of the tender.

5.2 In order to ensure supply of uniform quality of ballast, the following norms shall be followed in respect of sampling, testing and acceptance.

5.2.1 On supply of the first 100 cum, the tests for size, Gradation, Abrasion value, Impact value, “Flakiness Index, and Water Absorption shall be carried out by Railway. Further supply shall be accepted only after this ballast satisfies the specifications for these tests. Railway reserves the right to terminate the contract as per GCC at this stage itself in case the ballast supply fails to conform with any of these specifications.

*(Note: Not applicable for ballast supply on Narrow Gauge routes.)*

5.2.2 Subsequent tests shall be carried out as follow :-

<table>
<thead>
<tr>
<th>Supply in stacks</th>
<th>For each stack of</th>
<th>for each stack of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>volume less than</td>
<td>100 CUM</td>
</tr>
<tr>
<td></td>
<td>100 CUM</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>a)</th>
<th>Size &amp; Gradation Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Testing Frequency stack</td>
</tr>
<tr>
<td></td>
<td>Size of sample</td>
</tr>
<tr>
<td></td>
<td>for every 100 cum or part thereof</td>
</tr>
</tbody>
</table>
b) Abrasion value, value. Impact
Value Flakiness Index
& Water Absorption
Test.

<table>
<thead>
<tr>
<th>Testing Frequency</th>
<th>One for every 2000 cum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of Samp</td>
<td>45 kg.</td>
</tr>
</tbody>
</table>

** This sample should be collected using a wooden box of internal dimensions 0.3m X 0.3m X 0.3m from different parts of the stack / wagon.

These tests shall be done for the purpose of maintaining quality during supply. In case of the test result not being as per the prescribed specifications at any stage, further supplies shall be suspended till suitable corrective action is taken and supplies ensured as per specification. Test for Flakiness Index and Water Absorption are not applicable for ballast on Narrow Gauge routes.

The above tests may be carried out more frequently if warranted at the discretion of Railway.

5.2.3 If the quality of the ballast is noted to have changed during supply, as revealed by visual comparison with the approved sample, the properties as per clause confirm that it satisfies the properties as per clause 2.2. The approved sample of the changed supply should be preserved, for future checks, in three sealed transparent jars, jointly signed by the given in clause 5.1.

5.2.4 All tests for Abrasion Value, Impact Value, Flakiness index and water Absorption conducted subsequent to award of contract shall be done at railway's cost.

Annexure-I

Aggregate Abrasion Value

(Based on IS : 2386 Part IV-1963)

1. Apparatus.

1.2 The abrasive charge shall consist of 12 nos. cast iron or steel spheres approx. 46mm dia and each weighing between 390 and 445 gm, ensuring total weight of charge as 5,000+25gm.

1.3 IS sieves of sizes 50mm, 40mm, 25mm, and 1.70mm.

1. 4 drying Oven.

2. Test Sample.

2.1 The test sample of 10,000gm shall consist of clean ballast conforming to the following grading:

- Passing 50 mm and retained on 40 square mesh sieve. 5,000 gm @
2.2 The procedure

The test sample and the abrasive charge shall be placed in the Los Angeles abrasion testing machine and the machine rotated at a speed of 20 to 33 revolutions/minute for 1000 revolution. At the completion of test, the material shall be discharged and sieved through 1.70mm IS Sieve.

4. Analysis and Reporting of the result.

4.1 The material coarser than 1.70mm sieve shall be washed, dried in oven at 100-110 degree C to a percentage of the original weight of the test sample. This value shall be reported as:

Aggregate Abrasion Value = (A-B)/A x 100

Aggregate Impact Value
( Based on IS : 2386 Part IV-1963)

1. Apparatus

The apparatus shall consist of the following :

(a) Impact testing machine conforming to IS : 2386 part IV-1963 as per fig.-2.
(b) IS sieves of sizes 12.5mm, 10mm, and 2.36mm.
(c) A cylindrical metal measure of 75mm dia. & 50mm depth,
(d) A Tamping rod 10mm circular cross section and 230mm length, rounded at one end.
(e) Drying Oven

2. Test Sample

2.1 The test sample shall be prepared out of track ballast so as to conform to following grading.

- Passing 12.5mm IS Sieve 100%
- Retained 10mm IS sieve 100%

2.1 The sample shall be oven dried for 4 hours at temperature of 100-110 degree C and cooled.
2.2 The measure shall be filled about one-third full with the prepared aggregate and tamped with 25 strokes of the tamping rod. A further similar quantity of aggregate shall be added and a further tamping of 25 strokes given. The measure shall finally be filled to overflowing, tamped 25 times 25 times and the surplus aggregate struck off, using the tamping rod as a straight edge. The net weight of the aggregate in the measure shall be determined to the nearest gm.

(Weight 'A')

3. Test procedure.

3.1 The cup of impact testing machine shall be fixed firmly in position on the base the machine and the whole of the test sample placed in it and compacted by 25 strokes of the tamping rod.

3.2 The hammer shall be raised 380mm above the upper surface of the aggregate in the cup allowed to fall freely on the aggregate. The test sample shall be subjected to a total of 15 such blows, each being delivered at an interval of not less than one second.

4. Analysis and Reporting of the Result:

4.1 The sample shall be removed and sieved through 2.36mm IS sieve. The fraction passing-through shall be weighed (Weight 'B'). The fraction retained on the sieve shall also be weighed (Weight 'C') and if the total weight (B+C) is less than the initial weight (Weight 'A') by more than one gm. the result be discarded and a fresh test made.

4.2 The ratio of the weight of the fines formed to the total sample weight shall be expressed as a percentage.

\[
\text{aggregate impact value} = \frac{B}{A} \times 100
\]

4.3 Two such tests shall be carried out and the mean of the results shall be reported to the whole number as the Aggregate Impact Value of the tested material.

Annexure-3

Flakiness Index

(Based on IS : 2385 Part I-1963)

1. General.

The flakiness index of an aggregate is the percentage by weight of particles in it whose least dimension (thickness) is less than three-fifths of their mean dimension.

2. Apparatus

The apparatus shall consist of the following:

(a) Metal gauge for measuring thickness as per fig. 3

(b) Sieves-IS sieves of sizes as shown in table-1.
3. Test Sample

A sufficient quantity of track ballast shall be taken to provide a minimum number of 200 pieces of each fraction as per Table-I, which should be weighed (Weight 'A')

4. Test Procedure.

4.1 The sample shall be sieved through sieve specified in table-1.

4.2 Separation of Flaky material: Each fraction shall be gauged in turn for thickness on a metal gauge of the pattern shown in fig. 1. The width of the slot used in the gauge shall be of the dimensions specified in Table-1.

<table>
<thead>
<tr>
<th>Size of Aggregate</th>
<th>Passing through mm.</th>
<th>Retained on IS sieve mm.</th>
<th>Thicknes Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>50</td>
<td>33.90</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>40</td>
<td>27.00</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>25</td>
<td>19.50</td>
<td></td>
</tr>
<tr>
<td>31.5</td>
<td>25</td>
<td>16.95</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>20</td>
<td>13.50</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>16</td>
<td>10.80</td>
<td></td>
</tr>
</tbody>
</table>

4. The total amount of flaky material, which is passing through the gauge shall be weighed (Weight 'B')

5. Analysis and reporting of the Result :

5.1 The Flakiness index is the total weight of the material passing the various thickness gauges, expressed as a percentage of the total weight of the sample gauged.

Annexure-4

Water Absorption

(Based on IS : 2386 Part III-1963)

1. Apparatus

   The apparatus shall consist of the following:

   (a) Wire Basket- Perforated, electroplated or plastic coated, with wire hangers for suspending it from the balance.
(b) Water tight container for suspending the basket.

c) Dry soft Absorbent cloth 75x45 cm size 2 nos.

d) Shallow Tray of minimum 650 square cm area.

e) Air tight container of capacity similar to basket.

f) Drying Oven.

2. Test Sample.

A Sample of not less than 2000 gm shall be used.

3. Test Procedure.

3.1 The sample shall be thoroughly washed to remove finer particle and dust drained and then placed in the wire basket and immersed in distilled water at a temperature between 22-32 degree C.

3.2 After immersion the entrapped air shall be removed by lifting the basket and allowing it to drop 25 times in 25 seconds. The basket and sample shall remain immersed for a period of 24 +/- 1/2 hours afterwards.

3.3 The basket and aggregate shall then be removed from the water, allowed to drain for few minutes, after which the aggregate shall be gently emptied from the basket on to one of dry clothes and gently surface dried with the cloth, transferring it to second dry cloth when the first will remove no further moisture. The stone aggregate shall be spread on the second cloth and exposed to atmosphere (away from direct sunlight) until it appear to be completely surface dry. The aggregate then shall be weighed (weight 'A').

3.4 The aggregate shall then be placed in an oven at a temperature of 100-110 degree C for 24 hours. It shall then be removed from oven, cooled and weighted (Weight 'B').


   Water Absorption = (A - B) / B X 100

4.1 Two such tests shall be made individual and mean results shall be reported.
रेलपथ गिट्टी की विशिष्टियां

SPECIFICATIONS FOR TRACK BALLAST

IRS-GE-1
JUNE-2004

रू. तत्कालीन अभियंतारी के निर्देशन
अनुसार अभियंता और माध्यम लगान
लक्षणरूप 2297
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<th>Page No.</th>
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<td>2 Detailed Specifications</td>
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<td>3 Conditions for submission of tender</td>
<td>3</td>
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<td>4 Method of measurement</td>
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</tbody>
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## ANNEXURES
(Tests Methods based on relevant IS Codes)

<table>
<thead>
<tr>
<th>Title</th>
<th>Page No.</th>
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<td>1 Aggregate Abrasion Value</td>
<td>6</td>
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<td>7</td>
</tr>
<tr>
<td>3 Water Absorption</td>
<td>8</td>
</tr>
</tbody>
</table>
SPECIFICATION FOR TRACK BALLAST

1. **SCOPE:** These specifications will be applicable for stone ballast to be used for all types of sleepers on normal track, turnouts, tunnels and deck slabs etc on all routes.

2. **DETAILED SPECIFICATIONS:**

2.1 **GENERAL**

2.1.1 **Basic Quality:** Ballast should be hard durable and as far as possible angular along edges/corners, free from weathered portions of parent rock, organic impurities and inorganic residues.

2.1.2 **Particle shape:** Ballast should be cubical in shape as far as possible. Individual pieces should not be flaky and should have generally flat faces with not more than two rounded/sub rounded faces.

2.1.3 **Mode of manufacture:** Ballast for all BG main lines and running lines, except on 'E' routes but including 'E' special routes, shall be machine crushed. For other BG lines and MG/NG routes planned/sanctioned for conversion, the ballast shall preferably be machine crushed. Hand broken ballast can be used in exceptional cases with prior approval of Chief Track Engineer/CAO/C. Such approval shall be obtained prior to invitation of tenders.

On other MG and NG routes not planned/sanctioned for conversion hand broken ballast can be used for which no approval shall be required.

2.2 **PHYSICAL PROPERTIES**

2.2.1 Ballast sample should satisfy the following physical properties in accordance with IS:2386 Pt.IV-1963 when tested as per the procedure given in Annexure-I & II.

<table>
<thead>
<tr>
<th>BG, MG &amp; NG(planned/sanctioned For conversion)</th>
<th>NG &amp; MG(other than those planned for conversion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Abrasion value</td>
<td></td>
</tr>
<tr>
<td>30% Max.*</td>
<td>35% Max.</td>
</tr>
<tr>
<td>Aggregate Impact value</td>
<td></td>
</tr>
<tr>
<td>20% Max.*</td>
<td>30% Max.</td>
</tr>
</tbody>
</table>

* In exceptional cases, on technical and/or economic grounds relaxable upto 35% and 25% respectively by CTE in open line and CAO/C for construction projects. The relaxation in Abrasion and Impact values shall be given prior to invitation of tender and should be incorporated in the Tender document.
2.2.2 To carry out Impact Test on ballast, a test sample of ballast pieces (about 5 kg in weight) of size 10 mm to 12.5 mm will be required. Appropriate care should be taken by the railways that ballast selected for breaking down to 10 mm to 12.5 mm size for Impact Test should be random from the ballast supply to avoid any subjectivity in selection of test sample. Alternatively, the test sample in the recommended range of size be got manufactured along with the ballast in sufficient quantity required for this test.

2.2.3 The “Water Absorption” tested as per IS 2386 Pt.III-1963 following the procedure given in Annexure III should not be more than 1%. This test however, to be prescribed at the discretion of CE/CTE in open line and CAO/Con. For construction projects.

2.2.3.1 The power of relaxing for water absorption limit should be delegated to CTE in open line/CAO on construction for specified areas.

However, maximum water absorption in any case should not be allowed more than 2.5%. (Correction Slip No. 3)

2.3 SIZE AND GRADATION

2.3.1 Ballast should satisfy the following size and gradation:

a) Retained on 65mm Sq.mesh sieve 5% Maximum

b) Retained on 40mm Sq.mesh sieve* 40%-60% (* For machine crushed ballast only.)

c) Retained on 20mm Sq.mesh sieve Not less than 98% for machine crushed
   Not less than 95% for hand broken

2.3.1.1 In exceptional cases, where it is considered necessary on technical considerations, to reduce the maximum size of ballast for NG lines, CTE may modify the size & gradation of the ballast as defined above. In case of such modifications, provision given in para 2.3.2 to 2.3.4 below shall also be suitably modified. This will be finalized before invitation of tenders and should be incorporated in the tender documents. (Correction Slip No. 1)

2.3.2 Oversize ballast

i) Retention on 65mm square mesh sieve.

   A maximum of 5% ballast retained on 65mm sieve shall be allowed without deduction in payment.

   In case ballast retained on 65mm sieve exceeds 5% but does not exceed 10%, payment at 5% reduction in contracted rate shall be made for the full stack. Stacks having more than 10% retention of ballast on 65nm sieve shall be rejected.

ii) In case ballast retained on 40mm square mesh sieve (machine crushed case only) exceeds 60% limit prescribed in 2.3.1 (b) above, payment at the following reduced rates shall be made for the full stack in addition to the reduction worked out at i) above.

   - 5% reduction in contracted rates if retention on 40mm square mesh sieve is between 60% (excluding) and 65% (including).

   - 10% reduction in contracted rates if retention on 40mm square mesh sieve is between 65% (excluding) and 70% (including).

   - 251
ii) In case retention on 40mm square mesh sieve exceeds 70%, the stack shall be rejected.

iv) In case of hand broken ballast supply, 40mm sieve analysis may not be carried out. The executive may however ensure that the ballast is well graded between 65mm and 20mm size.

2.3.3 Under Size Ballast: The Ballast shall be treated as undersize and shall be rejected if-
   i) Retention on 40mm Sq. Mesh sieve is less than 40%.
   ii) Retention on 20mm square mesh sieve is less than 98% (for machine crushed) or 95% (for hand broken).

2.3.4 Method of Sieve Analysis:
   i) 2.3.4.1 The test sieves used for sieve analysis shall conform to the specifications given in Annexure -IV.

   2.3.4.2 While carrying out sieve analysis, the screen shall not be kept inclined, but held horizontally and shaken vigorously. The pieces of ballast retained on the screen can be turned with hand to see if they pass through but should not be pushed through the sieve.

   2.3.4.3 The percentage passing through or retained on the sieve shall be determined by weight. The weighing equipment used shall NOT have least count more than 100 grams. (Correction Slip No. 4)

3. CONDITIONS FOR SUBMISSION OF TENDER

3.1 Each tenderer at the time of tendering shall submit the test report of Impact Value, Abrasion Value, Water Absorption Value from approved laboratories and the list of these laboratories shall be mentioned in the tender documents.

3.2 The tenderer shall also furnish an undertaking as incorporated in the tender document that the ballast supply at all times will conform to Specifications for Track Ballast as specified by Railway.

4. METHOD OF MEASUREMENT

4.1 Stack Measurement

   Stacking shall be done on a neat, plain and firm ground with good drainage. The height of stack shall not be less than 1m except in lally areas where it may be 0.5m. The height shall not be more than 2.0m. Top width of stack shall not be less than 1.0m. Top of stack shall be kept parallel to the ground plane. The side slopes of stack should not be flatter than 1.5:1 (Horizontal : Vertical). Cubical content of each stack shall normally be not less than 30 cum in plain areas and 15 cum in lally areas.
4.2 Wagon Measurement

4.2.1 In case of ballast supply taken by direct loading into wagons, a continuous white line should be painted inside the wagon to indicate the level to which the ballast should be loaded. The cubical content in cubic meter corresponding to white line should also be painted on both sides outside the wagon.

4.2.2 In addition to painted line, mentioned in para 4.2.1, short pieces of flats (cut pieces of tie bars or otherwise) with cubical contents punched shall be welded at the centre of all the four sides as permanent reference. In case the supply is taken in general service wagon, actual measurements will be taken.

4.3 Shrinkage Allowance

Payment shall be made for the gross measurements either in stacks or in wagons without any deduction for shrinkage/voids. However, when ballast supply is made in wagons, shrinkage upto 8% shall be permitted at destination while verifying the booked quantities by the consignee.

5. SAMPLING AND TESTING

5.1 General

5.1.1 The samples shall be drawn with due diligence and adequate precaution so that they represent the true nature and condition of the ballast.

5.1.2 Being a heterogeneous material, the gradation of ballast loaded in wagons and/or dumped/inserted in the track may not remain same as that initially checked in stacks, due to lifting, loading, transportation, unloading etc. Similarly in case of direct loading into wagons, the gradation of ballast at destination may not remain same as that at source, due to loading, transportation etc. Therefore, the samples from wagons and track are not representative samples as far as gradation is concerned. Even in the same stack, results of two checks may not be same.

5.1.3 The samples from a stack taken after lapse of a long period of stacking are not representative samples of the ballast initially supplied in the stack, due to settling down of smaller size particles in voids underneath, dirt/dust getting accumulated in the stack, rains etc.
5. **Sampling Frequency**

In order to ensure supply of uniform quality of ballast, the following norms shall be followed in respect of sampling, testing and acceptance:

5.2.1 On supply of the first 100 cum, the tests for Size & Gradation, Abrasion Value, Impact Value and Water Absorption (if prescribed) shall be carried out by Railway. Further supply shall be accepted only after this ballast satisfies the specifications for these tests. Railway reserves the right to terminate the contract as per GCC at this stage itself in case the ballast supply fails to conform with any of these specifications.

5.2.2 Subsequent test shall be carried out as follows:

<table>
<thead>
<tr>
<th>Type of Tests</th>
<th>Supply in Stacks</th>
<th>Supply in Wagons</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Size and Gradation Tests</td>
<td>One for each 100 cum or part thereof in any stack</td>
<td>One for each 100 cum or part thereof for quantity to be loaded in wagons</td>
</tr>
<tr>
<td>b) Abrasion Value, Impact Value and Water Absorption Value (*)</td>
<td>One Test for every 2000 cum</td>
<td></td>
</tr>
</tbody>
</table>

(*) These tests shall be done for the purpose of monitoring quality during supply. In case of the test results not being as per the prescribed specifications at any stage, further supplies shall be suspended till suitable corrective action is taken and supplies ensured as per specifications.

The above tests may be carried out more frequently, at the discretion of Railway.

5.2.3 All tests for Abrasion Value, Impact Value and Water Absorption should be got done through approved laboratories or Railway’s own laboratories (list of those laboratories shall be mentioned in the tender document). These tests, subsequent to award of contract, shall be done at Railway's cost.

5.3 Supply of ballast in Stacks

5.3.1 Sampling Procedure

(i) At the time of formation of stacks, sufficient care should be taken to ensure that there is sufficient space around the stack to facilitate movement of JCB/Power Equipments. The length and width of each stack shall be kept in such a way that every part of the stack is accessible to the JCB or Power Equipment, to be deployed for drawing "Samples".

(ii) In case of ballast supply in stacks, three "Samples" each of 0.3-0.5 cum volume, one sample each from two sides and one sample from top after removing outer layer (150-200 mm) should be collected from stack for every 100 cum or part thereof, by JCB or other suitable Power Equipment.

(iii) The location (in plan) and depths of sampling points shall be varied for different "Samples" and different stacks in a lot.

(iv) Gross Sample should be prepared by thoroughly mixing the three "Samples" collected as in (ii) above, using JCB bucket or any other suitable Power Equipment, on a clean, flat and hard surface.
Note: In exceptional cases of site specific constraints, approval of Competent Authority (Engineer-in-charge) shall be taken prior to invitation of tender, for using manual means for collection and mixing of "Samples", and this should be incorporated in the Tender Document.

(v) A "Test Sample" of volume 0.027 cum shall be drawn from each of the "Gross Sample", by the method described in Para 5.3.1 (vi), for carrying out Size & Gradation tests.

(vi) Method for drawing "Test Sample": The ballast in "Gross Sample" shall be scooped into a cone shaped pile by taking care to drop each scoopful exactly over the same spot. After the cone is formed, it shall be flattened by pressing the top of cone with a smooth surface. Then it is cut into quarters by two lines which intersect at right angles at the centre of the cone. The bulk of the sample is reduced by rejecting any two diagonally opposite quarters. The remaining ballast shall be mixed and "test sample" shall be drawn for testing. After drawing "test sample", the left over ballast of "Gross Sample" shall be dumped back in the stack.

(vii) In case clean, flat and hard surface is not available then a tarpaulin or any other suitable sheet may be used on a flat surface for mixing, drawing and sieve analysis of samples.

5.3.2 In case of stacks of volume more than 1.00 cum, more than one "Test Samples" will be tested for Size & Gradation. In such cases, the sieve analysis results of all the "Test Samples" shall individually conform to following gradation, for acceptance/rejection of the whole stack:

(i) Retention on 20mm Sq. Mesh Sieve shall not be less than 98% for machine crushed ballast (not less than 95% for hand broken ballast).
(ii) Retention on 40mm Sq. Mesh Sieve shall be between 40 to 70%.
(iii) Retention on 65mm Sq. Mesh Sieve shall not be more than 10%.

The full payment/reduced payment for the whole stack, as given in Para 2.3 of the "Specifications for Track Ballast (IRS-GE-1, June-2004), shall be decided based on the average of the sieve analysis results of all the "Test Samples" for a stack.

5.4 Supply of ballast in Heaps for Loading directly in Wagons

5.4.1 Sampling Procedure

Samples of ballast shall be collected from heaps of ballast proposed to be loaded into the wagons. For this, the contractor shall inform ADEN in-charge in writing sufficiently in advance before placement of rake, about the locations of ballast heaps from where it is to be loaded into wagons. ADEN in-charge shall decide the location of heaps from which sampling is to be done, judiciously covering the entire quantity of ballast to be loaded in the rake.

5.4.2 Based on the approx. quantity of ballast to be loaded in the rake, methodology for sampling of ballast to be followed shall be the same as in Para 5.3.1 and 5.3.2 above.
ANNEXURE-I

Aggregate Abrasion Value
(Based on IS:2386 Part IV-1963)

1. Apparatus

1.1 The abrasion test for track ballast shall be carried out using Los-Angles Machine as per fig.1.

1.2 The abrasive charge shall consist of 12 nos. cast iron or steel spheres approx. 48mm dia and each weighing between 390 and 445 gm ensuring total weight of charge as 5,000 ± 25gm.

1.3 IS sieves of sizes 50mm, 40mm, 25mm and 1.70mm.

1.4 Drying Oven

2. Test Sample

2.1 The test sample of 10,000gm shall consist of clean ballast conforming to the following grading:
- Passing 50mm and retained on 40mm square mesh sieve 5,000 gm@
- Passing 40mm and retained on 25mm square mesh sieve 5,000 gm@
  @ tolerance of ±2% permitted.

2.2 The sample shall be dried in oven at 100 – 110 °C to a constant weight and weighed (Weight ‘A’).

3. Test Procedure

The test sample and the abrasive charge shall be placed in the Los-Angeles abrasion testing machine and the machine rotated at a speed of 20-33 revolutions/minute for 1000 revolutions. At the completion of test, the material shall be discharged and sieved through 1.70mm IS sieve.

4. Analysis and reporting of the Result

4.1 The material coarser than 1.70mm IS sieve shall be washed, dried in oven at 100 - 110°C to a constant weight and weighed (weight B).

4.2 The proportion of loss between Weight “A” and Weight “B” of the test sample shall be expressed as a percentage of the original weight of the test sample. This value shall be reported as:

\[
\text{Aggregate Abrasion Value} = \frac{A-B}{A} \times 100
\]

-6-
ANNEXURE - II

Aggregate impact value
(Based on IS:2386 Part IV-1963)

1. Apparatus
   The apparatus shall consist of the following
   a) Impact testing machine conforming to IS:2386 part IV-1963 as per fig.2.
   b) IS Sieve of sizes 12.5mm, 10mm and 2.36mm.
   c) A cylindrical metal measure of 75mm dia & 50mm depth.
   d) A tamping rod 10mm circular cross section and 230mm length, rounded at
      one end.
   e) Drying Oven

2. Test Sample
   2.1 The test sample shall be prepared out of track ballast so as to conform to following
       grading:
       - Passing 12.5mm IS sieve 100%
       - Retention 10mm IS sieve 100%
   2.2 The sample shall be oven dried for 4 hours at a temperature of 100-110°C and cooled.
   2.3 The measure shall be filled about one-third full with the prepared aggregate and
       tamped with 25 strokes of the tamping rod. A further similar quantity of aggregate
       shall be added and a further tamping of 25 strokes given. The measure shall finally be
       filled to overflowing, tamped 25 times and the surplus aggregate struck off, using and
       tamping rod as a straight edge. The net weight of the aggregate in the measure shall
       be determined to the nearest gm (weight ‘A’).

3. Test Procedure
   3.1 The cup of impact testing machine shall be fixed firmly in the position on the base
       of the machine and the whole of the test sample placed in it and compacted by 25 strokes
       of the tamping rod.
   3.2 The hammer shall be raised 380mm above the upper surface of the aggregate in the
       cup and allowed to fall freely on to the aggregate. The test sample shall be subjected
       to a total of 15 such blows, each being delivered at an interval of not less than one
       second.

4. Analysis and Reporting of the result
   4.1 The sample shall be removed and sieved through 2.36mm IS sieve. The fraction
       passing through shall be weighed ( Weight ‘B’ ). The fraction retained on the sieve
       shall also be weighed ( Weight ‘C’) and if the total weight (B+C) is less than the
       initial weight (Weight ‘A’) by more than one gm, the result shall be discarded and a
       fresh test made.
   4.2 The ratio of the weight of the fines formed to the total sample weight shall be
       expressed as a percentage.
       Aggregate Impact Value = (B/A) X 100
   4.3 Two such tests shall be carried out and the mean of the results shall be reported to the
       nearest whole number as the Aggregate Impact Value of the tested material.
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ANNEXURE-III

Water Absorption
(Based on IS: 2386 Part III-1963)

1. Apparatus

The apparatus shall consist of the following:

a) **Wire Basket** - Perforated, electroplated or plastic coated, with wire
   hangers for suspending it from the balance.

b) **Water tight** container for suspending the basket.

c) **Dry soft Absorbent cloth** 75x45 cm size 2 nos.

d) **Shallow Tray** of minimum 650 square cm area.

e) **Air tight container** of capacity similar to basket.

f) **Drying Oven.**

2. Test Sample

A sample of not less than 2000gm shall be used.

3. Test Procedure

3.1 The sample shall be thoroughly washed to remove finer particle and dust,
   drained and then placed in the wire basket and immersed in distilled water at a
   temperature between 22-32°C.

3.2 After immersion the entrapped air shall be removed by lifting the basket and
   allowing it to drop 25 times in 25 seconds. The basket and sample shall
   remain immersed for a period of 24 ± ½ hours afterwards.

3.3 The basket and aggregate shall then be removed from the water, allowed to
   drain for few minutes, after which the aggregate shall be gently emptied from
   the basket on to one of dry clothes and gently surface dried with the cloth
   transferring it to second dry cloth when the first will remove no further
   moisture. The stone aggregate shall be spread on the second cloth and exposed
   to atmosphere (away from direct sunlight) until it appears to be completely
   surface dry. The aggregate then shall be weighed (Weight ‘A’).

3.4 The aggregate shall then be placed in an oven at a temperature 100 - 110°C for
   24 hours. It shall then be removed from oven, cooled and weighed (weight
   ‘B’).

4. Analysis and Reporting of the Result

Water Absorption = \{(A-B)/B\}x100

4.1 Two such tests shall be made and individual and mean results shall be
   reported.
ANNEXURE IV

Specification of Test Sieves used for Sieve Analysis of Ballast

1. The test sieves shall be perforated plate sieve type with square holes/apertures, mounted on a frame. The test sieves are designated by the nominal size of holes/apertures.

2. Material of Perforated Plate: The perforated plate for test sieves shall be manufactured from Brass Sheet or Steel Sheet or Stainless Steel Sheet or Galvanized Steel Sheet or Electropolished Steel Sheet.

3. Plate Thickness: The thickness of plate used for making test sieve and the tolerance permitted for this shall be as following:
   - For 65mm Square Mesh Sieve: 3mm (Plus 1.0mm Minus 0.5mm)
   - For 40mm Square Mesh Sieve: 2mm (Plus Minus 0.5mm)
   - For 20mm Square Mesh Sieve: 2mm (Plus Minus 0.5mm)

4. Arrangement of Holes/Apertures: The square holes/apertures of size "W" in the perforated plate shall be arranged at Pitch "P" as per the sketch given below:

5. Sieve Opening Size, Pitch of Openings and tolerances: The nominal size of individual hole/aperture at mid-section (W), the Pitch of holes/apertures (P) and permissible tolerance for them shall be as under:

<table>
<thead>
<tr>
<th>Test Sieve of Square Mesh Size</th>
<th>Nominal Size</th>
<th>W Tolerance</th>
<th>Distance</th>
<th>P Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 mm</td>
<td>65 mm</td>
<td>±1.5 mm</td>
<td>80 mm</td>
<td>(+) 12.0 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-) 8.0 mm</td>
</tr>
<tr>
<td>40 mm</td>
<td>40 mm</td>
<td>±1.5 mm</td>
<td>50 mm</td>
<td>(+) 7.5 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-) 5.0 mm</td>
</tr>
<tr>
<td>20 mm</td>
<td>20 mm</td>
<td>±1.0 mm</td>
<td>25 mm</td>
<td>(+) 4.0 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-) 2.5 mm</td>
</tr>
</tbody>
</table>
6. **Sieve Frame**: The frame of test sieves shall be manufactured from Hardwood or Steel sheet or Brass sheet. The internal size of the frame (i.e. clear size of perforated plate mounted on frame) shall not be less than 100cm in length, 70cm in breadth and 10cm in height on sides.

7. **Marking on test sieves**: A label shall be fixed to the frame of each sieve, legibly marked with following information:

   (i) Nominal Aperture Size,
   (ii) Material of perforated plate,
   (iii) Material of sieve frame,
   (iv) Maker's Name or Trademark, and
   (v) An Identification Number for the sieve.
LOS ANGELES ABRASION TESTING MACHINE

NOTE 1 - SHAFT BEARING WILL BE MOUNTED ON CONCRETE PIER OR OTHER RIGID SUPPORTS.
NOTE 2 - SUGGESTED HORSE POWER FOR MOTOR IS NOT LESS THAN ONE.
FIG. 2

LOCKING PIN FOR RELEASE MECHANISM
ADJUSTABLE STOP FOR RELEASE
LIFTING HANDLE
RELEASE CLAW
RATCHET COUNTER (TO COUNT NUMBER OF BLOWS)
TUP (WEIGHT 13.5–14.0 Kg)
2 mm CHAMFER
CASE HARDENED SURFACE
TUP GUIDE BAR
CYLINDRICAL STEEL CUP
INNER SURFACES CASE HARDENED
CIRCULAR BASE

ALL DIMENSIONS ARE IN MILLIMETRES.

AGGREGATE IMPACT TEST MACHINE
CHAPTER 8

TRACK LAYING AND ALLIED WORKS

8.1 Sanctioned Provisions and Initial Planning:

At the very outset, following aspects/issues need to be checked, examined taken care of:

8.1.1 Detailed Estimate:

Before taking up the physical execution of the work, it should beensured that the Detailed Estimate (DE) is sanctioned. Field units should ensure that:

(i) Sanctioned copy of the DE is available with them.

(ii) It should be checked that whether provision of items available in the DE is as per latest Railway Board guidelines. In any case, planning of work should be done as per latest Railway Board guidelines and changes of items in estimate, if required, should be got done through Revised Estimate (RE).

8.1.2 Planning of P.Way Material & preparation indents of P.Way material:

Demand for P.way material should be raised after thorough planning of the project. While doing material planning following aspects should be taken care of:

(i) Heavy P.way material viz. Rails are procured at Railway Board level. Hence, material should be demanded after detailed scrutiny so that material asked is neither excess nor it falls short at execution stage. It may please be noted that HQ only coordinates with Railway Board after compilation demand received from all field units.

(ii) Quantity of material should be worked out on the basis of approved ESPs/proposed ESPs or Conceptual ESPs signed by Division & HQ. Indent should be prepared accordingly.

(iii) Indents should be prepared keeping in mind the latest Railway Board guidelines about the track structure or any other relevant instructions. If items required do not match with the items available in DE, same should be proposed in RE. However, indents are to be made as per prevalent available guidelines only.

(iv) In indents, description of items should be proper as standard drawing numbers of RDSO or other competent authority, allocation code, consignee code & address should be clearly mentioned.

(v) Sometimes it happens that indents of some of the critical matching fittings are inadvertent not prepared along with major items & same are not available at execution stage. Hence, while preparing indents it should be ensured that indents of all matching fittings are prepared
simultaneously with major items by referring to concerned available approved drawings so that none of the matching fittings are left out.

(vi) Indents should be got vetted at the earliest from associate finance. Procurement procedure for P.Way material starts only after vetting of indents from associate finance.

8.1.3 Approval of ESPs/Plans:
As soon as the Detailed Estimate is sanctioned, following ESPs/Plans should be initiated for approval of the competent authority:
(i) Yard ESPs
(ii) LWR Plans
(iii) Track Diagram
(iv) Other Plans as required for execution of the P.Way works.

8.1.4 Tender Planning:
Tender schedule should be prepared taking following aspects into consideration:
(i) Tender schedule should be prepared as per Standard Tender schedule issued by HQ & latest guidelines available.
(ii) Quantity should be worked out on the basis of approved/proposed ESPs/Plans & any other available instructions.
(iii) Estimated cost for the purpose of tender schedule should normally be on the basis of 3 latest available LARs in the area by following latest prevalent guidelines & instructions on the matter.
(iv) Requirement of submission of Method Statement should be included in special conditions related to side data and specifications as detailed in Annexure 8.04.

8.1.5 Use of mechanized equipment/ machinery for P.Way Works:
Availability of unskilled labour has become difficult and costly now-a-days. In addition, progress of works executed by manual means gets adversely affected in case of shortage/ non-availability of labour. Many small mechanized equipment/ machines, without complicated/sophisticated parts or circuitry, are available in the market or can be easily manufactured/ assembled. They are not very costly to procure or maintain. Use of such mechanized means for various construction activities may be suitably incorporated in the contract condition, for better progress as well as quality of work. Some of such equipment’s /machinery are described below;

(i) Hydras & JCBs can be effectively utilized for shifting/carrying of P.way materials including rails Special slings are attached to Hydra for lifting of rails/sleepers like UTV machine.

(ii) JCB can be used for ballast regulation. During ballast regulation, front wheel of JCB is in lifted condition.
(iii) Modified Tractor/Truck with rail wheels can be used for unloading of ballast directly in track, similar to BOBYN.

(iv) Two Hydras working in tandem can be efficiently utilized for dismantling/laying of Points & Crossings. However, use of T-28 machines for laying of turnout will result in better quality and T-28 machines can be utilized depending upon availability of machines in coordination with open line.

(v) Utilizing available light multi-purpose machines like JCB-70 and Hydra of 8T capacity for laying of track for laying and alignment of the track.

(vi) Use of T-28 for shifting of existing SEJ on running lines can be done to save SEJ and block time and effort.

(vii) T-28 machines can be very effectively used for carrying out major Cut-n-Connection during very less block time.

8.1.6 Cut & Connection Works:

(i) Cut and connection works should be meticulously planned as such work involve long traffic blocks and large labour and machinery input.

(ii) For cut-n-connection, additional ballast for new/revised alignment should be arranged well in advance. It is always desirable to carryout extra earth work for 50 m on either side of cut-n-connection. This not only helps in keeping material but also supports bank as some of cut-n-connection location, bank will not be fully compacted, for long high bank, restricted locations, it is must.

(iii) Keep 3/5 Rail panels welded in-situ ready on cess to reduce welding on linked track.

(iv) Slewing of track should be done in stages as slewing of the track to new alignment in one stroke will make series of small goose necks; sleepers will go out of square due to sharp curvature, breaking of ERCs (most dangerous) and breaking of PSC sleepers at inserts etc.

(v) T-28 machine can be successfully used for slewing track in cut and connection. This is best way as least damage is done to track sleepers and better alignment is achieved.

8.2 UNLOADING AND STACKING OF P.WAY MATERIAL:

Proper assessment of requirement of material in a yard or section/location should be done prior to leading the material to site so as to avoid re-handling of the material. Unloading & stacking of P. Way material should be done carefully. It should be ensured that handling is done safely without any infringement to the existing track or structure and without any damage to the material being handled. Instructions with regard to lifting of SH rails (Annexure 8.03) for proper coordination with open line to avoid double payment should be kept in view. Detailed checklist regarding handling & stacking of P. way material is appended below.

8.2.1 Unloading & Stacking of Rails:
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it is ensured that loose rails are being unloaded by road cranes?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that stacking of loose rails is done at level, firm &amp; well drained ground?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Whether it is ensured that pairs of 20 rail panels are being unloaded on the side of new formation in case of doubling/multiple line works? <em>(Required to avoid crossing of rails over existing track from safety consideration)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Whether it is ensured that unloaded rail panels are shifted beyond the toe of ballast of existing track?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Whether it is ensured that unloaded rail panels are supported @ 4m interval with head upwards? <em>(Ref: Para 254(1)(b), ACS No. 137 dtd. 18.06.2015)</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**8.2.2 Unloading & Stacking of Sleepers:**

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it is ensured that PSC sleepers are unloaded by road cranes?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that stacking PSC sleepers is done at level &amp; firm ground?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Whether it is ensured that leading &amp; stacking of sleepers is being done as per actual requirement at site to avoid shifting of sleepers at later stage?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**8.3 Formation and Fixing of reference pegs:**

Cross section, L-section and width of formation should be checked with approved drawings as well as with latest instructions. Extra width of formation & super elevation on proposed curve locations should also be checked. Reference pegs should be fixed at proper locations in such a manner that they do not get disturbed during spreading of ballast & laying/ linking of track. Reference pegs should have proper marking of ballast bed level, rail levels after each packing and final rail
level. Following points should be ensured during survey and track laying operation:

(i) Proper survey of all yards using Total Station should be conducted to calculate turnouts/crossover lengths.

(ii) In station yards, L-sections should be finalized meticulously keeping in view aspects of drainage, level crossings no change in grade in the turnout zone and junction points of new line with existing running lines.

(iii) Wherever existing loop line is proposed to be upgraded as main line in a doubling project, track works like slewing, lifting, TSR, TRR, deep/shallow screening etc. should be planned well in advance. Such loop lines should preferably be disconnected/isolated with addition/alteration in S&T gears/installations at least 20 days before commissioning. This will help in maintaining good quality work and running during speed trials without any speed restrictions.

(iv) List of OHE, S&T, Track infringements affecting the works of other departments, should be prepared in advance by foot to foot survey of the yard.S&T location boxes and OHE installations infringing the proposed main line/loop line required to be opened for traffic at time of commissioning should be shifted well in advance to avoid accumulation of P.Way works in the limited NI period.

Detailed checklist regarding formation & fixing of reference pegs is appended below:

8.3.1 Formation:

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it checked that formation width of 7.85m for Main line &amp; 6.85m for Loop lines is available before starting linking work? <em>(Ref: Annexure 2/11 of IRPWM, ACS No. 135 dtd. 07.05.14)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that extra widening on the outside of the curve and other locations depending upon local conditions is provided or not? <em>(Ref: Remarks of Annexure 2/11 of IRPWM, ACS No. 135 dtd. 07.05.14)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Whether it is ensured that formation level is sufficient to maintain same rail level at level crossings in case of double line/multiple</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Whether it is ensured that formation level is sufficient to maintain same rail level in new yards?

Whether certificate from SSE/Works has been taken mentioning that finished formation level is as per approved L-section?

8.3.2 Fixing of reference pegs:

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it is ensured that reference pegs have been provided by grouting at every 25m interval in case of straight track and 10m interval in case of curved track?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that marking of ballast bed level, rail level after 1st manual packing, 2nd manual packing, 1st Machine tamping, 2nd Machine tamping and Final rail level (as per approved L-sections) on reference pegs has been done ?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Whether it is ensured that reference pegs mentioned in item no.2 are fixed at distance of 3.75m from the centre of the new formation on cess side &amp; 2.75m on the existing track side from the existing track in case of doubling/multiple lines?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Whether it is ensured that reference pegs have been provided by grouting at TTP, CTP, Centre of curve and obligatory points?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.4 Ballast works, Laying of Sleepers and Linking of Normal Track:

Ballast spreading should not be started unless permission from the competent authority has been received as per latest instructions. It should also be ensured that before start of ballast spreading at least minimum quantity of ballast, as
required for initial ballast bed, is available at site. After preparation of ballast bed, sleepers should be laid with proper spacing as per proposed sleeper density. Centre line and squaring of sleeper should be checked according to proposed alignment. Latest instructions on track laying and linking should be adhered to. Detailed checklist regarding ballast works, laying of sleepers and linking of normal track is appended below:

8.4.1 **Ballast bed:**

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it is being ensured that reference pegs are not disturbed during leading &amp; spreading of ballast?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 2  | Whether it is ensured that **initially** minimum quantity of ballast just required for ballast bed of 150 mm and manual lifting & packing (@1.50 cum per track meter) is being put on the formation?  
   (Balance quantity to be leaded through hoppers after manual packing & before deployment of machine for optimum utilisation of ballast) |        |         |
| 3  | Whether it is ensured that uniform layer of ballast bed (150 mm in case of 350 mm cushion and 100 mm in case of 250 mm cushion) has been provided before placing sleepers for linking? |        |         |
| 4  | Whether it is ensured that rolling of ballast bed has been done by roller of 5 to 8 tonne weight? |        |         |
| 5  | Whether it is ensured that minimum ballast cushion of 350 mm in main line and 250 mm in loop line has been provided in track?  
   *(Ref: Para 263(2)(a)(i) of IRPWM, ACS No. 126 dtd. 21.6.2011)* |        |         |
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Whether it is ensured that shoulder ballast width 350 mm in straight track and 500 mm on outer side of curve in case of LWR track has been provided? &lt;br&gt; <em>(Ref: Annexure 2/11 of IRPWM)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Whether it is ensured that shoulder ballast 550 mm on the outside of turn in curves of turnout has been provided? &lt;br&gt; <em>(Ref: Annexure 2/11 of IRPWM)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Whether proper dressing of ballast (as mentioned in Note below) after completion of machine tamping’s has been done? &lt;br&gt; Note: Dressing of ballast on sleeper end should be done in such a manner that there is no excess ballast on top of sleeper ends (i.e. ballast between sleeper ends should be somewhat lower than sleeper top so that paint strips marked on sleepers are clearly visible) but should have upward taper from sleeper ends (as per Annexure-2/11 of IRPWM). Sleeper top at the ends should be painted with 2 inchwide yellow paint strips, which should be visible after dressing.</td>
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</tbody>
</table>

**8.4.2 Laying of sleepers and linking of normal track:**

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>1</td>
<td>Whether it is ensured that correctly centre marked sleepers by permanent marker is being provided at every 15 mtr interval and matching with proposed centre line of track in reference to fixed pegs?</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that string/rope is being used for correct laying of sleepers in between</td>
<td></td>
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<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/ No</td>
<td>Remarks</td>
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<tr>
<td>2</td>
<td>two centremarked laid sleepers?</td>
<td></td>
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<tr>
<td>3</td>
<td>Whether it is ensured that marking of sleeper spacing is done on rail head in one go only by using 30 m tape to avoid accumulation of errors?</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>Whether it is ensured that squaring of sleepers is done by marking the sleeper spacing on other rail head with the help of P.Way square?</td>
<td></td>
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</tbody>
</table>
| 5  | Whether it is ensured that continuous marking of sleeper spacing is transferred from rail-head to rail-flange using template with the help of permanent fine marker?  
* (Template needs to be developed in the shape of mould shoe. Required to avoid error as with marking on rail-head only centre of insert is decided by eye approximation only) |  |  |
| 6  | Whether it is ensured that required sleeper density 1660 no./km (60 cm c/c sleeper spacing) on Main line, 1540 no./km (65 cm c/c sleeper spacing) on loop line and siding has been provided?  
* (Ref: Para 244(4), ACS No. 130 dtd. 16.11.2012) |  |  |
| 7  | Whether it is ensured that correct sleeper spacing (sleeper to sleeper variation with respect to theoretical spacing within ± 20 mm) and squaring is being done?  
* (Ref: Para 316(2) table of IRPWM) |  |  |
| 8  | Whether it is ensured that sleeper to sleeper variation of gauge is maintained within 2 mm?  
* (Ref: Para 316(2) table of IRPWM) |  |  |
<p>| 9  | Whether it is ensured that no hammering is done on sleeper to make the sleeper square? |  |  |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 10 | Whether it is ensured that pandrol clip and steel liners is used in track having properly painted with anti-corrosive paint.  **(IS:9862 1981)** ?  
   *(Ref: CE Circular No. 258-R1)* |         |         |
| 11 | Whether it is ensured that grease is done in eye of MCI insert before insertion of pandrol clip?  
   *(Ref: Para 1411(5)(a) of IRPWM)* |         |         |
| 12 | Whether it is ensured that greased is applied on the leg of pandrol, below the liner and rail flange?  
   *(Ref: Para 1411(5) of IRPWM)* |         |         |
| 13 | Whether it is ensured that grease is used for lubrication is the specification **IS: 408-1981**?  
   *(Ref: Para 1411(5) (a)of IRPWM)* |         |         |
| 14 | Whether it is ensured that greasing is not done during extreme summer and during heavy rainfall?  
   *(Ref: Para 1411(5) (a)of IRPWM)* |         |         |
<p>| 15 | Whether it is ensured that greasing used in track has been tested by approved lab. ? |         |         |
| 16 | Whether it is ensured that liners collar is seated properly in between rail flange and MCI insert. |         |         |
| 17 | Whether it is ensured that end of central leg of ERC is matching with eye of insert during driving (to avoid over and under driven)? |         |         |
| 18 | Whether it is ensured that rail panels are longitudinally slewed on rail rollers for pairing rail panels? |         |         |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>19</td>
<td>Whether it is ensured that no rail panels are longitudinally slewed by hitting with rail at rail ends for pairing rail panels?</td>
<td></td>
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</tr>
<tr>
<td>20</td>
<td>Whether it is ensured that specified gap is kept at the joint (To avoid the number of A.T. weld)</td>
<td></td>
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<tr>
<td>21</td>
<td>Whether it is ensured that rails are painted with anti corrosive black bituminous paint?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Whether it is ensured that sleepers are correctly fitted at their position during fixing of pandrol clip?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 23 | Whether it is ensured holes in rail has been champhered?  
(Ref: Para 251 (d) of IRPWM) |  | |
| 24 | Whether it is ensured that rail joints are in square in straight and curve track upto radius flatter than 400 metre?  
(Ref: Para 425 of IRPWM) |  | |
| 25 | Whether it is ensured that rail joints (fish plate and weld joints) are not supported on sleepers? |  | |
| 26 | Whether it is ensured that fish plated joints should not fall within 3 mtr from level crossing in case of Fish plated track and 6 mtr in case of SWR track?  
(Ref: Para 921(3) and (5) of IRPWM) |  | |
| 27 | Whether it is ensured that fish plated joints should not fall within 3 mtr from bridge abutment?  
(Ref: Para 277(4) of IRPWM) |  | |
8.5 MANUAL PACKING & TAMPING BY MACHINES:

Before taking up manual packing & tamping of track by machine, it should be ensured that sufficient quantity of ballast is available in the track. Each lift during packing should be checked with marking on reference pegs. Alignment is also to be ensured to avoid false curve or kink in track. Before starting tamping by track machine fixtures viz. joggled fish plates, check rails etc. should be removed. Setting of tamping machine with respect to squeezing pressure, squeezing time, condition of tamping tools etc should be checked & adjusted as per latest instructions. Track parameters before and after tamping should be recorded. Detailed checklist manual packing & tamping by machine is appended below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it is ensured that sufficient ballast in track is available before commencement of packing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that reference posts for rail level and alignment has been correctly marked before commencement of packing?</td>
<td></td>
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<tr>
<td>3</td>
<td>Whether it is ensured that during 1st and 2nd round of manual packing track is lifted by 75 mm (In case of 350 mm cushion) and 50 mm (In case of 250 mm cushion) only?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Whether it is ensured that during 1st &amp; 2nd round of manual packing, designed alignment &amp; levels in straights and designed super elevation in curve stretches have been achieved?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
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</tbody>
</table>
| 5  | Whether it is ensured that for machine tamping, fixture like Check rail, Guard rail, joggled fish plates, S&T roddings/fixtures have been removed from track? In case of electrified section, earth bonds are also removed from track before tamping?  
(Ref: IRTMM 2019 Para 224(3)) |        |         |
<p>| 6  | Whether it is ensured that L-xing is opened for each machine tamping?                                                                                                                                               |        |         |
| 7  | Whether it is ensured that SE and Versines, CTP, TTP has been correctly marked on sleepers before tamping?                                                                                                        |        |         |
|    | (Ref: IRTMM 2019 Para 224(3))                                                                                                                                                                                      |        |         |
| 8  | Whether it is ensured that Track machine is calibrated before start of work?                                                                                                                                       |        |         |
| 9  | Whether it is ensured that Track machine is working in design mode and design data/track parameters is available for feeding data before machine working?                                                        |        |         |
| 10 | Whether it is ensured that sufficient ballast is heaped up in tamping zone and ballast should be clear from Rail head so as not to obstruct rollers?                                                                 |        |         |
|    | (Ref: IRTMM 2019 Para 224(3))                                                                                                                                                                                      |        |         |
| 11 | Whether it is ensured that squeezing pressure is in range of 110-120 Kg/sq.cm (in case of DUOMATIC) and 125-135 Kg/sq.cm(in case of UNIMAT) for PSC track/turnout?                                                            |        |         |
|    | (Ref: IRTMM 2019 Para 206(1))                                                                                                                                                                                     |        |         |
| 12 | Whether it is ensured that squeezing time is in range of 0.8-1.2 sec per insertion?                                                                                                                                  |        |         |
|    | (Ref: IRTMM 2019 Para 206(5))                                                                                                                                                                                     |        |         |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 13 | Whether it is ensured that machine tools are complete and wear should not be more than 20%. (size of tools for different types of tamping machines should be as per Annexure 2.1 of IRTMM 2019)?  
(Ref: IRTMM 2019 Para 206(6))                                                                                                           |        |         |
| 14 | Whether it is ensured that sleepers are properly spaced, squared and correctly gauged before machine tamping?  
(Ref: IRTMM 2019 Para 224(3))                                                                                                                   |        |         |
| 15 | Whether it is ensured that deficient fittings and fastenings, if any, are recouped before machine tamping?  
(Ref: IRTMM 2019 Para 224(3))                                                                                                                   |        |         |
| 16 | Whether it is ensured that single insertion is done for lift upto 30mm and double insertion for lift more than 30mm?  
(Ref: IRTMM 2019 Para 220(2)).                                                                                                                                 |        |         |
| 17 | Whether it is ensured that DGS is deployed behind the TTM machine?                                                                                                                                                   |        |         |
| 18 | Whether it is ensured that oscillation frequency of DGS adopted for machine operations is in the range of 30-35 Hz for Plasser make DGS)?  
(Ref: IRTMM 2019 Para 229(2))                                                                                                                   |        |         |
| 19 | Whether it is ensured that standard range of pressure variation of DGS is in range of 70 to 100 bars is adopted for machine operation?  
(Ref: IRTMM 2019 Para 229)                                                                                                                     |        |         |
| 20 | Whether it is ensured that working speed of DGS machine is in the range of 0.6 Kmph to 1.0 Kmph for 1st & 2nd round of DGS machine operation?  
(Ref: IRTMM 2019 Para 229(2))                                                                                                                   |        |         |
21. Whether it is ensured that proper record of track parameters before and after tamping is being maintained?

(Ref: IRTMM 2019 Para 229)

22. Whether it is ensured that boxing and profiling of ballast is done immediately post tamping?

23. Whether it is ensured that missing/broken fittings and fastenings, if any, are recouped after machine tamping?

(Ref: IRTMM 2019 Para 229(5))

24. Whether it is ensured that after machine tamping, fixture like Check rail, Guard rail, joggled fish plates, S&T roddings/fixtures have been refixed in track? In case of electrified section, earth bonds are also re-fixed in track after tamping?

(Ref: IRTMM 2019 Para 229(5))

8.6 Laying of Points and Crossings:

Laying of points and crossing should be done as per latest RDSO standard drawings. Marking for sleepers should be done accurately with cumulative method to ensure good running on turnouts. SRJ to SRJ distance and ANC to ANC distance should be marked as per layout calculations. Layout calculations should be done with actual centre to centre distance available at turnout locations.

As per Railway Board guidelines, in all new construction projects, Thick web switches are to be laid in facing direction, in place of OR Switches.

Detailed checklist regarding laying of points and crossings is appended below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it is ensured that there is no change of gradient up to 30 m from SRJ and crossing of turnout?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Ref: ACS 17 of IRSOD (B.G.) 2004 Chapter II)
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Note (e)(2) below Para 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that same rail level is maintained on both end of turnout in same crossover?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Whether it is ensured that layout calculation is available and same has been verified for its feasibility at site?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Whether it is ensured that correct length of crossover has been calculated as per available track centre at site?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Whether it is ensured that correct layout has been marked at site and concerned reference pegs have been fixed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Whether it is ensured that marking of calculated TNC to TNC distance done at site?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Whether it is ensured that during spreading of sleeper, RE marked on the sleeper is kept on right hand of Turnout?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Whether it is ensured that correct sleeper spacing is done at site as per standard drawing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Whether it is ensured that fixing of rubber pad on sleeper is done using suitable adhesive to avoid lateral shifting of rubber pad during working?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Whether it is ensured that Lead Rails joints are centrally placed between the sleepers?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Whether it is ensured that unavoidable joints are gapless?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
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<tr>
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</tr>
<tr>
<td>12</td>
<td>Whether it is ensured that all the screws required to be fixed in the dowels are greased before being put in ERC. Liners put in turnouts are properly greased?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Whether it is ensured that ‘J’ Type clip along with GFN liner (cut) is provided at glued joints and fish plated joints?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Whether it is ensured that the dowels fixed in the PRC sleepers are cleaned with the help of soft brush so that all dirt/muck is removed from them, making the fixing of the screw easy?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Whether it is ensured that CMS crossings are made gapless?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Whether it is ensured that complete standard fittings are provided in turnout as per standard RDSO drawing? Single coil washers and spherical washers are used for proper tightening of fittings?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Whether it is ensured that proper housing of tongue Rail is available?</td>
<td></td>
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</tr>
</tbody>
</table>
| 18 | Whether it is ensured that tongue rails are properly rested/seated at slide chair for free movement?  
   **Ref:** IRPWM 2004 Para 327(2)(e) |        |         |
| 19 | Whether it is ensured that proper gap (1.5 to 3mm) is kept between top of stretcher bar and bottom of the stock rail?  
   **Ref:** IRPWM 2004 Para 317(K) |        |         |
<p>| 20 | Whether it is ensured proper marking of points is done on turn out for inspection purpose as per proforma mentioned in IRPWM? |        |         |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
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</table>
| 21 | Whether it is ensured that proper throw of switch is available (Min. 115 mm in case of new works for OR Switch and 160 mm for Thick Web Switch)?  
*(Ref: IRSOD (B.G.)2004 Chapter II Para 16(ii))*                                                                                                                                                                                                                                                                         |        |         |
| 22 | Whether it is ensured that check rail clearance is available within 41 mm to 45 mm?  
*(Ref: IRSOD (B.G.)2004 Chapter II Para 13 note(a) and para 14 note)*                                                                                                                                                                                                                                                                                                      |        |         |
| 23 | Whether it is ensured that correct gauge is maintained at ATS and ANC of turn out?                                                                                                                                                                                                                                                                                                                                                         |        |         |
| 24 | Whether it is ensured that track parameter are within permissible limit:  
(i) **Gauge**: sleeper to sleeper variation 2 mm  
*(Ref: IRPWM 2004 Para 316(iii))*  
(ii) **Cross Level**: ±3 mm  
*(Ref: IRPWM 2004 Para 316(iii))*  
(iii) **Alignment**: ±2 mm measured on 10 mtr chord in case of straight track  
*(Ref: IRPWM 2004 Para 316(iii))*  
(iv) The variation in versine on two successive station in lead curve and turn in curve portion is not be more than 4 mm and versine at each station also not be beyond ±3 mm from its designed value?  
*(Ref: IRPWM 2004 Para 237(4)(d))*                                                                                                                                                                                                                                                                       |        |         |
| 25 | Whether it is ensured that all S&T fixtures, roddings, stretcher bars is removed from track in machine tamping of point & crossings?                                                                                                                                                                                                                                                                                                        |        |         |
| 26 | Whether it is ensured that sufficient ballast cushion is available (300/350 mm)?                                                                                                                                                                                                                                                                                                                                                         |        |         |
### SN | Item to be checked | Yes/ No | Remarks
--- | --- | --- | ---
27 | Whether it is ensured that at least one rail on either side of points and crossing is have same section of points and crossing assembly rail section?  
(Ref: IRPWM 2004 Para 317(e)) | | |
28 | Whether it is ensured that all avoidable joints have been welded on SRJ and Lead joints?  
(Ref: IRPWM 2004 Para 317(h)) | | |
29 | Whether it is ensured that fitness of point has been jointly checked by Engineering and S&T staff? | | |

8.7 Long Welded Rails (LWR):

LWR should be laid as per approved plans conforming to LWR manuals as well as with latest RDSO guidelines. Distressing should also be done after laying of rails as per LWR manual. Improved SEJ (RDSO drawing T-6022/T-6830) are to be used in place of ordinary SEJ. Detailed checklist regarding laying of LWR is appended below:

### SN | Item to be checked | Yes/ No | Remarks
--- | --- | --- | ---
1 | Whether it is ensured that LWR plan has been approved by Chief Track Engineer?  
(Ref: LWR Manual 1999 2nd reprint 2005 Para 3.4) | | |
2 | Whether it is ensured that LWR is laid at gradient not sharper than 1 in 100?  
(Ref: LWR Manual 1999 2nd reprint 2005 Para 3.3.1) | | |
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td>Whether it is ensured that LWR/CWR is continued through curves not sharper than 440 meter radius? <strong>Ref:</strong> LWR Manual 1999 2nd reprint 2005 Para 3.2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Whether it is ensured that LWR/CWR is continued through reverse curves not sharper than 875 meter radius? <strong>Ref:</strong> LWR Manual 1999 2nd reprint 2005 Para 3.2.2</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>Whether it is ensured that vertical curve is provided at the junction of the grade when the algebraic difference between the grades is equal to or more than 4 mm per meter or 0.4 percent, as laid down in Para 419 of IRPWM. (In case of BG track minimum radius of vertical curve shall be on A route =4000 mtr.B route=3000 metre, on C,D &amp;E route=2500 metre)? <strong>Ref:</strong> LWR Manual 1999 2nd reprint 2005 Para 3.3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Whether it is ensured that minimum clean stone ballast cushion (below the bottom of the sleeper) of 250 mm is provided at the time of installation of LWR/CWR? <strong>Ref:</strong> LWR Manual 1999 2nd reprint 2005 Para 4.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Whether it is ensured that minimum sleeper density 1540 no/km is provided in LWR track? <strong>Ref:</strong> LWR Manual 1999 2nd reprint 2005 Para 4.3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Whether it is ensured that LWR is isolated by providing SEJ in case of any change of rail section? <strong>Ref:</strong> LWR Manual 1999 2nd reprint 2005 Para 4.4.1(ii)</td>
<td></td>
<td></td>
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<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
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</tr>
<tr>
<td>9</td>
<td>Whether new SEJ has been inserted to new location, before withdrawing old SEJ, in case of shifting of SEJ due to change in yard diagram or other locations?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 10 | Whether it is ensured that rail used in LWR/CWR is without fish bolt hole as far as possible. In case of hole whether it is chamfered?  
   Note: Under any circumstances, no bolt hole should be made by gas cutting.  
   *(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.4.3)* |        |         |
| 11 | Whether it is ensured for making LWR/CWR by using SS rail, Rail end having battered, bolt hole has been cropped before lying?  
   *(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.4.2(ii))* |        |         |
| 12 | Whether it is ensured that where LWR/CWR is followed by fish plated/SWR, the same structure as that of LWR/CWR is continued for three rails beyond SEJ?  
   *(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.5.1)* |        |         |
| 13 | Whether it is ensured that Level crossings situated in LWR/CWR territory is not fall within the breathing lengths?  
   *(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.5.2)* |        |         |
| 14 | Whether it is ensured that where concrete sleeper turnouts are laid, instead of three normal rail lengths, one Three rail panels is provided between SEJ and SRJ as well as between heel of crossing and SEJ?  
   *(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.5.3)* |        |         |
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
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</thead>
</table>
| 15 | Whether it is ensured that All insulations for track circuiting in LWR/CWR not be done by providing glued joints G3(L) type?  
(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.5.4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |         |
| 16 | Whether it is ensured that SEJ with straight tongue and stock is not be located on curves sharper than 0.5 degree (3500 m radius) as far as possible and also on transition of curves?  
(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.4.5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |         |
| 17 | Whether it is ensured that curved SEJ is provided on curved sharper than 0.5 degree and up to 2 degree?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |         |
| 18 | Whether it is ensured that LWR /CWR is continued over bridges without bearing like slabs, box culvert and arches?  
(Ref: LWR Manual 1999 2nd reprint 2005 Para4.5.6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |         |
| 19 | Whether it is ensured that LWR/CWR shall not be continued over bridges with overall length as specified in Para 4.5.7.1 for B.G.?  
(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.5.7.(i))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |         |
| 20 | Whether it is ensured that Bridges on which LWR/CWR is not permitted/provided is isolated by a minimum length of 36 meter well anchored track on either sides?  
(Ref: LWR Manual 1999 2nd reprint 2005 Para 4.5.7.(ii))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |         |
<p>| 21 | Whether it is ensured that rail temperature of LWR is laid is being maintained?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |         |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Whether it is ensured that correct laying of SEJ and proper initial gap (40 mm) in SEJ is done as per standard R.D.S.O. drawing? (Ref: LWR Manual 1999 2ND reprint 2005 Para 5.6.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Whether it is ensured that LWR reference post is fixed correctly at SEJ and at the end of Breathing Length (LWR Manual as per para1.4 ANNEXURE 1B&amp; 1C) and centre of LWR/CWR?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Whether it is ensured that on the top of LWR reference post, arrow mark by chisel perpendicular to track is made?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Whether it is ensured that distressing of LWR is done before opening to traffic?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Whether it is ensured that distressing of LWR is done when the range of rail temperature is tm+5°c to tm+10°c? (Ref: LWR Manual 1999 2ND reprint 2005 Para 1.11 (b)(i))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Whether it is ensured that distressing of LWR is done by using rail tensor when prevailing rail temperature is lower than stress free temperature? (Ref: LWR Manual 1999 2ND reprint 2005 Para 1.13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Whether it is ensured that during destressing rail is lifted and placed at rollers on every 15th sleeper and in case of curved track, side rollers are used? (Ref: LWR Manual 1999 2ND reprint 2005 Para 5.7.4 ANNEXURE-VIII)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Whether it is ensured that during distressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
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</tr>
<tr>
<td></td>
<td>ATW are not supported on sleepers?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Whether it is ensured that just after distressing and welding paint mark is done on rail opposite to reference post for checking the creep movement?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Whether it is ensured that proper record of distressing is being maintained?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Whether it is ensured that LWR board is fixed and written with all requisite information?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Whether it is ensured that at least 2 round of machine tamping is done on newly laid LWR/CWR before its opening to traffic?</td>
<td></td>
<td><em>(Ref: LWR Manual 1999 2ND reprint 2005 Para 1.18(iv))</em></td>
</tr>
<tr>
<td>34</td>
<td>Whether it is ensured that at least 1 round of DGS is run on newly laid LWR/CWR before its opening to traffic?</td>
<td></td>
<td><em>(Ref: LWR Manual 1999 2ND reprint 2005 Para 1.18(iii))</em></td>
</tr>
<tr>
<td>35</td>
<td>Whether it is ensured that shoulder ballast width 350 mm in straight track and 500 mm on outer side of curve in case of LWR track has been provided?</td>
<td></td>
<td><em>(Ref: Annexure 2/11 of IRPWM) and LWR Manual 1999 2ND reprint 2005 fig4.2.1(a))</em></td>
</tr>
<tr>
<td>36</td>
<td>Whether it is ensured that all weld done in LWR/CWR track is tested by USFD team and DFW is removed from track?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 8.8 Level Crossings:

All the works at Level Crossing should be planned and executed on the basis of Class of level crossing & class of the road keeping in view latest provisions in IRPWM, Railway Board guidelines, approved ESPs etc. Different parameters for road as well as for track should be ensured as per latest instructions. Safety items viz. lifting barrier, safety chains, speed breakers and road sign board etc are the most important items at level crossings. Road surface is also most important for road users. Smooth road surface should be provided to smooth entry & exit of heavy road vehicles through level crossings. Machine made check rails instead gas cut check rails should be used at level crossing in construction projects as per Annexure 8.02. Detailed checklist regarding level crossing works is appended below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether L-xing up gradation plan (if it is qualifying) got approved?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/ No</td>
<td>Remarks</td>
</tr>
<tr>
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</tr>
<tr>
<td>2</td>
<td>Whether <strong>gate posts</strong> have been provided at correct distance (between 3 m to 3.3 m from centre line of track in B.G.)?</td>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/1 Para 904 ACS no. 151 dated 19.11.2019)</em></td>
</tr>
<tr>
<td>3</td>
<td>Whether minimum <strong>width of Road</strong>: gates has been provided as per class of Road?</td>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/1 Para 904 item 1)</em></td>
</tr>
<tr>
<td>4</td>
<td><strong>Check rails</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) Whether minimum length of <strong>check rail</strong> has been provided (Minimum 2 m more than width of gate)?</td>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/1 Para 904 item 2)</em></td>
</tr>
<tr>
<td></td>
<td>(ii) Check Rail clearance is available between 51mm to 57 mm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iii) Check rails are flared at the ends? No gas cut allowed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(iv) Whether Chamfering of holes is done?</td>
<td></td>
<td><em>(Ref: Para 251(d) of IRPWM)</em></td>
</tr>
<tr>
<td>5</td>
<td><strong>Gate lodges</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>In case, provision of new <strong>Gate Lodge</strong> is made:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimum distance of Gate Lodge from centre line of nearest track is 6 metres?</td>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/1 Para 904)</em></td>
</tr>
<tr>
<td></td>
<td>Minimum distance of Gate Lodge from centre line Edge of road metalling is 6 metres?</td>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/1 Para 904)</em></td>
</tr>
<tr>
<td></td>
<td>If the line of approach road is on a curve at or near a L-xing, whether gate lodge is built on the outside of curve?</td>
<td></td>
<td><em>(Ref: IRPWM Para 911, PCE Circular No 262)</em></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
</tr>
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</tr>
</tbody>
</table>
| 3  | Whether, In case of straight track, the gate lodges have been provided alternatively on either side of track or governed otherwise?  
    *(Ref: PCE Circular No 262)*                                                                                                                                  |        |         |
| 6  | Whether **Fencing** of 15 m minimum from each gate post parallel to track has been provided?  
    *(Ref: IRPWM Annexure-9/1 Para 904)*                                                                                                                                 |        |         |
| 7  | **Width of metalling:**  
    *(Ref: IRPWM Annexure-9/1 Para 904 item 12)*                                                                                                             |        |         |
|    | (i) Between gates – Whether Width of metalling is same as that of width of gates?                                                                                                                                   |        |         |
|    | (ii) Outside gates: Whether Minimum width as per class of Road has been provided?                                                                                                                                  |        |         |
| 8  | **Level length and gradients**  
    *(Ref: IRPWM Annexure-9/1 Para 904 item 15)*                                                                                                             |        |         |
|    | (a) Between gates: Whether Road surface is level?                                                                                                                                                                 |        |         |
|    | (b) Outside gates:                                                                                                                                                                                                 |        |         |
|    | (i) Whether Road surface Level upto and gradients have been provided as per class of Road?                                                                                                                        |        |         |
| 9  | **Speed Breakers**                                                                                                                                                                                                  |        |         |
|    | (i) Whether speed breaker is provided at required distance. (20 m from L-xing gate post or Railway boundary)?  
    *(Ref: IRPWM Annexure-9/6 Para 918(1), PCE Circular no 266 Para 3 &4, Annexure 9 & 10, ACS No 128 Para 7.0)*                                                   |        |         |
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii)</td>
<td>Whether speed breaker design and painting is as per standard?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/6 Para 918(1))</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Whether <strong>Road sign boards</strong> are provided at correct locations?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(Ref: IRPWM Para 916, PCE Circular no 266 Para 3 &amp; 4, Annexure 9 &amp; 10)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td><strong>STOP Board</strong>: for unmanned L-xing at 5 m from centre of nearest track</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td><strong>Warning board</strong> for Speed breakers: at 50 m from speed breaker?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii)</td>
<td><strong>Warning board for L-xing</strong>: at 100 from gate post?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iv)</td>
<td>Whether <strong>Road sign boards</strong> are of standard design, painting and fixed at appropriate height?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/7 Para 918(2), ACS No 135 Para 5, PCE Circular Annexure 1 to 8)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Whether <strong>WL boards</strong> have been provided at correct locations?- At 600 m from L-xing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Whether <strong>WL boards</strong> have been provided as per correct dimensions and at appropriate height.(clear height of W/L board at 2m from Rail level in block sections and 0.3 m from Rail level in yards)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(Ref: IRPWM Annexure-9/5 Para 916(1))</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td><strong>Lifting Barriers</strong> (to be provided by S&amp;T Deptt in interlocked gates and by Engg. Deptt in case of non interlocked gates)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Whether lifting barrier is of standard drawing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Whether Lifting barrier is fixed at correct distance from centre line of track?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/ No</td>
<td>Remarks</td>
</tr>
<tr>
<td>----</td>
<td>-----------------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>(iii)</td>
<td>Whether height of lifting barrier is proper when closed? (between 0.8 m to 1.0 m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Whether <strong>safety chains</strong> have been provided for emergencies (in case of boom breakage)?</td>
<td>Yes</td>
<td>(Ref: IRPWM Para 905)</td>
</tr>
<tr>
<td>15</td>
<td>Whether posts for fixing the safety chains provided and safety chains are of sufficient length and fixed at correct height?</td>
<td>Yes</td>
<td>(Ref: IRPWM Annexure 9/2 Para 905)</td>
</tr>
<tr>
<td>16</td>
<td><strong>Height Gauge</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>In case of electrified territory, Whether <strong>Height gauge</strong> have been provided on both side of L-xing?</td>
<td>Yes</td>
<td>(Ref: IRPWM Para 910(4))</td>
</tr>
<tr>
<td>(ii)</td>
<td>Whether height gauge is located at a minimum distance of 8 m from gate post?</td>
<td>Yes</td>
<td>(Ref: IRPWM Para 910(4))</td>
</tr>
<tr>
<td>(iii)</td>
<td>Whether adequate vertical clearance is available under the Height gauge? (4.67 m from Road surface to underside of height gauge)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Whether <strong>Protection diagram</strong> has been provided at L-xing gate? (In case of doubling, it should be as per double line protection diagram)</td>
<td>Yes</td>
<td>(Ref: IRPWM Annexure 9/3 Para 913(3))</td>
</tr>
<tr>
<td>18</td>
<td>Whether Correct name, Chainage and class of L-xing has been exhibited at Gate lodge? (In case of up-gradation, please check it is as per new upgraded class).</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td><strong>Track structure in level crossings</strong></td>
<td></td>
<td>(Ref: IRPWM Para 921)</td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
</tr>
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<td>---------</td>
</tr>
<tr>
<td>(i)</td>
<td>Has it been ensured that no Rail joints in check rails and running rails within level crossing and 3 m on either side?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>In case of SWR is continuing through L-xing, has it been ensured that there is no fish plated joint on L-xing and within 6 m from end of L-xing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii)</td>
<td>In case of LWR, has it been ensured that L-xing do not fall within breathing length of LWR?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iv)</td>
<td>Has it been ensured that rails are painted properly before laying through L-Xing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(v)</td>
<td>Whether Gauge is ensured in the range (-)5mm to (+)3 mm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vi)</td>
<td>Whether Cross level is ensured in range ±3 mm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vii)</td>
<td>Whether check rail clearance is in ensured in the range 51 mm to 57 mm?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(viii)</td>
<td>It is ensured that Rail level and road level should meet at level preferably or in unavoidable circumstances proper gradient is available for Road between the tracks in case of doubling.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ix)</td>
<td>Whether it is ensured that during each machine tamping, the L-xing is opened for continuing the tamping through L-xing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(x)</td>
<td>In case of road pavers used as road surface at L-xing, the fixing of pavers should be done preferably after machine tamping.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 8.9 Track Structure on Bridges:

Before taking up the work on bridges, all relevant & reference drawings/literature should be studied thoroughly. Instructions of LWR manual should be strictly followed in case of LWR track is laid on the bridge. Provision of guard rails, walkways and ballast cushion on the bridges as well as on approaches should be
checked with latest instructions before laying of track over the bridge. Detailed checklist regarding track structure on bridges is appended below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 1  | Whether it is ensured that in case of small bridge openings less than 6.1m span, rail joints are avoided?  
*(Ref: IRPWM 2004 Para 272(3))* |        |         |
| 2  | Whether it is ensured that LWR is not continued over Bridges with overall length of 11 m in case of Rail free fastenings on bridges and 23 m for Rail free fastenings on bridges and partly Box-anchored. *(For temperature zone IV, 60 Kg Rail & PRC Sleepers)*?  
*(Ref: LWR Manual 2005 : 2nd Reprint Para 4.5.7(i))* |        |         |
| 3  | Whether it is ensured that on Bridges on which LWR is not continued are isolated by a min. 36 m long well anchored track on either side?  
*(Ref LWR Manual 2005 2nd Reprint Para 4.5.7(ii))* |        |         |
| 4  | Whether it is ensured that Steel sleepers used on girder bridges are fabricated as per standard RDSO drawing? |        |         |
| 5  | Whether it is ensured that steel sleepers used on girder bridges are galvanised? |        |         |
| 6  | Whether it is ensured that Max centre to centre sleeper spacing is not more than 600mm, clear distance between two sleepers is not more than 450 mm and clear distance between joint sleepers is not more than 200mm?  
*(Ref: ACS 128 of dt. 05.03.2012 of IRPWM 2004 Para 273b(3))* |        |         |
<p>| 7  | Whether it is ensured that location of steel sleepers is marked correctly on the girder? |        |         |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Whether it is ensured that Rail joints are so located that after laying sleepers, joints do not become supported joints?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Whether it is ensured that after laying steel sleepers, tightening of all fittings including hook bolts is done?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Whether it is ensured that marking of arrow on the top of the bolts at right angle to the rails pointing towards the rail?</td>
<td></td>
<td><em>(Ref: Para 278(3) of IRPWM)</em></td>
</tr>
<tr>
<td>11</td>
<td>Whether it is ensured that suitable quantity of steel sleepers along with fittings is kept as emergency reserve?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Whether it is ensured that fish plated joints should not fall within 6 mtr from bridge abutment in case of SWR?</td>
<td></td>
<td><em>(Ref: Para 272(4) of IRPWM)</em></td>
</tr>
<tr>
<td>13</td>
<td>Whether it is ensured that fish plated joints should not fall within 3 mtr from bridge abutment?</td>
<td></td>
<td><em>(Ref: Para 277(4) of IRPWM)</em></td>
</tr>
<tr>
<td>14</td>
<td>Whether it is ensured that Guard rails are provided on all major bridges?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Whether it is ensured that design of guard rail is as per standard drawing as per IRPWM Para 275(2)B.G?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Whether it is ensured that guard rail provided is of one section lower than the running rail of bridge track structure?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
</tr>
<tr>
<td>----</td>
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</tr>
<tr>
<td>17</td>
<td>Whether it is ensured that the ends of guard rail are bent vertically and buried into the ballast and a block of timber is fixed at the end? (Ref: ACS No 102 dt 29.05.2007 of Para 275(3) of IRPWM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Whether it is ensured that approach guard rail is provided as per drawing no RDSO/T-4088 to 4097?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Whether it is ensured that lateral clearance between guard rail and running rail is 250±50 mm in case of B.G. Track? (Ref: IRPWM Para 275(2) Table)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Whether it is ensured that guard rail is not lower than the running rail by more than 25 mm? (Ref: IRPWM Para 275(2))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Whether it is ensured that rail screws used in guard rails are properly greased before fixing?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Whether it is ensured that track fittings are complete and tight on bridge proper and 100 m on either approach of bridges? (Ref: IRPWM Para 277(2))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Whether it is ensured that provision of walkway by chequered plates with holes is provided on un-ballasted girder bridges? (Ref: IRPWM Para 276)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Whether it is ensured that minimum 300 mm ballast cushion is available on bridges?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Whether it is ensured that full ballast section is maintained upto 100 m from abutment in case of LWR on bridges? (Ref: IRPWM Para 277(5))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/ No</td>
<td>Remarks</td>
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<tr>
<td>26</td>
<td>Whether it is ensured that on bridge approaches for a length of 100m width of cess 90 cm clear of full ballast section along with suitable ballast retainers are provided? (Ref: IRPWM Para 277(b) (2))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Whether it is ensured that joggled fish plate with clamp or two far end bolts on good AT weld is provided on bridges having length of water way as 100 m or more and on approaches up to 100 m length? (Ref: ACS 131 Dt. 11.01.2013 IRPWM Para 277(a) (7))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Whether it is ensured that In case of LWR on slab /arch /box major bridges, without guard rails, full ballast is provided between bridge parapets up to sleeper top level. (Ref:IRPWMPara 275)</td>
<td></td>
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</tr>
</tbody>
</table>

8.10 **Aluminothermic (AT) Welding:**

As far as possible, AT welding should be avoided and mobile flash butt welding to be adopted. However, in exceptional cases AT welding may be adopted for welding of joints of long rail panels, SEJs, P&C, loops, sidings, dead ends etc after obtaining approval of CAO/C. For doing AT welding guidelines/instruction on the issue should be referred to & followed. Welding should be done keeping in view tolerances & instructions mentioned therein. Proper alignment (horizontal and vertical) and gap between rails are to be maintained before AT welding is started. Preheating of rail ends and reaction time of portion are the critical activities which have major effect on the quality of AT weld. Parameters of finished AT weld should be within the defined range. The test check on measurements and quality of AT should be conducted for contractors bills as prescribed in Annexure 8.01. USFD testing should be done at the earliest. Detailed checklist regarding AT welding is appended below:
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 1  | Whether approval of CAO/C has been taken for AT welding in the project before starting AT welding?  
 **(Ref:** Railway Board Letter No. Track/21/2009/0110/7 dated 05/05/2015) |        |         |
| 2  | Whether it is ensured that AT Welding is done by R.D.S.O. approved agency?                                                                                                                                 |        |         |
| 3  | Whether it is ensured that execution of AT Welding is done by welder who has valid competency certificate issued from TPP/LKO or R.D.S.O.?                                                                       |        |         |
| 4  | Whether it is ensured that portion used for AT welding is inspected and passed by R.D.S.O. team?                                                                                                               |        |         |
| 5  | Whether it is ensured that technique used for AT Welding is approved by R.D.S.O/Rly Board?                                                                                                                       |        |         |
| 6  | Whether it is ensured that end bends of rail used for AT Welding are within +0.5 mm,-0mm in vertical and ±0.50 mm in lateral direction when checked with 01 metre straight edge  
 **(Ref:** Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 3.1) |        |         |
| 7  | Whether it is ensured that end cropping of second hand rail is done before welding. ?                                                                                                                         |        |         |
| 8  | Whether it is ensured that when the welding work is done in situ, the rail fastening for at least five sleepers on either side of proposed weld location is opened?  
 **(Ref:** Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.6.1) |        |         |
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>Whether it is ensured that the rail ends shall be cut by sawing or using abrasive disc cutter and not by flame cutting. <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 3.3(v))</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Whether it is ensured that in case of repair of fractured rail/defective weld with wide gap (75mm gap) weld, the rail shall be cut from center of rail fracture/defective weld 37-38mm each side for making suitable gap of 75mm, provided bolt holes do not fall within 40mm from cut faces. <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 3.3(x))</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Whether it is ensured that the rail end face and adjacent sides at foot(top and bottom), web and head up to 50 mm shall be thoroughly cleaned using kerosene oil and brushing with wire brush to remove all dirt, grease and rust before welding. Any burns at the rail ends shall be removed by chiseling or grinding. <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.4)</em></td>
<td></td>
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<tr>
<td>12</td>
<td>Whether it is ensured that no Alumino Thermic welded joint shall be located closer than 4 m from any other welded or fish plated joint? <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.4)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Whether it is ensured that Gap between rail ends before welding is within permissible limit <em>i.e. 25±1/50±1/75±1mm?</em> <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
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<tr>
<td>4.5</td>
<td>Whether it is ensured that before welding, lateral alignment of two rail ends, after alignment shall be within +0.5 mm and vertical alignment is 2 to 2.4 mm for 90 UTS rails when checked with a 1.0 m straight edge at rail ends? <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.7.1.1 &amp; 4.7.1.2)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Whether it is ensured that three piecemoulds is used? <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.8.1.1)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Whether it is ensured that During fixing the moulds, it shall be ensured that the centre line of the rail gap coincides with the centre line of the mould to avoid cross joint? <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.8.3)</em></td>
<td></td>
<td></td>
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<tr>
<td>16</td>
<td>Whether it is ensured that no welding shall be carried out if it is raining. In case, the rains start while the joint is under execution, immediate arrangement to adequately cover the site shall be made? <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.10.7)</em></td>
<td></td>
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<tr>
<td>17</td>
<td>Whether it is ensured that Single Shot Crucible technique is used?</td>
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<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
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</tbody>
</table>
| (i) | Whether it is ensured that the cutting of weld is done by weld trimmer?  
(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 4.10.5) |  |  |
| (ii) | Whether it is ensured that the finishing of weld is done by profile grinder? (Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 5.4.1) |  |  |
| 19 | Whether it is ensured that the first train should be allowed to pass on the newly welded joint only after 30 minutes have elapsed since pouring of weld metal?  
(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 5.3) |  |  |
| 20 | Whether it is ensured that all the finished joints are checked for weld geometry with tolerances:  
(i) measured on one metre straight edge: +1.0mm, -0.0mm for vertical alignment, +0.5mm for lateral alignment.  
(ii) measured on 10cm straight edge: +0.4 mm, -0.0mm for finishing of top surface, +0.3 mm over gauge side of the rail head for head finishing on sides?  
(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 5.4.2) |  |  |
| 21 | Whether it is ensured that the details of geometry of each joint shall be jointly signed by the firm’s and Railway’s representative and kept as record?  
(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 5.5) |  |  |
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 22 | Whether it is ensured that the each joint is distinctive marked indicating month, year of welding, agency and welder/supervisor identification code number (as appearing on his competency certificate) at non-gauge face side of A.T. weld on head?  
 *(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 5.6.1)* |        |                                                                                                                                                                                                        |
| 23 | Whether it is ensured that ‘Thermit Weld Register’ as per standard proforma is maintained?  
 *(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 5.6.2)* |        |                                                                                                                                                                                                        |
| 24 | Whether it is ensured that Painting of weld collar is done on all welds to protect them against corrosion immediately after the welding?  
 *(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 5.7.1)* |        |                                                                                                                                                                                                        |
| 25 | Whether it is ensured that all the welded joints are ultrasonically tested as per the provisions of ‘Manual for Ultrasonic testing of rails and welds’?  
 *(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 6.3)* |        |                                                                                                                                                                                                        |
| 26 | Whether it is ensured that defective welds found in ultrasonic testing are removed and necessary safety precautions taken?  
 *(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 6.3.2)* |        |                                                                                                                                                                                                        |
### 27

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Whether testing of AT welds (One out of every 100 joints shall be selected at random within one month of welding and tested for Hardness, Transverse Load, Deflection test and Porosity as per Para 4.2 of IRS:T-19-2012) and whether such tests have complied with laid down guidelines? <em>(Ref: Manual for Fusion welding of rails by Alumino Thermic Process Reprint 2006 PARA 7)</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**8.11 In-situ Glued Insulated Rail Joints:**

G3(L) type of glued joints should be provided as per track circuiting plan. Use of prefabricated glued joints should be minimized and cast-in-situ glued joints should be adopted in general to minimize all in-situ joints. Glued joints should be fabricated following NR CE circular number 259/R-2(P.way) dt. June 2015 annexed as Annexure 8.05 AT welded. Detailed checklist regarding AT welding is appended below:

### 1

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether materials for glued joints are procured from RDSO approved suppliers?</td>
<td></td>
<td><em>(Ref: Para 2.1 of NR CE Circular no. 259/R-2(P Way) dt. June 2015)</em></td>
</tr>
</tbody>
</table>

### 2

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Whether flash butt/thermit welds avoided within 3 m from the insulated joint?</td>
<td></td>
<td><em>(Ref: Para 3.4 of NR CE Circular no. 259/R-2(P Way) dt. June 2015)</em></td>
</tr>
</tbody>
</table>

### 3

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Whether speed restriction of 30 KMPH is imposed on running line before starting the work?</td>
<td></td>
<td><em>(Ref: Para 4.1 of NR CE Circular no. 259/R-2(P Way) dt. June 2015)</em></td>
</tr>
</tbody>
</table>

### 4

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Whether holes in rail are done with 30 mm dia HTS drill bit?</td>
<td></td>
<td><em>(Ref: Para 4.3 of NR CE Circular no. 259/R-2(P Way) dt. June 2015)</em></td>
</tr>
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<td></td>
</tr>
</tbody>
</table>
| 5 | Whether minimum traffic block of 2 hours sanctioned for glued joints to be fabricated in running track?  
| 6 | Whether bolts have been tightened using torque of 105 Kg-N?  
| 7 | Whether every fabricated/assembled joint is checked for vertical and lateral alignment with 1m straight edge and results are within following tolerances?  
a)- Vertical alignment at end of straight edge: (+) 1mm and (-) 0 mm  
b)- Lateral alignment measured at centre of 1 m straight edge placed along gauge face: (+) (-) 0.5 mm  
| 8 | Whether insulation resistance of each joint is tested and the same is not less than 25 mega ohm by applying meggering voltage of 110 V in dry condition?  
| 9 | Whether Pull out test has been done on a lot of every 50 glued joints and samples passed the test for load of 150 tonne and 175 tonne for 52kg and 60 kg rail respectively?  
(Ref: Para 3 of Manual for Glued Insulated Rail Joints) |   |

### 8.12 Rail Painting:

Before taking up rail painting, all the relevant paras of IRPWM and latest instructions on the issue should be referred to & followed. Selecting & passing of paint confirming to latest instructions is foremost & important activity. It is to be ensured that preparation of rail surface is being done with latest instructions. Time gap between first and second coat of painting should be ensured and thickness of painting should be measured with approved type of elco-meter and should be recorded properly.

Detailed checklist regarding Rail Painting is appended below:
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/ No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether it is ensured that Rail painting is done by using Anti corrosive black bituminous paint conforming to IS:9862? (Ref: Para 250(2)(b)(iii) of IRPWM; ACS No. 124 dtd. 24.2.2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Whether it is ensured that preparation of rail surface is done by using hand operated or power operated tools i.e. scrappers, wire brushes, sand papers, pumice stone etc.? (Ref: Para 250(2)(b)(iii) of IRPWM; ACS No. 124 dtd. 24.2.2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Whether it is ensured that surface preparation is not done when ambient temperature is below 10°C or above 50°C? (Ref: Para 250(2)(b)(iii) of IRPWM; ACS No. 124 dtd. 24.2.2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Whether it is ensured that surface preparation is not done in rainy season, during night, in winter before 08 A.M.? (Ref: Para 250(2)(b)(iii) of IRPWM; ACS No. 124 dtd. 24.2.2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Whether it is ensured that surface preparation is not done in summer between 11 A.M. to 03 P.M. and in extremely windy/Misty/Dusty Condition? (Ref: Para 250(2)(b)(iii) of IRPWM; ACS No. 124 dtd. 24.2.2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Whether it is ensured that chemical is not used for surface preparation? (Ref: Para 250(2)(b)(iii) of IRPWM; ACS No. 124 dtd. 24.2.2011))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Whether it is ensured that rail painting is done in two coats of thickness 100 micron in each coat? (Ref: Para 250(2)(b)(iii) of IRPWM; ACS No. 124 dtd. 24.2.2011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Item to be checked</td>
<td>Yes/No</td>
<td>Remarks</td>
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<tr>
<td>8</td>
<td>Whether it is ensured that minimum 8 hrs elapsing period is given between 1st and 2nd coat of rail painting?</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><em>(Ref: Para 250(2)(b)(iii) of IRPWM, ACS No. 124 dtd. 24.2.2011)</em></td>
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<tr>
<td>9</td>
<td>It is ensured that no thinner/external chemical etc. is mixed with Anti corrosive black bituminous paint in painting.</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td>Whether it is ensured that thickness of painting is checked by approved type Elcometer?</td>
<td></td>
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</tr>
</tbody>
</table>

### 8.13 P-Way Registers and other records:

P.Way registers and other records should be maintained as per IRPWM and other instructions issued from time to time. Records should be maintained as per standard Proforma issued. Same are required for quality checks and as permanent records also for handing over the newly created assets to open line after commissioning. Check List of records/registers to be maintained is as under:

<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whether it is ensured that the following Registers are prepared as per PCE Circular No 268 R1 Para 7.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- LWR/CWR/SWR Register
- Welding Register(ATW,FBW)
- Curve Register
- Points and Crossing Register
- Section
- Rail/Weld failure Register
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remark</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Level Crossing Register</td>
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<tr>
<td></td>
<td>USFD Register</td>
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<td></td>
<td>Asset Register</td>
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<tr>
<td></td>
<td>Deep Cutting Register</td>
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<tr>
<td></td>
<td>Tunnel Inspection Register</td>
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<tr>
<td></td>
<td>Bridge inspection Register</td>
<td></td>
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<tr>
<td></td>
<td>The index plan Register</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land Boundary Register (807(b),(c),(d) (e), (f) of IRPWM</td>
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<td></td>
<td>Standard Measurement Book for Service buildings/Staff Quarter etc.</td>
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<tr>
<td></td>
<td>Infringement Register with details of condo nation to the infringements.</td>
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<td></td>
<td>Bad bank Register</td>
<td></td>
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<tr>
<td></td>
<td>Rivet (loose) Inspection Register/Camber Register.</td>
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</tbody>
</table>

In addition to above following register shall also be prepared:

- Ballast Cushion Register T.P. Wise
- Destressing Register
- Track Parameters Register
- Sand Hump Inspection Register
- Toe load Measurement Register
Whether it is ensured that the following **Records (Plans/Drawing)** are prepared as per PCE/NR’s Circular no. no 268 R1 Para 7.1?

- The Index plan & "L" Section in tracing paper duly approved.
- The certified land plans, land acquisition documents and compensation paid, Mutation etc
- P. Way Diagram
- The original Completion drawing of all the bridges including road over bridges, road under bridges, pipe line crossings, buildings, station yard plans, Level crossings etc.
- Colony layout plans.
- The water supply arrangement details and plans for water supply distributor system
- The details of water purification plant
- List of section having ballast deficiency
- History of major breaches, Cutting slips etc?
- List of RATs with details/ History/ plans
- Special feature like tilting of wells of major bridges, unusual phenomenon encountered while construction of new line etc.
- CRS’s sanctions.
- Compliances of CRS observation at the time of opening.
- List of Bridges.
- List of Buildings.
- List of Level crossings.
- List of Bench marks
- List of Completion drawings.
- Approved Site Plan
- Approved GAD.
- Approved structural drawings.
<table>
<thead>
<tr>
<th>SN</th>
<th>Item to be checked</th>
<th>Yes/No</th>
<th>Remark s</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>In addition to above, following P-way documents are also prepared:</td>
<td></td>
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<tr>
<td></td>
<td>• Ballast testing reports</td>
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<td></td>
<td>• U.S.F.D. testing report</td>
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<td></td>
<td>• Rail testing Certificate issued by RITES at the time of supply of</td>
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<tr>
<td></td>
<td>• new rails from BSPC.</td>
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<tr>
<td></td>
<td>• Welding (ATW/FBW) deflection, Metallurgical test report.</td>
<td></td>
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</tbody>
</table>

8.14 Annexures:

<table>
<thead>
<tr>
<th>8.14</th>
<th>Annexures:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Annexure - 8.01 - Circular regarding Test Check of AT weld/FBW</td>
</tr>
<tr>
<td>(ii)</td>
<td>Annexure - 8.02 - Providing Machine made Check rails on Level</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>Crossings</td>
</tr>
<tr>
<td>(iii)</td>
<td>Annexure - 8.03 - Lifting of SH Rails</td>
</tr>
<tr>
<td>(iv)</td>
<td>Annexure - 8.04 - Method Statement</td>
</tr>
</tbody>
</table>
**SUB: Test Check of AT-Weld/FBW.**

**REF:** (1) This office letter even No. dated 20.01.2016.

In continuation of the above referred letter at SN-(1). The field level Test Check is modified for AT Weld/FBW on 1 in. & 10 cm straight edge as prescribed on the manual.

<table>
<thead>
<tr>
<th>SN</th>
<th>Name of work</th>
<th>Measurements recording authority</th>
<th>% Test check by AXEN/XEN</th>
<th>% Test check by Dy. CE/C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Works costing up to Rs. 10 lakhs only.</td>
<td>SSE/SE/JE-I</td>
<td>50% test check in every Bill.</td>
<td>10%</td>
</tr>
<tr>
<td>2.</td>
<td>Works costing above Rs. 10 lakhs only.</td>
<td>SSE/SE/JE-I</td>
<td>100% test check by AXEN/XEN in every Bill.</td>
<td>20% test check on atleast every Bill.</td>
</tr>
</tbody>
</table>

This issue with the approval of CAO/CNR.

**DA: As above**

(Pramod Sharma)
Chief Engineer/Const./Sp. c/c.

**CC:**
(1) The Secy. to CAO/C for kind information of CAO/C.
(2) CE/CC, NW, NC, Survey, East for kind information please.
Dy. Chief Engineer/Const.,
Northern Railway,
TKJ, SERD, CSB-I & II, SSB, NDWCS
UMB, CDG-I, II, JUC, MB, LKO-I, II & III, JAT-D

Sub:- Test check of AT weld/FBW.

To ensure the quality of welds on various works in Construction Organization, hence forth following checks are being introduced for AT and FBW being executed in field.

1. The agency executing the weld will submit the tolerance of finished joint as prescribed in the manual on 1 mtrs and 10 cm straight edge alongwith the bill.

2. At field level following test check is being introduced for AT weld/FBW on 1 mtr & 10 cm straight edge as prescribed in the manual.

SSC/C/P-way 100%
AEN/XEN/C 50%
Dy.CE/C 20%

This issue with the approval of CAO/C/ N.Rly.

(Pramod Sharma)
Chief Engineer/Const/Spl

Copy to:-
Secy to CAO/C for kind information of CAO/C.

CE/C/C, NW, NC, Survey, East for information and necessary action.

Dy. Chief Engineer/Const.,
Northern Railway,
LKO-I, II & III, MB, UMB, CDG-I & II, TKI, SERD, SSB, CSB-I & II, NDWCS.

Sub:- Providing machine made Check Rails on Level Crossing.

Henceforth on construction projects, machine made check rails will be provided at level crossing instead of gas cut check rails. The machine cut check rail will have flaring of head, flange cutting and hold drilling through machine only and no gas cut or gas hole is permitted.

Accordingly the item to be made for check rail is given below for ready reference:

"Manufacturing & supplying of machine made special check rails 52 kg. for use with level crossing & conforming to specification No. IRS/T-10, Pre-stressed concrete sleepers PSC-51 to drawing No. RDSO/T-4215 (Rails will be supplied free of cost by Railway)."

As the cost of this item is nominal, thus field Dy.CE/Cs may arrange providing machine cut check rail at their end by introducing NS Item in the existing contract or through quotation as per the tender obligation and field requirement.

This issues with the approval of CAO/C.

DA: Copy of drawing.

(Subodh Kumar)
Dy. Chief Engineer/Const./TS
For Chief Administrative Officer/Const.

Copy to:
1. Secy. to CAO/C, N.Rly., for kind information of CAO/C.
2. CE/C/Central, NW, NC, East, Spl. & Survey for kind information please.
NORTHERN RAILWAY
(Construction Organization)

HEADQUARTER OFFICE
23, CHANDRAKANT JAIN MERE GATE DELHI

NO. 18-S/C/2015-16/P way/Requirement

Date: 15.01.2016

Dy. Chief Engineer/Const.,
Northern Railway,
TKJ, SERD, CSB-I & II, SSB, NIDWCS
UMB, CDG-I & II, JUC, MB, LKO-I, II & III, JATP

Sub:- Lifting of SH rails.

Ref:- This office letter of even no. dt. 6.01.16-copy overleaf.

CAO/C during review meeting with CE/Cs on 14.01.16, reviewed the progress of lifting of SH rails. As against 5987 MT, only 878 MT has been lifted so far. Rails are mainly to be lifted from Agra, Jhansi Division (NCR) and Delhi Division (N.Rly). The main reason for slow progress of lifting of rails is non-availability of rails at the loading points.

To expedite the progress of lifting of rails, it was decided that in case rails are not at loading point, then concerned field Dy CE/Cs will make arrangements to bring the rails at loading point by informing his counterpart officers of Open Line and by carrying out joint survey/inspection at supervisor level of Construction Deptt & Open Line, so that double payment on this account may not happen in any circumstance.

Further, while leading the rails till loading points all safety precautions must be adhered.

Copy for information and necessary action to:-

CE/C/NC, Survey, Central, NW, East

Copy to:-

Secy to CAO/C for kind information of CAO/C.

(Pramod Sharma)
Chief Engineer/CISpl
Addressed as per mailing list attached.

Sub: New clause 25.0 Method Statement for inclusion in “Special Conditions related to Site Data and Specifications”.

It has been decided that hence forth a New Clause 25.0 regarding submission of Method Statement as per enclosed Annexure-A, should be included in “Special Conditions related to Site Data and Specifications” of tender documents for all tenders of LH5s, ROB, P. Way irrespective of cost and for all other tenders costing more than 5 crores.

Above clause should be included in all such tenders being floated after 07.04.14 and also in those tenders where tender document is yet to be uploaded on website.

Dy.CEO shall scrutinize the Method Statement submitted by the contractor duly considering the contractual and codal provisions and site conditions. While approving Method Statement, he should clearly satisfy himself that equipment & staff proposed to be deployed by the contractor is commensurate with that required for timely & successful completion of activity. Dy.CEO shall ensure that work is carried out as per approved method statement. It is anticipated that Method Statement for all the activities will be available in reasonable time.

A few sample Method Statements collected from DMRC are available in Headquarter office and a copy of same may be collected from undersigned, if required. These sample Method Statements are only for guidance and Dy. CEO should get Method Statements prepared as per their specific requirement of work and site conditions.

This issues with the approval of CAO/C.

(Pradip Kumar)
Dy. Chief Engineer/C/T&C

DA: As above

1. XENITIS PRO
2. AKTIVISTZ E&P
3. STAGES OF DR/DP/INT
4. WCTC & CS/ACM/P&S

Pradeep Kumar
New clause 25.0 Method Statement for inclusion in ‘Special Conditions related to Site Data and Specifications

25.0 Method Statement

The contractor should identify the various major activities required for successful completion of the work and submit the method statement for each major activity before start of activity for approval of Railway. The method statement shall be submitted activity wise and should broadly contain the following:

1. Purpose
2. Scope
3. List of references used for preparation of method statement and that required during execution of activity.
4. The responsibilities of its staff involved in execution.
5. The detailed methodology of execution for the activity including its sub-activities step by step along with sketches/drawings/photographs/other relevant details, as required.
6. List of various equipments/tools/ plants, their capacity and numbers required
7. List of technical persons to be deployed for supervision.
8. List of type of other staff along with their numbers.
9. Tests required to be carried out, if any, before start of activity, during activities or after completion of activity, if any, duly referring to various IS, IRS, IRC, other codes as applicable along with acceptance criteria for various tests.
10. Quality Assurance Plan with Quality Control measures.
11. Various Performa’s required for recording of data/tests results/observations during the activity for ensuring proper Quality Control.
12. Check list to be observed at various stages of activity as applicable.
13. Safety measures to be adopted at site
14. Any other details as considered necessary for specific activity.

Contractor should submit method statement well in advance of likely start of activity. Contractor shall not have any claim for extension of time of completion due to delay in approval of method statement.
Mailing List

The Secy. to CAO/C for kind information of CAO/C.

The Secy. to PCE/Northern Railway, Baroda House, New Delhi for information of PCE/Northern Railway.

The PS to FA&CAO/C for kind information of FA&CAO/C.

The Chief Engineer/Const. Central, NC, NW, East, Spl. & Survey/ Kashmere Gate, Delhi.

Chief Electrical Engineer/Const./TKJ

The Chief Signal & Telecom Engineer/Const./IIR/Baroda House, New Delhi.

The FA&CAO/C/Central, NC & Genl; N.Rly. Kashmir Gate Delhi.


The Dy. FA&CAO/C/LKO.


The Dy. CE/C/D-I, D-II, East, NW, TS, Genl-I & II, Kashmere Gate, Delhi.

The Dy. CSTE/C/NR, Baroda House, New Delhi.

The Dy. CSTE/C/Pilg & HQ, N.R. Baroda House, New Delhi.

The Dy. CSTE/C/TKJ-I & II, D&D, PS, CW/NDLS.

The CEE/C/TKJ/NDLS. The Dy. CEE/C/DRM office/NDLS.

The CEE/C/CSB, The CEE/C/JUC, Dy. CEE/C/LKO.

The Director of Audit, N.Rly. K. Gate, Delhi.

The Dy. CVO/Engg; NR, Baroda House, New Delhi.

Dealing Officials of WA/Cell, in K. Gate, Delhi.
NORTHERN RAILWAY

CE Circular No. 259/R-2/P Way dated: June 2015

Sub: In situ fabrication of Glued Joints

1.0 General:-

1.1 Glued Joints are laid at places where insulation of rails as well as continuity of rails is required. Welded track is the example of such locations. An utmost care is needed for fabrication of G3(L) type Glued Joints as per RDSO Dir No.T-5361 for 52 Kg and T-55643 for 60 Kg rails.

1.2 Normally Glued Joints are fabricated in shop floor and transported to the site. However as the Glued joints fabricated at the site save effort needed in transportation and also save at least two Thermit welds which are a weak link in Track. It has been decided that henceforth glued joints required on all TIR & ITR works would be fabricated in situ on cess and then the rail renewal be done. Repairs to a failed/damaged glued joint can also be conveniently done at site. Carefully fabricated glued joint in the field can give as good a service as a shop fabricated glued joint.

2.0 Material and Equipments:-

2.1 Materials:-

The requirement of material for one glued joint is given in Annexure-4. The input material should be procured from RDSO approved suppliers only. List of the approved suppliers as on 17.2000 is enclosed as Annexure-V. List of approved suppliers, updated by RDSO every year, should be referred from time to time.

2.2 Equipment:-

List of equipment required for in situ fabrication of glued joints is given in Annexure-III.

2.3 Material Specification:-

Specification of material as contained in Manual for Glued Insulated Rail Joints (1985) shall be followed. A copy of the material specification is given in Annexure-III.

3.0 Selection of Rails:-

3.1 The rail to be converted into glued joint shall be free from burrs, excessive side wear/vertical wear, kinks corrosion and scabbing etc.

3.2 Both ends of the joint should be made as far as possible by cutting the rail.

3.3 Old free rail joints having battering etc. should not be selected for glued joint.

3.4 Flash butt/thermit welds should be avoided within 3.0 m from the insulated joints.

4.0 Pre-fabrication works :-

4.1 After selecting the location and rail, a speed restriction of 30 Kmph should be imposed.

[Signature]
4.2 The rail shall be cut with a rail cutting machine. The cuts made should be square and right up to the bottom edge of the rail. All burrs should be removed. It shall be ensured that rail pieces cut from the rail are jointed together at the cut end for fabrication of joint.

4.3 The holes in the rail shall be drilled concentric to the holes of the fishplates.

The holes should be drilled in a manner such that with the end post joint is in a frozen condition. This is very important as otherwise difficulty may arise during fabrication. The holes should be drilled with 30 mm dia H.T.S. drill bit. The burr around holes shall be removed. All the holes should be chamfered. Accuracy of holes should be checked with the fishplates and bolts in dry condition.

4.4 The above operations should be done with proper protection of track.

4.5 Proper round holes are cut on the glass cloth carrier and insulating channel coinciding with the holes of the fishplates to accommodate the bolts.

4.6 Rolling marks of rail occurring in the zone of contact of rail & fishplates shall be ground with a grinder so as to merge with the parent profile/contour.

4.7 It should be checked that the fishplates should have correct profile so that contact with rail on the fishing surface and web is proper.

5.0 Fabrication works:-

5.1 In case the fabrication is being done in running track, minimum traffic block of 2 hours shall be taken and track protected with banner flag and detonators. Rail should be made free of fittings over a length of 2.00 m on either side.

5.2 Grinding of rail to a length of 50 cms on either end should be done with the A4-9 grinder and it shall be ensured that no rolling mark, rust, dents are in contact with the fishplate.

5.3 Both the fishplates shall be ground to make the surface free from dust, dents, grease etc.

5.4 The gap shall be maintained slightly more than 10 mm to accommodate the end post (to achieve this, tensor shall be applied).

5.5 The rail ends shall be aligned laterally and vertically with straight edge using suitable wedges. After aligning no hammering/disturbance to ends should be done.

5.6 The rail ends and fishplates surfaces shall be cleaned with acetone and dried completely.

5.7 The resin and hardener shall be thoroughly mixed to get homogeneous mixture.

The mixed glue shall be consumed within 15 min. (Generally 30 minutes).

5.8 A thick layer of glue shall be applied on mating surfaces of the fishplates simultaneously by two workmen.

5.9 One piece of glass cloth carrier shall be placed on the fishplates and evenly pressed so that the glue seeps out through the glass cloth. The curing glue shall be uniformly spread over. A layer of glue shall be applied on inside of the insulating channel followed by then placement on the glued glass cloth carrier on the two fishplates.

5.10 A layer of glue shall then be applied on the outside of the insulating channel and a clean piece of glass cloth carrier shall be laid. The curing glue shall be uniformly spread.

5.11 Glue shall be applied to both the faces of end posts and placed between the two rail ends. The tenon may be tightened to place the end post firmly if the same is loose due to more gap. Alignment checked again at this stage and Corrected if disturbed.

5.12 The insulating bushes duly dipped in glue shall be placed in rail holes. The bonding surfaces of the rail shall then be coated with a layer of glue and the fishplates made ready shall be placed in position in contact with the rail web.

5.13 H.T.S. bolts washers and nuts well cleaned and free from oil, dust etc. shall be placed in position and tightened with torque wrench. The torque shall be increased gradually on all the bolts. Care shall be taken to tighten inner bolts first and then outer bolts. Finally all the bolts shall be tightened with the torque of 105 kg-M.
5.14 The above operation shall be finished within 45-60 minutes so that minimum 60 minutes setting time is achieved.

5.15 About 20 minutes after initial tightening, all the bolts shall be re-tightened with the torque of 105 Kgs. M.

5.16 The joint shall be finished by covering all the visible edges of glass cloth carrier with glue.

5.17 After re-tightening the bolts, joint is left for setting with tensor in clamped condition.

5.18 After setting, the removed fittings are restored in position, tensor removed and traffic block shall be cancelled.

5.19 Before passing the traffic, it shall be ensured that no extra material like settled glue etc. remains on top of the head & gauge face side of the rail.

5.20 Traffic may be passed at restricted speed of 30 Kmph for about two hours after which the speed restriction shall be relaxed to normal.

5.21 In works where rail renewal is also involved or spare rails are available, fabrication of glued joints should be done on coss and a rail panel of required length made on coss without need of a traffic block.

6.0 Precautions during Fabrication:

6.1 The mating surfaces of rails & fishplates shall be kept clean and free from oily traces and shall not be touched after cleaning.

6.2 The workmen shall wear hand gloves and apron while working.

6.3 The resin and hardener should not be mixed with bare hands.

6.4 A tube of Betonov cement should be kept at site and any splash of resin on the body should be removed with warm soapy water and cement applied.

6.5 Rail jumppers must be used in electrified section for return current.

7.0 Cleaning of Tools:

All tools, equipments and containers used shall be cleaned of glue immediately after assembly of the joint with acetone.

8.0 Repair to existing Glued Joint:

8.1 Repairs to End Post -

If end post at top is broken and gap between two rails exists at the head, repairs to end post will be carried out as under:

8.1.1 A traffic block of minimum 90 minutes is taken.

8.1.2 Joint is properly leveled on sleepers and approach sleepers packed.

8.1.3 Gap between two rails from all the sides is sealed with the help of an insulated tape.

8.1.4 Two components of glue (Hardener & Resin) should be mixed in prescribed ratio and fiber glass powder is added to the extent that mixture remains in form of slurry. This slurry is poured in the gap from top of the railhead and rail head is tapped slightly so that slurry fills all vacant space inside the joint.

8.1.5 It should be ensured that minimum one hour is passed before permitting any traffic so that the repair material dries up.

8.2 Through repair to Glued Joint:

8.2.1 Thorough repair to glued joints are necessitated if there is loss of resistance due to failure of bushes or channels, fracture of fishplate or complete working out of end post. Procedure will be as under:

8.2.2 Speed restriction of 30 Kmph will be imposed as far in situ fabrication.

8.2.3 Two hours traffic block should be taken.

8.2.4 During traffic block, the glued joint should be heated by a blow lamp to a temperature of over 200 degree Celsius. Nuts shall then be loosened and taken out. A chisel shall be inserted between rail & fishplate with the help of gentle blows of hammer, fishplates will be removed.
8.2.4 The released components i.e. fishplates, bolts, nuts & rail ends shall be cleaned to remove the old glue.
8.2.5 The joint shall then be fabricated in-situ as per Para 5.0

9.0 Quality check of Glued Joint:

9.1 Dimensional Check:
   Every fabricated/assembled joint shall be checked for vertical and lateral alignment with 1 m long straight edge. The tolerance permitted shall be as under:
   (i) Vertical alignment: Variation at the joint shall be within +1 mm and -0 mm measured at the end of 1 m straight edge placed at the top of railhead.
   (ii) Lateral alignment: Variation at the joint shall not be more than ±0.5 mm measured at the centre of 1 m straight edge placed along the gauge face.

9.2 Insulation Resistance Test:
   To be conducted on each glued joint.
   In dry condition: Each joint shall be subjected to insulation resistance test in dry condition. A measuring Voltage of 100 V. DC shall be applied across the joint. The value of the insulation resistance shall not be less than 25 Mega ohms.

10.0 Record Keeping:
   Record of production of glued joints and consumption of glue & fibreglass shall be maintained as per Performa given in Appendix IV.

11.0 To the extent possible, fabrication of Glued Joints, on the rails lying on case, should be done before insertion into track.

Rakesh Goyal
(Chief Track Engineer)

No. 219 W/24/01/IV/19
Dated: 03-06-2015
Material required for fabrication (in-situ) of one glued joint

Material required for in-situ fabrication of one glued joint shall be as under:-

<table>
<thead>
<tr>
<th>S. No.</th>
<th>NAME OF ITEMS</th>
<th>QTY.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>950 mm Long Fish Plates for glued joints</td>
<td>2 Nos. (Pair be checked for concentric holes)</td>
</tr>
<tr>
<td>2.</td>
<td>H. T. S. Bolts with nuts</td>
<td>6 Nos.</td>
</tr>
<tr>
<td>3.</td>
<td>Punched Plain washers</td>
<td>12 Nos.</td>
</tr>
<tr>
<td>4.</td>
<td>Insulating Bushes.</td>
<td>6 Nos.</td>
</tr>
<tr>
<td>5.</td>
<td>Insulating Fibre Glass Channels</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>6.</td>
<td>End Post 10 mm thick</td>
<td>1 No.</td>
</tr>
<tr>
<td>7.</td>
<td>Glue:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mis CIBA-GIEGY LTD.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Araldite Hardner XY-27 XY-28</td>
<td>1.4 kg (approx.) in the ratio of 100:40</td>
</tr>
<tr>
<td></td>
<td>Mis SIP INDUSTRIES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Epoxy Adhesive EMA-411 EH-445</td>
<td>1.4 kg (approx.) in the ratio of 100:66</td>
</tr>
<tr>
<td></td>
<td>Mis ATUL LTD.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resin Hardner A-63 K-83</td>
<td>1.4 kg (approx.) in the ratio of 100:40</td>
</tr>
<tr>
<td>8.</td>
<td>Fibre Glass cloth carrier</td>
<td>4 piece of (15 x 100 cm.)</td>
</tr>
<tr>
<td>9.</td>
<td>Acetone</td>
<td>1.0 Ltr.</td>
</tr>
<tr>
<td>10.</td>
<td>Kerocleanse chemical</td>
<td>1.0 Ltr. for cleaning hands,</td>
</tr>
<tr>
<td>11.</td>
<td>Emery paper</td>
<td>2 sheets</td>
</tr>
<tr>
<td>12.</td>
<td>Cotton waste</td>
<td>0.5 Kg approx.</td>
</tr>
</tbody>
</table>
LIST OF ESSENTIAL EQUIPMENTS REQUIRED FOR FABRICATION (IN SITU) AND TESTING OF GLUED JOINTS

1. Rail cutting machine or hacksaw machine.
2. Rail drilling machine with 30 mm dia HSS drill bit.
4. Mechanical Tensor
5. Tongue Spanner.
6. Chamfering Kit.
8. Scissors.
9. Straight edge 10 M long.
10. Steel Pans (about 30 cm dia.) for mixing glue.
13. Rubber hand gloves.
15. Brushes for glue application.
16. Rail jumpers.
17. Megger 100 V DC for testing insulation resistance in dry condition.
SPECIFICATION OF MATERIAL

1.0 SPECIFICATION FOR FISHPILATES

1.1 Steel of fishplates shall conform to IS:1995
1.2 The dimensions of fishplate shall conform to relevant drawing of the glued joints.

2.0 SPECIFICATION FOR HTS BOLTS & NUTS

HTS bolts and nuts shall comply with the following specifications:

2.1 Bolts: Hex bolts shall be as per IS: 1363 conforming to property clause 10.9 of IS: 1367.
2.2 Nuts: Hex nuts shall be as per IS 1363 conforming to property clause 12 of IS: 1367.

3.0 SPECIFICATION FOR PUNCHED WASHERS

Steel of Punched Washers shall conform to IS:2062.

4.0 SPECIFICATION OF INSULATING BUSHES/SLEEVES, LINERS AND END-POSTS

The insulating components viz. bushes/sleeves, liners and end-posts shall be made with the following materials in the premises of manufacturer as per the procedure indicated under para C.5.2.

5.0 MATERIALS:

5.1.1 GLASS-CLOTH CARRIER REINFORCEMENT

Glass-cloth carrier reinforcement shall conform to IS: 11273:1992 clause 4.5 type C for the properties not covered below:

a) Nominal weight: 350 36 gms/m²
b) Nominal thickness: 300 30 microns
c) Construction: Ends per inch: 15.5 2.5% Picks Weave per inch: 14 2.5%
d) Binder: The glass roving shall contain a sizing agent to facilitate weaving at impregnate high wet strength to liners, bushes/sleeves and end-posts. The sizing agent shall be compatible with epoxy resins. Approximate size of glass cloth piece is given below for guidance:

For G3/3*: 15 X 100 cm for 60kg, 52kg and 90R joints

5.1.2 GLUE: (FOR MAKING INSULATING COMPONENTS)

Glue consists of epoxy and hardener. Hardener and resin shall be mixed in the ratio of 10:1.
5.2 **FABRICATION TECHNIQUE:-**

5.2.1 The liners, end-posts and bushes/sleeves shall be fabricated either by the hand lay-up process or by pressure-moulding technique or by any other standard method.

5.2.2 In hand lay-up process the components are to be fabricated by building-up layer after layer till sufficient thickness is achieved. Generally 20 layers of cloth would be needed for end-posts of 6 mm thickness and 5 layers for liners, bushes/sleeves for obtaining the stipulated thickness.

5.2.3 The end-post may be built-up by using suitable sized rectangular pieces of glass-cloth. Nominal pressure shall be maintained till the piece is cured. The rectangular piece shall then be cut and profiled to the shape of the end-post.

5.2.4 The liner may be fabricated in the hollow of a rail-web by placing a rail piece with its web horizontal and by building up layer after layer. Nominal pressure shall be maintained in this case also till the piece is cured.

5.2.5 The bushes/sleeves are to be fabricated by winding a wide piece of glass-cloth on a bolt-shank and then cutting up the finished tubing into suitable size after curing.

5.2.6 In all the above cases, a coating of a release agent "Release-7" or a similar product shall be applied on the surface on which the component is fabricated to enable easy separation of the same after curing.

5.3 **DIMENSIONS OF FINISHED PRODUCT:-**

The liners, end-posts and bushes/sleeves shall be given final finish conforming to the dimensions shown in the relevant drawings.

5.4 **QUANTITY PER JOINT**

5.4.1 Quantity of raw material required for insulating components per 52 kg G3 (L) type glued joint, with 10 mm thick end-post drawing, shall be approximately as Under:

<table>
<thead>
<tr>
<th>Material</th>
<th>Qty reqd per joint</th>
<th>Glass cloth (gm)</th>
<th>Hardener (gm)</th>
<th>Resin (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Insulating Liners</td>
<td>2</td>
<td>500</td>
<td>450</td>
<td>45</td>
</tr>
<tr>
<td>2. End post</td>
<td>1</td>
<td>125</td>
<td>105</td>
<td>11</td>
</tr>
<tr>
<td>3. Bushes</td>
<td>8</td>
<td>25</td>
<td>30</td>
<td>3</td>
</tr>
</tbody>
</table>

5.4.2 Quantity of raw material required for G3(S) type joints can be obtained by reducing proportionately.

6.0 **QUANTITY OF GLUE REQUIRED FOR MAKING GLUED JOINT:-**

The tangential shear strength of glue is claimed to be about 120 kg/sq.cm by the manufacturer.

6.1 Resin and Hardener shall be mixed in proportions of 100:40 in general or as prescribed by manufacturers. The approximate quantity of combined adhesive required for 52 kg rail joint is 1.4 kg for G(3) type joints.
NOTE:

(i) The weight of raw indicated above is approximate and includes allowance for wastage and is based on experience gained at the time of development of these joints in RDSC.

(ii) Detailed instructions regarding the method of storage, mixing, pot-life and minimum period of curing of adhesive at various temperatures shall be obtained by purchaser from the suppliers and shall be scrupulously followed.

(iii) The resin and hardener should be of same firm as approved, i.e. resin of one firm and hardener of another firm can not be used.
### PROFORMA FOR MAINTAINING RECORD OF PRODUCTION

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Date of Fabrication</th>
<th>Exact Location of Joint</th>
<th>Name of Artisan Staff</th>
<th>Name of Supervisor</th>
<th>Whether made on Cross/Traffic Block</th>
<th>Inspection By</th>
<th>Dimensional Check (O.K./Not O.K.)</th>
<th>Insulation Resistance (in Mega Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Signature: [Signature]

Date: [Date]


326
APPLOYED SUPPLIERS OF MATERIALS FOR GLUED JOINTS

1. STEEL FISHPLATES:
   1. Bhasin Industrial Development Ltd., 1/1, Camac Street, 3rd Floor, Kolkata-700001
   2. Eastern Track Lubyog Pvt. Ltd., 41, N S Road, 4th Floor, Room No. 408, Kolkata-700001.
   3. Ganapati Industrial Pvt. Ltd., 2, Hare Street (Nicco House), VI Floor, Kolkata-700001
   4. Kontinental Steel Corporation, 18 R.N. Mukherjee Road, Kolkata-700001
   5. Laxis Ltd., 33-B, Industrial Area, Panchsbhadi-21301
   7. Techma Engineering Enterprise, 52, Nutaji Subhash Road, Kolkata-700001

2. H.T.S.BOLTS & NUTS:
   2. Nixo Industries, Over Lock Road, Millor Gari, Ludhiana-141003 (Punjab)
   3. Rathee Industries Ltd., Century Towers, 5th Floor, 45, Shakespeare Sarani, Kolkata-700017

3. GLUE:
   1. Atul Ltd., Polymers Division 6, 7 & 9(a), Indira Place, I-Block, Connaught Place, New Delhi-110001

4. GLASS CLOTH CARRIER (WOVEN ROVINGS)
   2. Harb-Deep Industries, 335/336, GIDC, Road No.6, Kutchwada, Ahmedabad-382430

5. PROSPECTIVE SUPPLIERS FOR TORQUE SPANNERS:
   1. M/S Mekaster, 908 Ansari Bhawan, 16 Kasturbha Gandhi Marg, New Delhi.
   2. M/S India Trade_unks, Sultanwind Road, Opp. Octroi Post, Amritsar (Punjab).
CHAPTER 9

PLANNING AND EXECUTION OF BRIDGES

9.1 Preamble

9.1.1 Introduction:

A bridge is a structure built to span physical obstructions without closing the way underneath, e.g., body of water, valley, road etc. for the purpose of providing passage over the obstacle. There are various designs of bridges with each serving a particular purpose and suitable to particular situations. There is no single solution for deciding type of bridge and designs of bridges vary depending on the function of the bridge, the nature of the terrain and location where the bridge is constructed, proposed material of construction and aesthetics required.

9.1.2 Type of bridges:

Bridges can be classified in many ways based on the form, material of construction and usage. Following are major classifications:

A) Form
   a. Simply supported bridge
   b. Continuous bridge
   c. Cantilever bridge
   d. Balance cantilever bridge
   e. Arch bridge
   f. Tied arch (Bow string) bridge
   g. Open web girder
   h. Cable stayed bridge
   i. Suspension bridge
   j. Bascule bridge

B) Material
   a. Wooden bridges
   b. Masonry bridges
   c. MCC bridges
   d. RCC bridges
   e. PSC bridges
   f. Steel bridges

C) Usage
   a. Railway bridges
   b. Road bridges
   c. Road over bridges
   d. Road under bridges
   e. Foot over bridges
   f. Rail cum road bridges
   g. Flyover
   h. Viaduct
   i. Pipe line bridges
9.1.3 **Topics covered:**

The present chapters cover various aspects of bridges starting from definition and classification. Various codes and manuals concerning the bridges have also be listed for ready reference. Thereafter survey for bridges is discussed including Geographical, Hydrological, Geotechnical, Seismic and Utility surveys followed by Planning of bridges at initial stages. Execution of bridge works has been discussed in detail for different type of sub and superstructures. Construction records are important part of execution and same have been duly deliberated upon. Post construction inspection of bridges has also been discussed.

9.1.4 **Codes, Manuals and Guidelines (sequence to be followed):**

Design and construction of bridges is governed by their respective latest codes based on their usage as given below. Always latest versions of the codes, manuals and guidelines shall be followed.

<table>
<thead>
<tr>
<th>Type of Bridges</th>
<th>Codes</th>
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<tbody>
<tr>
<td>Railway bridges</td>
<td>IRS, IRC, IS codes, other International</td>
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<tr>
<td>codes</td>
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<tr>
<td>Rail cum road bridges</td>
<td>IRS, IRC, IS codes, other international</td>
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<td>codes</td>
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<tr>
<td>Road bridges</td>
<td>IRC, IS codes, other international codes</td>
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<tr>
<td>Pedestrian bridges over rail</td>
<td>IRS and IS codes</td>
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<td>Pedestrian bridges over road</td>
<td>IRC and IS codes</td>
</tr>
<tr>
<td>Pipe line bridges</td>
<td>IRS, IRC and IS codes</td>
</tr>
</tbody>
</table>

9.2 **Survey:**

Survey for any work is an essential part of planning. The survey of construction of bridges is covered in detail in Chapter 3 of Indian railway Bridge manual. The survey or investigation for bridges should cover the particulars of catchment area, the soil characteristics, the anticipated flood level and other relevant hydraulic particulars. A bridge requires Geographical, Hydrological, Geotechnical, Seismic, Utilities survey which are discussed further below.

9.2.1 **Geographical:**

For planning of new bridges/ extension of bridges, detailed geographical survey of site is required. The survey should cover the following points:

(A) Following features falling up to a distance of 200 m on either side of bridge

a. Borrow pits.

b. Rivers, streams, drains, sullage and sewer drains and their sizes with direction of flow.

c. Pipelines with direction of flow.

d. Temples, mosques and graves.

e. LC, ROB, FOB with Roads and footpaths with the names of towns or villages they lead to.

f. T/Out, obligatory points, electric crossing etc.
g. Mining activity in the river bed, especially on the downstream side.

(B) For important/major bridges on new lines, the river to be surveyed for a distance of 8 km upstream and 2 km downstream, all spill channels in upstream should also be covered in survey. These should include cross section and L-section of the stream along with data for HFL, discharge etc.

(C) All bridges in upstream and downstream should be recorded along with their discharge, opening and HFL. This helps in deciding about the proposed bridge.

(D) Climatic data, e.g., maximum and minimum shed air temperature, humidity, rainfall, pollution level and type etc. Exposure condition should be determined on the basis of this data. These data have impact on design of bridge & its components and should be recorded in general arrangement drawing of the bridge for further use by design office.

9.2.2 Hydrological:

To collect the hydraulic data for the stream, a hydrological survey is required to be taken up. The Hydrological survey should include the following data:-

a. Area and shape of the catchment.

b. Details of the course of the main stream along with its slope, material and its tributaries.

c. Nature of soil and vegetation in the catchment.

d. Discharge of stream.

e. HFL with year.

f. If discharge is not available it, need to be determined from applicable formula g.

g. Information from the rainfall records of local or nearby rain gauges.

h. Other climatic conditions (like temperature, humidity etc.).

i. Bank erosion and bed scour observed at the bridge site in the case of alluvial rivers and the nature of the material transported.

j. The maximum observed scour depth in the vicinity of the proposed bridge crossing.

k. Full description of existing bridges in both upstream and downstream from proposed bridge.

l. Factors affecting water stage at the proposed bridge site.

m. Aggrading /degrading types of river bed in case of bridge in foothills terrain having bouldery strata.
9.2.3 **Geotechnical:**

Geotechnical investigation is important for determining type of substructure and its right proportioning. Sometimes even span arrangement may be governed on the basis of results of Geotechnical investigation.

The following particulars are usually collected during soil investigation:

a) Ground water table and its tidal and seasonal fluctuations;

b) Soil profile and bore hole log;

c) In-situ bulk and dry density ;

d) Index properties of soil ;

e) Shear properties of soil. If required Plate load test, Standard Penetration Test (SPT) may be done;

f) Consolidation properties, in case of clays ;

g) Particle size gradation.

h) Chemical analysis of soil and ground water to identify sulphate and chloride content or any other deleterious chemical content.

The tests and their extent depends upon type and size of foundation which in turn depends upon soil conditions. Thus soil investigation is an iterative exercise. Usually, one bore hole of sufficient depth (the depth depends upon type of proposed bridge foundation and experience from adjoining structure) is carried out. Its results are analysed and foundation is proportioned approximately based on results from one bore hole. If open foundation is proposed, then soil bearing capacity shall be confirmed by Plate Load Test, which is a direct and better representative test. Subsequently other bore holes / tests shall be planned.

Liquefaction potential shall also be assessed for the site. Deep foundation becomes necessary in case of liquefiable soils.

For a typical major bridge, following tests are required:

a. One bore hole per abutment pier with soil samples and SPT.

b. One PLT, however, if bore hole data varies from pier to pier, then more may be required.

c. Grain size distribution, shear strength parameters, Cu, Cc, Atterberg limits (for plastic soils) on soil samples

d. Water table with fluctuation details

e. Chemical analysis for chlorides and sulphates

9.2.4 **Seismic:**

The location of bridge should be plotted on seismic zone map to ascertain its seismic zone. Any fault in the vicinity (with in 20 km) to site shall also be noted. Liquefaction potential and soil type shall be obtained from soil exploration. These data have impact on seismic design of bridge and should be recorded in general arrangement drawing of the bridge for further use by design office.

9.2.5 **Utilities:**

Utility survey is required to identify services at site. Besides site tell tails/ markers, information may also be obtained from existing plans, registers, records etc. Cable layout plans for S&T and electrical shall be obtained from respective
Placing of bridges requires detailed analysis of data acquired during the various type of surveys. The purpose is to plan the bridge in such a way that it is suitable to the requirement and can be constructed most economically within the given site constraints. Therefore, each parameter requires the due deliberation. After the planning, checklist for preparing the general arrangement drawing for the bridges is also given at the end.

9.3.1 Overall length:

The economy and safety of the bridge requires judicious selection of appropriate water way to be provided which in turn decides overall length of the bridge. Hence, determination of overall length of the bridge is an important aspect which need due consideration. As far as possible, bridge should be planned perpendicular to stream (especially for important bridges). Besides avoiding the skew designs, this helps in reducing overall length of the bridge also.

For deciding the water way to be provided, following factors need to be considered:

a. Discharge of the stream
b. Type of terrain
c. Bed material
d. Lacey’s water way (In alluvial soils)
e. Water way of the bridges in upstream and down stream
f. River training works in approaches

In the case of a river which flows between stable high banks and which has the whole of the bank-to-bank width functioning actively in a flood of magnitude Q, the waterway provided shall be particularly equal to the width of the water spread between the stable banks for such discharge. If however, a river spills over its banks and the depth of spill is appreciable, the waterway shall be suitably increased beyond the bank-to-bank width, in order to carry the spill discharge as well.

In the case of river having comparatively wide and shallow section, with the active channel in flood confined only to a portion of the full width from bank to bank, constriction of the natural waterway would normally be desirable from both hydraulic and cost considerations. A thorough study of both these factors shall be made before determining the waterway for such a bridge.

The waterway shall be designed as per para 4.5 of the I.R.S. Code of practice for the design of substructures and foundations of bridges.

9.3.2 Span arrangement:

Span arrangement, i.e. no. of span and their lengths are to be determined next. The span arrangement is another important factor which governs the economy,
safety and ease of construction. Following factors should be given due consideration while deciding span configuration:

a. Height of Bridge (Bed level to formation level)
b. Nature of steam (perennial/intermittent/seasonal)
c. Scour depth
d. Type of foundation
e. Type of spans (Steel/PSC/RCC)
f. Superstructure Construction methodology (In-situ construction, cantilever construction, precast and launched etc)
g. Availability of materials

In case of perennial streams, construction of piers is difficult and costly and hence to minimize the piers, longer spans should be preferred.

Over all height of pier from scour level to Pier cap and type of foundation governs the cost of substructure. Well and pile foundations are costly and for their economic utilization, longer spans should be preferred.

For overall economy, cost of substructure should be approximately equal to cost of substructure.

In case of PSC girder, maximum span length of PSC girder has been restricted to 24.4 mtr.

9.3.3 **Type of foundation:**

The following types of foundations are normally provided for Railway Bridges, depending on the site conditions:

i) Open foundations.

ii) Well Foundations.

iii) Pile foundations.

a. Open foundation is suitable for bridges where rock or firm subsoil is available at shallow depth and there is not much scour in the stream.

b. Well foundation provides a solid and massive foundation for heavy loads and large horizontal forces. This has a larger cross sectional area and hence the total foundation bearing capacity is much larger than what may be offered by a cluster of piles. The well provides a very good grip when taken sufficiently deep and hence is most suited for river beds subjected to heavy scour. Being cast above water level, good quality control can be exercised in construction of well foundation hence, these should be preferred over pile foundation.

However, a well foundation should not be constructed in close vicinity to existing structures as construction of well foundation may affect the existing foundation, if constructed in close vicinity. Usually, a minimum clear distance equal to dia of well being constructed should be provided from existing structure for its safety.
d. Pile foundation can be used where the foundations have to be built very deep or taken through deep layers of soil subjected to little scour. Larger diameter piles can be provided to take care of large horizontal forces when the foundations are deep.

Assessment of pile capacity is based on empirical formula which use direct and indirect results from soil exploration (Usually disturbed samples are used for tests in lab), which is further confirmed by conducting initial pile load tests. So, all the activities, i.e. soil exploration, its testing in the Lab, estimation of pile capacity by empirical formula, boring for initial test piles, bore holes washing, casting of initial test piles, their testing, etc. should be carried out with maximum possible precision. Because, based on these test results, detailed foundation design will be carried out and also economy in the foundation will be effected.

Further, concreting of pile is mostly required to be done under water. So, while using tremie for concreting, extra care shall be exercised to achieve quality in concreting. Also, clear cover to reinforcement may also be difficult to ensure due to absence of provision of shuttering, hence, good quality PVC cover blocks should be used to ensure proper cover.

9.3.4 Type of superstructure:

The following types of superstructures are normally provided for Railway Bridges, depending on the site conditions:

a. RCC Box – These are used for culverts, subways, RUBs, services etc., boxes segments are casted preferably in longer barrel length, for construction of LHS. However, as there is no connection in adjoining segments, there is no lateral load dispersion and any damage to even a single segment may require closure of bridge. RCC box should not normally be provided, where the bed is likely to be scoured. In case it is provided, it should be protected with a Drop/Curtain wall of adequate depth (2M on upstream side and 2.5 M on downstream side,(Annexure-9.01)

b. RCC slabs – These are provided for small bridges (less than 3 m spans) and used for culverts, services etc.

c. PSC slabs – These are used for more than 3 m spans and up to 12.2 m spans.

d. PSC I girders/box girders - These are used for more than 9 m spans and have been used up to 40 m spans.

e. PSC balanced cantilever box girders – These are used for long spans and have been used upto 72+102+72 m continuous girders. These are constructed by cantilever construction method using NRS gantry.

f. Steel I-girders – Steel girders are normally used for 12.2 to 30.5 m spans. These can be fabricated in work shop under good quality control and then assembled and erected/ launched at site.

g. Steel open web girders – Steel open web girders are normally used for 30.5 m and longer spans. Open web girders use steel more effectively than I-girders and hence require less steel than I-girder for same span. However, these require more sophisticated equipment and higher level
of precision in fabrication. These can be fabricated only in work shop under good quality control and then assembled and erected/ launched at site. These are also provided with camber to counter deflections.

Earlier only riveted field connections were permitted in Railway girders. Now HSFG bolts can also be used in connections making their erection easier.

9.4 **Execution:**

Execution of bridge requires close supervision and periodic construction survey for its successful completion. Chapter 4 of Indian Railway Bridge manual gives in detail the procedure for various activities. Important points are given below for ready reference:

9.4.1 **Setting layout of bridge:**

The bridge layout should be done after center line of track has been marked in the field. The reference marks shall be outside the construction zone and duly protected against damage. All measurements should be done either using calibrated steel tape (all corrections should be applied appropriately, viz., tension, temperature and slope) or preferably using electronic measuring devices e.g. total station or EDM.

Firstly, the center of all piers and abutments should be marked and cross checked. Thereafter, layout of individual footings should be marked. In case of curved bridges, due consideration should be given to shift in center line of curve due to transitions. Besides that, usually pier centers deviate outward in radial direction also. This this be noted carefully, if provided in drawing and necessary corrections be applied to pier center. Checklist for GAD is annexed at the end.

9.4.2 **Utilities shifting:**

Utilities identified during survey may be classified as

a. Utilities to be shifted and

b. Utilities to be supported during construction

Those requiring shifting (normally wires, cables, small dia pipes are easy to shift) should be shifted prior to excavation to avoid any damage to services.

For those requiring support (Usually larger dia pipes, gas pipes etc. are difficult and costly to shift and foundation is planned with then as it is) during construction, support system should be planned well in advance with sequence of execution. All material required for support should be available at site before start of execution.

9.4.3 **Selection of material source (RMC, aggregate etc.):**

Source for all construction material should be identified for ensuring their supply during the work. This helps in maintaining quality and speed of construction. Following factors need deliberation while selecting source:

a. Distance from source to site

b. Quality of aggregate available
c. Quantity of material required

d. Rate of supply (cum/hr.etc.) required

e. Capacity of source

f. Backup arrangements in case of failure

g. Past experience of source

9.4.4 Substructure:

9.4.4.1 Open foundation:

Excavation should be done in such a way that the surrounding soil can stand by itself by suitably sloping the sides. When excavations have to be deep or when the side slopes are not stable, suitable shoring may be provided from top, using sheet pile, timber planks, walling pieces and struts.

In deep foundations and large size excavations, where the seepage is there, suitable pumps may be used for dewatering. A small sump on the side or corners should be provided for collection of the water to be pumped.

After excavation upto desired level, excavated surface should be thoroughly inspected for any loose pocket of earth. If any loose pocked is noted it should be compacted before laying of PCC.

If required, a plate load test may be carried out to confirm the bearing capacity of foundation.

Open foundations must rest on a stratum with adequate bearing capacity. The footings should rest on a lean concrete bed of adequate thickness

9.4.4.2 Well foundation:

After setting up of layout, first the pitching of well curb is carried out. Correct pitching of cutting edge is important for further work. The curb should be generally pitched at about 15 cm to 30 cm above the low water level. The pitching level may be kept higher if the water level in the river is subjected to greater fluctuations like in tidal areas. In case the site is dry, excavation should be carried out upto the level at which the well curb is proposed to be pitched and the centre of the well curb carefully marked. The well curb should then be assembled on wooden blocks or sand bags placed at intervals of about 1.5 metre. In case the well has to be sunk in water, an island is formed, and the top of the island is levelled and compacted lightly and marking for setting the cutting edge is done on the level surface. Gauges should be marked on curb to monitor tilt and shift.

Thereafter, reinforcement for well curb is fixed followed by shuttering. Sinking should be done at least 7 days after casting. As the well is unstable in beginning, it is desirable to partially sink cutting edge alone first before casting first lift. Further, in the beginning, smaller lifts of about 1.5 m should be done followed by sinking till well stabilized against tilt. Thereafter higher lifts may also be done to expedite the progress.

During the sinking, tilt and shifts be monitored continuously and rectification measures be taken at the earliest whenever they are observed. If final tilt and shift is more than prescribed limit (based on dia and depth of well), design office should be consulted before plugging.

After well is sunk to desired level, soil strata should be verified to ensure that it is
resting on planned strata. In case of deviation, a short depth bore may be done to verify the availability of strata. In case of major deviations, opinion of design office may be required.

Once the founding strata is confirmed, surface be prepared for bottom plugging by making the concave or KUNDI. Concreting of bottom plug should be done by tremie. After concrete has set, dredge hole be filled with sand followed by top plug, well cap and substructure.

In case of execution of a new bridge with a well foundation near to the existing bridge, distance between both bridges should be preferably kept at 6D (D is the diameter of Well). Ref: RDSO letter No CBS/DWF dated 15.07.2019 on “Centre to centre distance of deep foundations of existing and new Bridges” (Annexure 9.02).

9.4.4.3 Pile foundation:

As, piles are executed under almost concealed conditions and hence susceptible to quality issues, therefore, greater care is required to be exercised in execution of piles. For better quality control, integrity test of piles should also be conducted preferably by CHUM method. For boring and concreting of pile, detailed provisions as given in Section 1100 of Specification for Road and Bridge Works (fifth revision) published by Indian Road Congress shall be followed. Some of the commonly used provisions are given below for ready reference.

- Boring shall be carried out using rotary equipment. Percussion type of equipment shall not be used unless specifically approved by engineer-in-charge.

- Properties of bentonite suspension shall be periodically checked for its properties as per clause 1115.2.3 of Specification for road and bridge works (fifth revision).

- Bores with collapsed wall shall be rejected and should not be used.

- Deviation in location of pile at piling platform level shall not be more than 75 mm.

- Variation from vertical shall not be more than 1:150.

- Variation in cross section of pile shall be within +50/-10 mm.

- Clean the pile shaft of all loose material before placing reinforcement cage.

- Do not provide L-bends at the bottom of the reinforcement cage for cleaning of shaft.

- Ensure that no debris remains at the bottom of the shaft before concreting.

- The bore shall be washed by bentonite flushing to ensure clean bottom after completion of boring as well as before start of concreting after
placing the reinforcement cage. Flushing with bentonite shall be done continuously with fresh bentonite slurry till the consistency of inflowing and outflowing slurry is similar.

- Provide minimum 2 m temporary casing at top during concreting. Longer casing shall be used wherever required to prevent collapse of side walls of the bore hole.
- Concrete mix shall be M35 grade of concrete with minimum cement content of 400 kg/m³, maximum water cement ratio of 0.4 and slump in the range of 150-200 mm as per Clause 709.1.9 of IRC 78.
- As tremie method of concreting in not under water concreting, there is no need to add 10% extra cement (clause 709.6.2.3(h) of IRC 78).
- Wherever practicable, concrete should be placed in a clean dry hole.
- Concreting should invariably be carried out using tremie with a funnel.
- Dia of tremie should be minimum 200 mm.
- Tremie pipe should always be well into the already placed concrete.
- Tremie should always be full of concrete.
- Rate of placing of concrete shall not be less than 6 m (length of pile) per hour.
- Maintain sufficient head of green concrete to prevent inflow of water and soil in concrete.
- A continuous record shall be kept by engineer as to the volume of concrete placed in relation to pile that is cast.
- Once started, concreting shall be carried out continuously till complete casting of pile.

9.4.5 **Superstructure:**

9.4.5.1 **RCC bridges:**

RCC bridges form simplest type of superstructure. RCC slabs are restricted upto 3 m span. However, RCC boxes are being constructed in larger spans also (upto 12 m constructed). As the railway loads are dynamic in nature and concrete is prone to cracking, maintenance of proper reinforcement spacing and cove is essential.

Concrete mix design shall be carried out for the proposed mix of concrete. During hydration of cement, a lot of heat is generated causing evaporation of water from concrete and thermal gradient in green concrete. Loss of water in early stage causes reduction in strength and higher shrinkage in concrete. Thermal gradients may result in thermal cracks in early stages. To minimize these effects, attempt
should be made to minimize the cement during mix design to reduce shrinkage and thermal effect in concrete. Further, good quality aggregate should be used in concrete, especially those requiring higher strengths. Fine aggregate should be silt free (silt being within permissible limits). New PC (Polycarboxylate) based plasticizer are available which require less dose for same slump in comparison to old generation plasticizers (lignosulfonate based). Though these are costly but due to its reduced quantity required, the net cost effect is insignificant. Hence, PC based plasticizers should be preferred. Usually potable water should be used in concreting and further curing.

For cast in situ construction, first shuttering should be fixed. Shuttering plays an important role in quality and surface finish of the concrete. Only steel shuttering with proper de-shuttering oil shall be used for good surface finish. Shuttering should be free from dents, holes etc for good surface finish of concrete. It is recommended to use 4-5 mm thick steel plate in fabrication of shuttering for good surface finish in repeated jobs. Plates shall be securely fixed with each other to avoid chances of bulging during concreting. The joints between plates shall be leak proof to avoid leakage of slurry from concrete. Leakage of slurry leads to poor surface finish and honey comb in concrete. When depth of concrete is more, properly designed tie rods or wailers shall be provided.

Reinforcement shall be stacked and covered on staging to avoid contact with ground/soil. Reinforcement shall be free from rust, dirt, oil etc and cut and bend, preferably using machines, as per bar bending schedule. Thereafter, reinforcement shall be fixed. Sometimes, in heavily reinforced sections with shear stirrups, sequence of fixing of bars should be decided based on complexity of reinforcement.

Cover blocks for maintaining the cover mentioned in the drawing shall be fixed as required.

The reinforcement and shuttering shall be checked and any deficiencies noted be rectified.

Concreting scheme shall be prepared for quantity to be poured. Care should be taken to ensure that cold joints do not form in the process. Construction joint, if any, shall be thoroughly cleaned and wetted before start of concreting.

During extreme winter and summer, ambient temperature should be monitored and necessary steps shall be taken to cold/hot weather concreting as applicable.

Thereafter, concreting shall be carried out. Concrete shall preferable be obtained from RMC plant or automated batching plant at site.

Slump test shall be done and cubes for strength be filled as per frequency specified in IS:456.

Shutter and/or needle vibrator shall be used for proper compaction of concrete.

Construction joint, if any, should be prepared for next concreting before concrete just placed if final set.

Curing shall start soon after the final set and continue for 14/21 days as specified. For surfaces where wet curing is not possible, curing compound may be used with Approval of engineer in charge. If curing does not start early, shrinkage cracks may develop.

De-shuttering should be done at specified time. Surface should be inspected soon after de-shuttering and minor repairs required, if any, should be done
expeditiously. An early repair results in better bond.

Props below soffit should be removed after specified time.

HOT WEATHER CONCRETING:

DOs:

- Depute competent inspection personnel at site to anticipate the need for requirements during hot weather concreting and ensure them.

- When temperature conditions are critical, carry out concreting during evening or night.

- If ambient temperature is likely to exceed 40 degree Celsius during period of concreting, start concreting only if arrangements for hot weather concreting are in place.

- Plan the locations of construction joints ahead of time with hot weather contingencies in mind.

- Do not add water to pre-mixed concrete at the job site unless it is part of the amount required initially for the specified maximum water-cement ratio and the specified slump.

- Use all available means to maintain the materials at as low temperatures as practicable.

- Provide shades on stockpiles to protect them from direct rays of the sun.

- Sprinkle water on the coarse aggregate piles & apply moisture correction accordingly.

- Use cold water in concrete and keep it cold by protecting pipes, water storage tanks, etc.

- Mix ice directly into the concrete as part of the mixing water.

- Design the mix with minimum cement content consistent with other functional requirements.

- Use lower heat of hydration cements instead of that with greater fineness and high heat of hydration.

- Check concrete temperature frequently using a metal clad thermometer by embedding it in concrete.

- Keep the mixing time to the minimum as required to ensure adequate quality and uniformity.
Paint the exposed mixer surface yellow or white, cover it with hessian cloth and spray cool water.

Keep the period between mixing and delivery to an absolute minimum.

Coordinate the delivery of concrete with the rate of placement to avoid delays in delivery.

Sprinkle forms, reinforcement, and subgrade with cool water just prior to placement of concrete.

Wet the area around the work to cool the surrounding air and increase its humidity.

Deploy ample personnel to place concrete immediately on delivery to minimise the delay losses.

Place concrete in thin layers and small areas to reduce time interval between consecutive placements.

Moist fresh the concrete by means of fog sprays, wet hessian cloth, cotton mats, or other means if cold joints or cracks tend to form, especially shortly after placement and before finishing.

Protect the concrete from evaporation of moisture, preventing ingress of external water, by means of wet (not dripping) gunny bags, hessian cloth, etc., immediately after consolidation and surface finish.

Commence the moist curing once the concrete has attained some degree of hardening sufficient to withstand surface damage (approximately 12 hour after mixing).

Sprinkle water on formed surface while forms are still in place. Keep the vertical and steeply sloping formed surfaces moist by applying water to the top surfaces prior to and during form removal.

Keep the exposed surfaces moist by wet curing & provide wind breaker wherever possible.

Spray the covering material with water to keep them soaked.

Heavily reinforced area should be given special attention.

**DO NTs:**

Use such large chunks of ice that do not melt down completely before mixing is completed.
Use concrete if its temperature is above 40 degree Celsius

Rely on the protection afforded by forms for curing in hot weather.

In initial stages of hardening, temp of curing water should be approximately equal to that of concrete.

Remove wet covers until they are completely dry.

Delay in finishing air entrained concrete in hot weather.

Let the concrete surface dry during curing causing alternate drying and wetting conditions.

Prolong mixing.

Finish slabs prematurely, e.g. While bleed water is still on the surface.

9.4.5.2 PSC Bridges:

Shuttering, reinforcement and concreting operation in PSC bridges are same as for RCC bridges. Besides that, fixing of pre-stressing conduits (sheathing), cone and subsequently prestressing operation are additional activities.

Note type of sheathing to be used from drawing. Only that type of sheathing should be used.

Note down cable coordinates at points as shown in the drawings.

Workout cable bottom levels at same points.

Prepare reinforcement ladders for fixing of sheathing.

Fix ladders along with reinforcement.

Note cable exit angles from drawing.

Prepare end shuttering as per recess for cone and exit angles.

Insert sheathing.

Ensure proper sealing of sheathing joints to prevent ingress of cement slurry during concreting.

Fix cones on end shutters.

Fix bearing sleeves.
• Fix shuttering including end shuttering.

• Insert few strands in each sheathing.

• Concreting to be done as enumerated in RCC bridges. Move strands in sheathing to and for as the concreting progresses to ensure no blockage during concreting.

• Curing and de-shuttering to be done in same way as for RCC bridges.

• After concrete has attained specified age and strength, insert all strands for stressing. In case of stage stressing, only cables to be stressed in that stage should be inserted.

Stressing of cables is a specialized activity requiring site calculations & decisions and therefore should be carried out in supervision of experienced technical personal only. Following are the steps involved in stressing:

i) Note following data from drawing
   a. Theoretical Area and Modulus of elasticity of strand.
   b. Grip length of jack used in calculation.
   c. Elongation of each cable for both ends along with pulling force (usually both ends have equal elongation but in special layouts, these may be different).
   d. Sometimes, ram area of jack is given along with pressure. If a jack of different ram area is to be used then corresponding pressure need to be worked out.
   e. Note Theoretical Area and Modulus of elasticity of strand from mill certificates.

ii) Note actual Grip length of cable

iii) Workout corrections as follows
   a. Correction for Area and Modulus of elasticity of strand
   b. Correction for change in grip length, if any
   c. Correction for change in ram area of jack, if any.

iv) Calculate modified elongation of cable and jack pressure

v) Calculate elongation at 20%, 40%, 60%, 80%, 90%, 95%, 100% and 105% of jack pressure

vi) Start stressing
a. Fix bearing plate and wedges
b. Fix jacks at each end of cable
c. Fix master wedges
d. Tighten each strand to remove slack
e. Re-fix master wedges after removal of slack
f. Note initial reading for further calculation of elongation
g. Apply 20% of jack pressure
h. Note elongation and compare with theoretical elongation. (Deviation may be there at 20% pressure due to residual slack)
i. Increase jack pressure to 40%.
j. Note elongation and calculate incremental increase. Compare with theoretical increase in elongation. These should be comparable within 5%.
k. Repeat I & j till pressure reaches 100% or elongation reaches 100%.
l. If elongation at 100% pressure is less than theoretical value, increase pressure till 100% elongation is achieved. Pressure not to be increased beyond 105%. If 100% elongation is achieved then lock the cable.
m. If pressure at 100% elongation is less than theoretical value (100%), increase pressure to 100%. Pressure not to be increased beyond 105% elongation. If 100% pressure is achieved with elongation <= 105% then lock the cable.
n. After cable is locked, release the jacks and note cable retraction giving wedge set. It should not be more than wedge set specified in drawing.
o. Observe cable for slow slip for next 24 hours.
p. If no slip is observed, grout the cable. Detailed procedure for grouting is given in bridge manual.
q. Complete with trimming of strands using grinder followed by capping of end cones.
r. If conditions in m are not satisfied and cable is not locked, abandon stressing and investigate the cause. Rectify it. Further stressing should be carried out using fresh cable. Cable once stressed should not be reused.
vii) All stressing record should be preserved as permanent record and form part of completion plan for future reference.

viii) After stressing, further work should be done as for RCC bridges.

9.4.5.3 Steel Bridges:

In steel bridges, fabrication is a specialized job covered in separate chapter. Following are the main points to be kept in mind:

i) QAP should be prepared as the first activity.

ii) All detailed drawings should be available before start of work. Part drawings may create problem at later state leading to wastage of material.

iii) Prepare plate/section cutting plan to minimize the wastage.

iv) Order material accordingly.

v) While ordering material, Grade and Quality of steel should be specially taken care of.

vi) Strength designation of steel has been changed in code during last 10 years from name based to Fe to dual E/Fe followed by E. To further complicate the issue, Old Fe denoted yield strength whereas Fe in dual regime denoted ultimate strength. Now E is used which denoted yield strength.

vii) Quality of steel has also seen variations. It defines manufacturing process (killed/semi killed/ normalized etc) along with usability (weld ability increases from Quality A onwards) and impact resistance. Earlier it was called grade (now grade denotes strength and not quality). Further a new Quality (old grade) has been added by splitting B in to B0 and BR. Earlier B has become B0 and BR is new quality.

viii) So whenever old drawing is referred with some Steel specification written, it need to be deciphered correctly for present day code.

ix) Next step is to prepare WPSS to be validated by tests.

x) Welder qualification is also required. A welding procedure along with welder is qualified for a particular combination of plates to be welded, weld size and procedure (SAW/MMAW etc)

xi) Jigs and fixtures should be prepared as required

xii) The code to be followed should be selected based on work. IRS codes to be followed for railway and rail cum road bridges whereas IRC codes to be followed for Road bridges.
xiii) Similarly, RDSO approval is related to railway and rail cum road bridges.

xiv) Camber in steel bridges is important and salient points are covered below in 9.4.5.4.

xv) Now-a-days, HSFG bolts are being used. RDSO has issued detailed guide lines on the same. The salient points are covered below in 9.4.5.5.

xvi) Painting of steel bridges is covered in 9.4.5.6 below.

9.4.5.2 Camber:

Open web girders are designed based on the theory of truss where all joints are assumed to be pin joints and all members are considered to carry axial forces only. In practice, open web girders have rigidity in joints due to the size of rivets or bolts in connections. This rigidity in joints causes secondary stresses in members due to deformation of joints under load. To realise the assumption of pin joints, there are two ways, viz., to pre-stress the girder in direction opposite to direction of deformation of joints by providing camber or to account for secondary stresses in design.

IRS codes have adopted first method, i.e., to provide camber in girders (Cl. 34 of IRS:B1-2001). Normally it is considered that cambering is against deflection of girder in large spans, however, besides compensating the deflection, it has another important purpose of prestressing the girder members against secondary stresses, due to which, cambering needs to be given due importance to ensure longevity and proper load carrying capacity of girder.

The pre-stressing of girders is achieved by fabricating member length as per nominal layout. The angular difference in member direction between nominal and camber layout induces the reverse deformations in members for pre-stressing it against secondary deformations. As a result members are straight at full load thus fulfilling the assumption of pin joints.

Detailed procedure for providing camber is given in Appendix-III of IRS:B1-2001.

The procedure for erection in brief is given below for ready reference.

1. Prepare erection bed. In case of in-situ erection, fix trestles/ service girders for supporting panel points.

2. Fix camber jack on each panel point support.

3. All camber jacks shall be in level of highest joint initially.

4. Lay bottom chords, cross girders and bracings starting from one end. Align members and match joints. Provide 40% drifts and 40% bolts in joints.

5. Fix verticals and diagonals. Provide 40% drifts and 40% bolts in joints.

6. Provide camber by lowering of camber jacks.

7. After all vertical and diagonals are erected, start erection of top chords from center proceeding out ward.
8. Provide top bracings along with erection of top chords.

9. Check and adjust camber.

10. Fix end rackers.

11. Complete 40% drifts and 40% bolts in all joints before refitting.

The Dos and Don’ts for achieving camber are as under

Do’s

- Start with all camber jacks in level

- In the case where the girders are erected on yielding supports such as a service span, provide due allowance for the anticipated yield when the camber blocks are set out.

- Provide 10% extra initial camber even on unyielding supports to cater for unforeseen settlements during erection.

- Check camber frequently during erection, preferably at least on alternate days.

- Drift number of holes simultaneously, if drifting is unavoidable.

- Fix upper end of end racker first

- Re-tighten service bolts frequently as the riveting proceeds

Don’ts

- Provide camber till all bottom chord, verticals and diagonals have been erected.

- Drift joints as far as possible.

- Use hammers exceeding 1 kg.(2 lb) in with turned barrel drifts

- Carryout reaming of holes. Align holes by drifting instead.

- Fix lower end of end racker first.

- Start riveting until the Engineer has personally satisfied himself that the alignment of the girders is correct, the verticals plumb laterally, the camber according to that shown on the camber diagram with camber jacks screwed tight, all the joints and cover plates well up, service bolts tight and field rivet holes coinciding.
9.4.5.5 HSFG bolts:

High strength Friction Grip (HSFG) bolts works on the principal of direct transfer of force from one member to another through friction against the conventional bolted joints in which force transfer takes place from one member to another through bearing surface of bolts along with shearing of bolts. Hence joints with HSFG bolts are also termed as friction type joints whereas conventional bolted joints are termed as bearing type joints. To generate high friction, high force normal to the connected surface is required for which high strength bolts capable of providing high tension in bolts are used. Hence these are called high strength friction grip bolts. The connection made using HSFG bolts is designed for no slip condition. If slip takes place in joints with HSFG bolts during load transfer then behaviour of joint changes from friction joint to bearing joint resulting in change of methodology of load transfer and also changing the design basis. Therefore, due care is required to be exercised during execution so that a joint designed as a friction type behaves in the same way after execution.

As the friction generated is the physical property of surfaces in contact, proper preparation of contact surfaces is of paramount importance in case of friction type joints. Friction factor as per IS 4000 for some of the common surface finishes is given below for ready reference.

<table>
<thead>
<tr>
<th></th>
<th>Surface condition</th>
<th>Friction factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Surface not treated</td>
<td>0.20</td>
</tr>
<tr>
<td>2</td>
<td>Surface blasted with shot or grit with any loose rust removed, no pitting</td>
<td>0.50</td>
</tr>
<tr>
<td>3</td>
<td>Surfaces blasted with shot or grit and hot-dip galvanized</td>
<td>0.10</td>
</tr>
<tr>
<td>4</td>
<td>Surfaces blasted with shot or grit and spray-metallized with zinc</td>
<td>0.25 (thickness 50-70 mm)</td>
</tr>
<tr>
<td>5</td>
<td>Surfaces blasted with shot or grit and painted with ethyl-zinc silicate coat</td>
<td>0.30 (thickness 30-80 mm)</td>
</tr>
<tr>
<td>6</td>
<td>Surfaces blasted with shot or grit and painted with alkali-zinc silicate coat</td>
<td>0.30 (thickness 0-30 mm)</td>
</tr>
<tr>
<td>7</td>
<td>Surfaces blasted with shot or grit and spray metallized with aluminium</td>
<td>0.50 (thickness &gt; 50 mm)</td>
</tr>
</tbody>
</table>

NOTE: The contact surfaces shall not be sand blasted.

It is worth noting that shot or grit blasting is essential for use of HSFG bolts. Presently sand blasting is being used for surface preparation which is prohibited with HSFG bolts. Further metallizing is most suited with friction factor of 0.50 and hot dip galvanising is least suited with 0.10. The desirable and prohibited activities while using HSGF bolts are given at the end for ready reference.

**Do's**

1. Check class (8.8 or 10.9) of bolts from drawing carefully.
2. Check bolt tension and type of surface preparation from drawing. If not available in drawing then refer to design office.
3. Check supply of bolt to ensure class.
4. Obtain torque required to produce desired tension through lab test.
5. Re-assess torque through lab test if source of bolts changes
6. Carryout surface preparation as mentioned in drawing using shot/graft blasting only.
7. Tighten bolts using torque wrench at specified torque only.
8. Use nuts and bolts as supplied.

**Don'ts**
1. Use bolts of class lower than that specified in drawing.
3. Use paint other than that specified for surface preparation.
4. Tighten bolts using a normal spanner.
5. Assume tightening torque.
7. Use rusted bolts.

**9.4.5.6 Painting:**

Site conditions and access to site govern the painting system to be used. Galvanization, Metallising or Epoxy paints should be preferred for corrosive conditions. Also provide a good solution to corrosion. All these systems provide long life up to 20 years. Other paints need recoating after every 5 years or earlier. Painting of steel structures should be carried out after approval of fabrication as per the selected painting system. After the steel work is erected at site, the second finishing coat shall be applied after touching up the primer and the finishing coat if damaged in transit. The Schedule of painting as detailed in IRS B-1 specification shall be adopted. Dry Film Thickness shall be measured by elcometer or any other approved method.

**A) Metalizing**

i) The surface shall be thoroughly cleaned and roughened by compressed air blasting

ii) Metal spraying (150 microns in 2 layers) shall be carried out as soon as possible after surface preparation (Details in Appendix VII of IRSB1)

iii) One coat of etch primer to IS:5666.

iv) One coat of zinc chrome primer to IS:104 with the additional proviso that zinc chrome to be used in the manufacture of primer shall conform to type 2 of IS:51.
v) Two coats of aluminum paint to IS:2339 brushing or spraying as required. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second finishing coat shall be applied after touching up the primer and the finishing coat if damaged in transit.

B) Epoxy painting:

i) Prepare the surface by sand or grit blasting to Sa 2-1/2 to IS:9954 i.e. near white metallic surface

ii) Apply by brush/airless spray two coats of Epoxy Zinc Phosphate primer to RDSO Specification No. M&C/PCN/102/86 to 60 microns min, dry film thickness (DFT) giving sufficient time gap between two coats to enable the first coat of primer to hard dry.

iii) Apply by brush/airless spray one coat of Epoxy Micaceous Iron Oxide paint to RDSO Specification No. M&C/PCN/103/86 to 100 microns minimum DFT of 100 and allow it to hard dry

iv) Apply by brush/airless spray two coats of polyurethane aluminum finishing to RDSO Specification No. M&C/PCN-110/88 for coastal locations or polyurethane red oxide (red oxide to ISO 446 as per IS:5) to RDSO Specification M&C/PCN-109/88 for other locations to 40 microns minimum DFT giving sufficient time gap between two coats to enable the first coat to hard dry. The finishing coats to be applied in shop and touched after erection if necessary.

C) Conventional painting:

i) Remove oil/grease from the metal surface by using petroleum hydrocarbon solvent to IS:1745

ii) One coat of ready mixed paint zinc chrome priming to IS:104 followed by one coat of ready mixed paint red oxide zinc chrome priming to IS:2074.

or

Two coats of zinc chromate red oxide primer to IRS:P-31

iii) Two finishing coats of red oxide paint to IS:123 or of any other approved paint shall be applied over the primer coats. One coat shall be applied before the fabricated steel work leaves the shop.

9.4.5.7 Launching of Girder:

Girders of superstructure can either be erected in-situ or assembled at different convenient locations and launched in position subsequently. In case of launching, many methods are available. Some of the popular methods are listed below for ready reference.

i) Launching by crane
ii) End launching by pulling

iii) Cantilever erection

Use of a method depends primarily on the following factors:

Site condition

i) Weight of girder

ii) Availability of suitable cranes

iii) Availability of skilled man power

For small girder, it is convenient to assemble them on ground and launch using cranes. Crane working is simple and more reliable. Now a days, cranes of higher capacity (300-500 T) are available which may be used to launch even heavier girders. Even open web girder of 30 m span have been launched using cranes after assembling then on river bed. Following precautions should be taken while launching by crane:

1. Detailed plan shall be prepared duly marking position of crane and girders to be erected. Final position of girder should also be marked on the same plan.

2. Any obstruction to free movement of hanging girder shall be noted and written on the plan for proper calculations of crane capacity.

3. Maximum lifting (working) radius of the crane should be worked out from the plan.

4. Boom length and angle should be worked out from sectional details (Level of crane and girders).

5. Girder weight should be worked out from drawings

6. Select suitable crane out of available crane in the market based on above data (working radius, boom angle, boom angle and weight to be lifted.

7. After finalising the crane, check the plan for its placement in detail ensuring grounding of its out riggers on firm ground. Grounding on weak soil or on slope may result in tilting/ toppling of crane.

In end launching, girder is assembled at on bank of the bridge and then pulled using winches. The girder is placed on rollers/ trolleys over track for pulling. In cantilever erection, first a dummy span is erected on bank and then using it as starter, first span is erected using cantilever crane. The span being erected is in cantilever during erection, hence the name cantilever erection. After a span is completed, it is supported on pier at other end. Then using it as starter, another span is erected and so on. End launching and cantilever erection are specialized subjects and services of an expert are required for planning and execution of the same.

9.4.6 Installation of Bearing:

“A bearing is a small part of a bridge and unfortunately the attention it receives from the engineers is also negligibly small. In fact, the importance of this small part should have been inversely proportional to its size, as the entire load is transmitted through this tiny component and any mis-behaviour of bearing may
lead to catastrophic results both for substructure as well as superstructure\(^1\).

The bearing essentially performs three functions viz.

(1) To transfer load from superstructure to substructure,

(2) To allow the permitted movements and

(3) To prevent the undesirable movements.

There has been significant improvement in bridge bearings after use of Elastomer and PTFE was started. Many modern bearings have been developed using these materials which includes Elastomeric bearing, POT bearing, POT-PTFE bearing, spherical bearing, friction pendulum bearing. These bearings are able to support medium to high loads while permitting large deformations (translation and rotation) and hence fit for medium to large spans.

Bridge bearings requires due importance since first stage of installation. Following points should be kept in mind while fixing the bearing:

i) Bearing should be procured only from approved manufacturers

ii) Bearing should be inspected for any transit damage before fixing. All transit clamps shall be securely fastened.

iii) Bearing location shall be precisely marked on the pedestal and superstructure

iv) Pedestal and sleeve pockets shall be cleaned before placement of bearing.

v) Bearing shall be gently placed in location without any undue application of force.

vi) All bracings and diaphragms of girder should be fixed/ cast before fixing of bearing.

vii) Girder should be kept in proper line and level on wooden blocks before fixing of bearing.

viii) Bearing should then be lifted and aligned to connect it to girder. In this position, bearing shall suspend freely from girder with space between bearing and pedestal.

ix) Tight bearing by driving steel wedges between bottom of bearing and pedestal to ensure no gap in bearing elements.

x) Fix bearing by pouring non-shrink grout in between pedestal and bearing.

xi) After gout is set (about 12 hrs), remove steel wedges and fill the created space with grout.

xii) Remove clamps after 24 hrs of grout. If clamps are left for longer duration after bearing is fixed, it may damage the bearing by restricting its movement.
9.5 **Construction records:**

9.5.1 **RCC:**
Maintaining of site records is essential for quality control. Following records shall be maintained for RCC construction:

i) Site order book

ii) Steel (Reinforcement) register

iii) Material testing register (Coarse aggregate, Fine aggregate)

iv) Concrete cube strength register

v) Moisture correction register for concreting

vi) Water test

vii) Cement register

viii) Concreting register

ix) Slump register

x) Daily activity register

xi) Labour register

xii) Unusual incidence register

xiii) Approved drawings set

xiv) Site layout

9.5.2 **PSC Girders:**
In addition to records maintained for RCC work, following additional record be maintained for PSC work:

i) Sheath profile record

ii) Stressing record

iii) Grouting register

iv) Strand record

v) Sheathing record

vi) Anchor record

9.5.3 **Steel Girders:**
Records to be maintained for steel girders are given in IRS-B1 and reproduced below for ready reference:

i) Jigs register

ii) Rivet checking register

iii) Material offering and inspection register

iv) RDSO inspection note and compliance register

v) Welding procedure data register

vi) Radiographic inspection register

vii) Statement of material test certificates

RDSO inspection note and compliance register is required for railway girders only and not for ROB and FOB. Besides the above following registers should also be maintained for composite girders.

i) Shear studs checking register

ii) HSFG Bolt checking register (if used)

9.6 Safety precautions for OHE and utility:

Now days, most of the utilities e.g. electric cables, telephone wires, optical fibers, gas pipe lines, oil pipe line, water pipe lines, severs etc. are provided under ground to give a neat appearance. However, these underground utilities cause hindrance in works and need due care during execution for safety of both utilities and workmen. Whereas damage to some of the utilities may lead only disruption of service to related facility e.g. telephone wires, optical fibers etc. damage to some other may be catastrophic e.g. gas or oil pipe line. A detailed utility survey, as already stated earlier, is required and helpful. All utilities should be got shifted prior to work is possible. If it is not possible to shift some of the utilities, a detailed scheme for their protection should be prepared in consultation with respective department and implemented at site for ensuring the safety.

In case of electrified tracks, OHE is present requiring special safety precautions. Safety precautions in electrified area have been given in detail in para 282 to 290 of IRPWM. Some of the important precautions related to bridges are listed below for ready reference.

i) No work shall be done within a distance of two metres from the live parts of the O.H.E. without a ‘permit-to-work’.

ii) No crane shall be worked except on the authorised ‘permit-to-work’. In every case of working a crane, arrangement should be made for the presence of authorised overhead equipment staff to ensure that all safety precautions are taken.

iii) Steel tapes or metallic tapes with woven metal reinforcement should not be used in electrified tracks. Linen tapes are safer and, therefore, should be used even though they are not accurate.
iv) It is important to note that dangerous voltages may be induced in metallic masses such as fencing posts in the vicinity of traction conductors. To avoid possibility of shock due to such voltages, the metallic structures are bonded together and earthed.

v) All electrical equipment, every power line or cable shall be regarded as being ‘live’ at all times.

vi) For work adjacent to overhead equipment the Engineering Inspector shall apply to the proper authority sufficiently in advance for sanctioning the traffic and power block required.

vii) The Traction Power Controller through Traction Foreman will arrange to isolate and earth the section concerned on the date and at the time specified in consultation with the Traffic Controller. He shall then issue ‘permit-to-work’ to the Engineering Inspector.

9.7 Conclusion:

In this chapter, a brief overview of bridges has been covered which includes planning and construction of different types of bridges. Various available options and practices have been discussed. Do’s and don'ts for some critical activates have also been given. The purpose is to acquaint the reader with various terms and field practices on the subject. For detailed information on any subject, related specifications/codes/manuals are required to be referred. Indian Railway Bridge Manual, Indian Railway Works Manual, Indian Railway Concrete Bridge Code and Indian Railway Standard Specification for Fabrication and Erection of Steel Girder Bridges and Locomotive Turn-Tables are the major references for railway bridges. For Road bridges, IRC-22, IRC-24 and IRC-112 may be referred.

CHECK LIST FOR GAD OF RAILWAY BRIDGES

<table>
<thead>
<tr>
<th>Br. No.</th>
<th>Span</th>
<th>Km</th>
<th>Section</th>
<th>Name of work</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>DRAWING SPECIFICATIONS</td>
<td>Complied/Not Reqtd</td>
<td>Remarks</td>
<td></td>
</tr>
<tr>
<td>(All para refer to IRWM unless specified otherwise)</td>
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<td></td>
</tr>
<tr>
<td>1.</td>
<td>Drawing is prepared on standard paper size i.e. A0= 841-1189 mm (Important/Major Bridge works) A1= 594 - 841 mm (Other Bridge works)</td>
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<td></td>
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<tr>
<td>2.</td>
<td>Drawing is prepared on Auto Cad</td>
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<tr>
<td>3.</td>
<td>Borders provided as per BIS:SP-46-1988</td>
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<td>4.</td>
<td>Title block placed at Right Bottom Corner as</td>
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<tr>
<td><strong>5.</strong></td>
<td>Folding marks made on drawing as per Annex 9.2</td>
<td></td>
<td></td>
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<tr>
<td><strong>6.</strong></td>
<td>Drawing is to the Scale as per Para 905 of IRWM</td>
<td></td>
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<tr>
<td><strong>7.</strong></td>
<td>Drawing is on Good Quality Tracing paper</td>
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<tr>
<td><strong>8.</strong></td>
<td>Drawing has been properly rolled and has no folding/cut marks. Edges have been protected with tape.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>9.</strong></td>
<td>Colour scheme and line types/thickness are as per para 907 of IRWM</td>
<td></td>
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</tr>
<tr>
<td><strong>10.</strong></td>
<td>Reference to sanction (PB No.) mentioned on Drawing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>11.</strong></td>
<td>Only standard abbreviations as per Annex 9.3 used.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>12.</strong></td>
<td>Font size for text is 2.5-3 mm and for headings 4-5 mm.</td>
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<td></td>
</tr>
</tbody>
</table>

### B. DRAWING DETAILS: GENERAL

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong></td>
<td>Key plan/ site plan (To scale) provided with following details</td>
</tr>
<tr>
<td></td>
<td>Junction/terminal stations at each side of bridge (Kilometers should increase left to right)</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>UP &amp; DN Direction of the track shown</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>Direction of flow</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>Existing structures at site with distance to bridge</td>
</tr>
</tbody>
</table>
2. In case of curves on bridges and/or on approaches (upto 200 m on either side), following details have been shown/ given for each curve

A  Degree of curve
B  Radius of curve
C  Superelevation
D  total angle of deflection
E  tangent points on the line, both on the plan and in the longitudinal section
F  beginning and end of transitions together with their lengths

3. In case of gradient on bridges and/or on approaches (upto 200 m on either side), Gradients together with the distance from which the level or gradient extends has been shown/ given

4. Infringements of standard dimensions, if any.

5. The nature of the soil (from trial pit, and bore log details)

6. Following features falling up to a distance of 200 m on either side have been shown

A  Borrow pits
| B | Rivers, streams, drains, sullage and sewer drains and their sizes with direction of flow |
| C | Pipelines with direction of flow |
| D | Temples, mosques and graves |
| E | LC, ROB, FOB with Roads and footpaths with the names of towns or villages they lead to |
| F | T/Out, obligatory points, electric crossing etc. |

**C. DRAWING DETAILS: BRIDGE PROPER**
(as per para 906 of IRWM)

1. Plan of the proposed bridge, showing half top & half bottom details drawn
2. Front and side elevation of abutments and piers drawn
3. Sections through the bridge in such directions as are necessary to show the intended form and dimensions of the various parts drawn
4. Drawings of non-standard details, if any, drawn
5. Over all & clear span and c/c of bearing mentioned
6. UP & DN Direction of the track shown
7. Type of bearing (Fixed/Free) mentioned
8. Formation width on approach given
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<tr>
<td>9.</td>
<td>Skew angle of bridge mentioned (mention square also)</td>
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<td>10.</td>
<td>Shape of pier /Cut water shown</td>
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<td>11.</td>
<td>Plan &amp; Section of river/ nalah/ drain/ road/ground with levels along track given</td>
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<tr>
<td>12.</td>
<td>For Doubling: Details of existing bridge with ground plan of foundations, superstructure, protection work etc. Shown</td>
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<tr>
<td>13.</td>
<td>For Doubling: Overall opening is not less than existing</td>
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<tr>
<td>14.</td>
<td>For important/major bridges on new lines, the river to be surveyed for a distance of 8 km upstream and 2 km down stream, all spill channels upstream shown on the plan; following to be mentioned.</td>
</tr>
<tr>
<td></td>
<td>A catchment area</td>
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<td></td>
<td>B velocity obtained by calculation and by experiments (preferably at high flood )</td>
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<td></td>
<td>C increase in velocity and probable HFL after afflux</td>
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<tr>
<td>15.</td>
<td>Hydraulic data</td>
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<td></td>
<td>A HFL with year</td>
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<td></td>
<td>b Discharge</td>
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<td></td>
<td>c Clearance (required, existing &amp; proposed) mentioned &amp; found adequate as per code</td>
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<td></td>
<td>d Freeboard (required, existing &amp; proposed) mentioned&amp; found adequate as per code</td>
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<td>Velocity</td>
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<td>Bed level</td>
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<td>Low Water level</td>
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<td>Scour Level</td>
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<td>i</td>
<td>Silt factor</td>
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<td>j</td>
<td>Any past history of washout/breaches</td>
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<tr>
<td>16.</td>
<td>Track structure (Rail/ Sleeper/Ballast cushion) mentioned</td>
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<tr>
<td>17.</td>
<td>Proposed (&amp; Existing for doubling) Rail level &amp; Formation level mentioned w.r.t. given BM (Item B1)</td>
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<td><strong>D NOTES</strong></td>
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<td>Following has been specified in notes</td>
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<tr>
<td>1.</td>
<td>Standard of Railway loading</td>
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<td>2.</td>
<td>Seismic zone</td>
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<td>3.</td>
<td>Exposure condition</td>
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<td>4.</td>
<td>Sanctioned sectional speed</td>
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<td>5.</td>
<td>Speed on curve, if applicable</td>
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<tr>
<td>6.</td>
<td>Reference to the type drawing of the girder/slab</td>
</tr>
<tr>
<td>7.</td>
<td>Sub structure material (MCC/RCC etc.)</td>
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<td>8.</td>
<td>Grade of Concrete proposed to be used</td>
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<td>9.</td>
<td>Grade of Reinforcing steel</td>
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<td>10.</td>
<td>Grade and quality of Structural steel</td>
</tr>
<tr>
<td>11.</td>
<td>Dismantling /Disturbance to the existing structure - nature and extent mentioned</td>
</tr>
<tr>
<td>12.</td>
<td>Drawing no of Approved L-Section mentioned</td>
</tr>
<tr>
<td>13.</td>
<td>Modus Operandi for construction mentioned</td>
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<tr>
<td>14.</td>
<td>Note for Weep Holes</td>
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<td>15.</td>
<td>Note for backfill and filter media material</td>
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<td>16.</td>
<td>Note for protection work</td>
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<td>17.</td>
<td>Note regarding requirement of CRS sanction mentioned clearly</td>
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**E** SITE FEASIBILITY RECORDED ON THE PLAN BY DYCE/C in terms of Para 130 of Engg Code

**F** CHECKS WITH OTHER DRAWINGS

<p>| | |</p>
<table>
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<tbody>
<tr>
<td>1.</td>
<td>Span arrangement as per approved L-section</td>
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<td>2.</td>
<td>Matching of levels with the approved L-section</td>
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<td>3.</td>
<td>Availability /Suitability of super structure</td>
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<td>4.</td>
<td>In case of box, barrel length is not smaller than that specified on each side of track.</td>
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<td>5.</td>
<td>Over all &amp; clear span and c/c of bearing are as per referred drawing</td>
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<td>6.</td>
<td>‘Dimensions of substructure are tentative.’ Mentioned</td>
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<td>7.</td>
<td>Data &amp; past history verified from bridge register (copy of pages of bridge register enclosed)</td>
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<tr>
<td>8.</td>
<td>Basis of the design discharge is linked (calculation as per RBF-16, certificate from canal authorities etc. enclosed)</td>
</tr>
<tr>
<td>9.</td>
<td>Completion plan of existing bridge annexed (for doubling/ replacement works)</td>
</tr>
<tr>
<td>10.</td>
<td>Soil strata verified by soil exploration &amp; report enclosed</td>
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G  **APPROVAL & SIGNATURE**

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<tbody>
<tr>
<td>1.</td>
<td>Approval/Signature of local authority for canal bridges, RUB or as applicable as per local conditions with date</td>
</tr>
<tr>
<td>2.</td>
<td>Approval/Signature of Divisional officers with date</td>
</tr>
<tr>
<td>3.</td>
<td>Name of all officials mentioned with designation</td>
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Certified that above mentioned items have been checked and found complied/ not required/ not applicable, except the following for the reasons mentioned against them

**Signature**

Name & Designation of Dy.CE

9.8  **Annexures:**

(i) Annexure - 9.01 - Drop and Curtain wall in Bridge with Open Foundation

(ii) Annexure - 9.02 - RDSO Guidelines on Centre to Centre Distance of Deep Foundation
Headquarters Office
Kashmiri Gate, Delhi.

No.: I-MISC/DOP/BRIDGES
Dated: 17.09.2015.

The Dy. CE/CSE Road, CSB, CSB-II, SSB, TKJ, S/TKJ,
I.KO-I, II, III, MB, CDG-I, II, UMB, JUC, DJAT,

Sub:- Drop and Curtain wall in bridges with open foundations.

Instructions for using Drop & Curtain walls in case of shallow foundations of bridges have been given in Para 204 of Indian railway bridge manual (IRBM) of 1998 and sketch showing the same as Annexure 2/2 of IRBM-1998 is enclosed for reference. Similarly Drop & Curtain walls have been shown in all RCC BOX drawings issued by RDSO. In addition to this, instructions for using Drop & Curtain walls in open foundation of bridges have also been issued vide item no. 1.14 of CAOC/inspection note no. CAOC/inspection/2014 dated 24-02-2014.

In view of above, the Drop & Curtain walls should be provided at site for the bridges with open foundation.

This has approval of competent authority.

DA: As above.

Copy to:-
1. Secy to CAOC for information of CAOC, please.
LONGITUDINAL SECTION

CURTAIN WALL, DROP WALL AND FLOORING

NOTE:
ALL DIMENSIONS ARE IN MILLIMETRES ONLY.
The Chief Bridge Engineer:

1. Eastern Railway, Patrile Place, Kolkata-700 001
2. East Central Railway, Raispur - 844101
3. Northern Railway, Baroda House, New Delhi- 110 001
4. North-Central Railway, Allahabad-211 001
5. North Eastern Railway, Gorakhpur-273 001
6. North Western Railway, Jaipur-302 001
7. Northeast Frontier Railway, Maligaon, Guwahati-781 011
8. Southern Railway, Park Town, Chennai-600 003
9. South Central Railway, Rail Nilayam, Secunderabad-500 371
10. South East Central Railway, Bilaspur-495 004
11. South Eastern Railway, Garden Reach, Kolkata-700 043
12. South Western Railway, Hubli 580 023
13. Western Railway, Mumbai-400 020
14. West-Central Railway, Jabalpur-482 001
15. Central Railway, Mumbai CST-400 001
16. East Coast Railway, Bhubaneswar-751 016

Sub: Centre to Centre distance of deep foundations of existing and new Bridge.

Ref: Railway Board’s letter no. 2017/37/CE-III/BR/BSC/85 Seminar dated 17.05.2019

NCR referred the issue of the minimum clear distance of deep foundations between the existing and proposed bridges vide letter no. 136-W/BR/DPCCIL dated 09.02.2017. Vide letter No. CBS/insp./3/427/NCR dated 14/02.03.2017, RDSO suggested criteria for distance between the existing and new foundations based on interaction of their scour regions, pressure bulb zones and other factors.

The matter was discussed as the Item No. 1074 in 85th BSC meeting held in Nov. 2018, as instructed by Board, by keeping the above letter of RDSO in abeyance. During the deliberations in the BSC, it came out that minimum/desirable distance between the well foundations of the existing and new bridge is site specific and it is difficult to lay down criteria with certainty.
Based on the recommendations of the 85th BSC, duly accepted by Board, following guidelines may be considered while finalizing the distance between the well foundations:

a. It is a good practice to propose the piers of new bridge in the same alignment as that of the piers of the existing bridge.

b. The desirable minimum clear distance between the existing and new foundations from the consideration of interaction of scour regions is 6D (where D is diameter of well).

c. There should be no interference in the pressure bulb zone of foundations of existing and proposed bridge.

d. There should be no reduction in passive earth pressure due to excavation of new foundation in close vicinity of the existing foundation.

e. Sufficient space is required for easy operation of machinery and equipment for construction of proposed bridge to avoid any chance of interference to the train movement on the existing bridge.

f. Effect of extra load of excavated material, machinery, equipment etc. on the surrounding soil mass and foundation of existing bridge.

In case, the Railway does not consider carrying out detailed technical studies, the above guidelines may be followed. CBEs should finally decide, only after detailed investigation, whether reduction in distance between the existing and new foundations from the distance as per guidelines prescribed above is required.

Accordingly, CBEs should finally decide the distance between the well foundations keeping in view the above guidelines and site specific requirements.

(V.K. Srivastava)
Executive Director/Structures

Copy to: EDCE/B&S, Railway Board, Room No.-140A, Rail Bhawan, New Delhi-110 001.
CHAPTER- 10
GRADE SEPARATOR

(PART-I) - Planning and design

10.1 Introduction:

Grade Separator-

Grade separator is a form of intersection in which one or more conflicting movements on intersecting ground transport facility such as road, rail, pedestrian way or cycle path are segregated in space. Flyover, Railway over bridges, under bridges, subways and under passes both for vehicular and pedestrian traffic are all grade separators and will be reckoned as such.

On Indian Railways, grade separator is generally provided to eliminate level crossings. As the name envisages, in Railway terminology, a Level crossing is an arrangement provided for facilitating the crossing of Railway tracks at the same level by people and vehicles using the road. In the past, when both Rail and Road traffic passing through the level crossing was low, not much hindrance was caused to the road traffic as Rail traffic being given priority at level crossings. However, since last few years, owing to the increased Rail traffic and due to the development of expressways, National highways, improvement of roads allowing higher speed and proportionate increase in the number of road users using better motorized vehicles with higher speed potential, level crossings have been proving to be rather impediments in the free flow of road traffic. Due to long detentions caused to the road traffic waiting at level crossings, not only precious time and fuel is wasted but also many a times the situation becomes hazardous in terms of consequent congestion and attitude of people to cross first and at the earliest. Bikers and cyclist's don't even hesitate crossing below the closed barriers and that too till the train almost approaches level crossing. Installed warning boards and persuasion by the gateman, in such situations, are not of much help. In some instances, even intimidation of gatemen coupled with forced lifting up of barriers and thereby serious accidents have been noticed at level crossings. Material position at unmanned crossings is further worse.

To come out of such uncalled for situations, since last years, Railways have decided to replace the level crossings (both unmanned and manned) with Road Over/Road Under bridges/LHSs. Till date large number of level crossings have already been replaced and work on many more is either under actual progress or in the planning stage. As per latest Railway Board Guidelines all Level crossing to be eliminated.

Grade separator may be of many types as explained below.

10.1.1 Road Over Bridge

A Bridge over the rail line for the purpose of crossing it without interruptions with approaches on both sides is commonly called as Road Over Bridge - ROB.

10.1.2 Road Under Bridge

Generally used for a bridge which carries rail lines or other services above the road.
10.1.3 Via-Duct

Portion of approaches on stilts for affecting economy in cost of construction or for providing opening in part of the approach of ROB or Flyover in place of solid earth filled embankment with or without return walls for allowing cross traffic or for use of space below for godown, office shops and such uses.

10.1.4 ROB cum RUB

An innovative design of ROB cum RUB have been developed, which solves the problem of non – closure of level crossing even after construction of ROB by providing an road under bridge (RUB) within open foundation of ROB.

10.2 Planning and Design

10.2.1 Inherent features for planning of Grade Separator

Road Over or Road Under bridges have their own inherent features to be taken into consideration while making a choice between them. To sum up, a few of them are as follows:

a) ROB requires width of land equal to the full width of road in the initial length of approaches but very lesser width (sufficient for only a central pier) thereafter by adopting a cantilever type of construction. Whereas, RUB requires full width of land for complete length of approaches. In city areas where land is a scarce and valuable resource, choice between the two shall be made judiciously.

b) Overall height of ROBs is substantially more than the overall depth of RUBs by reason of lesser required vertical clearance in case of road vehicles in comparison to the same for Railway movements. Still further, due to requirements of comparatively longer spans in case of ROBs, overall height further increases due to increase in depth of girder. Adoption of trussed spans, however, can be of some help to lessen this difficulty but then launching of such spans is in itself a specialized affair.

c) Due to the reasons enumerated above, length of approach roads is more in case of ROBs than RUBs.

d) Except in hilly terrains, Railways are generally laid in embankments. Where height of embankment is moderate or high, scale of choice between ROB and RUB tilts towards RUBs. Length of approaches gets substantially reduced. In case of cuttings ROB’s can be planned.

e) Drainage, however, is a crucial consideration which does not tilt in favour of RUBs. Nevertheless, if other conditions favour, RUB can be thought of with sump and pump arrangement for effective drainage.

f) A smaller version of RUBs i. e. LHS is feasible for use of light traffic. It requires much shorter length of approaches. No such version is possible in case of ROBs.

g) Number of existing tracks to be spanned along with any future tracks.
h) Any other lines of communication, water supply/sewer lines passing through the site.

i) Type of structures, their age, foundation system and minimum lane width required to provide access to them.

j) Thus, while making a choice between ROBs and RUBs, all the controlling and influencing parameters shall be given due consideration.

10.2.2 Selection of ROB/RUB- parameters

Following parameters shall be taken into consideration while making a choice for provision of RUB/ROB.

a) **Height of Railway embankment** - Where railway embankment is substantially high than the general ground level, it gives an edge to the choice of RUB in place of ROBs. It shall require lesser length of approach roads. Even in case of moderate to sub moderate height of embankment, RUB shall be preferred in place of ROB.

Still further integrated structure consisting of ROB cum RUB shall be preferred to have ease of passing of both normal to heavy traffic on the ROBs and local light traffic through the RUBs.

b) **Type of road traffic to be passed** - Vertical clearance required for road vehicles in suburban area is 5.50m for all types of road traffic. Whereas, for light traffic even lesser clearance of the order of 3.0 shall suffice. Clearance required varies as per class of roads as given in IRC i.e. NH, SH, district road, rural roads etc. This throws an added advantage for selecting RUB instead of ROB. In case of ROBs irrespective of the type of road traffic (even for pedestrians) minimum required vertical clearance is 6525mm

c) **Any subsidiary lanes to be connected with the main road** - Connecting other subsidiary roads to the main road is easy in case of RUBs. In case of ROB it may not be possible. It may be avoided by providing RUB being less length of approach.

d) **Vertical clearance required** - In case of ROBs irrespective of the type of road traffic (even for pedestrians) minimum required vertical clearance is 6525 mm. This difference of 6525-5500 = 1025mm coupled with larger depth of super structure. In case of ROBs, it results into more overall height in comparison to the less overall depth in case of RUBs. Also span lengths of the superstructure are lesser in case of RUBs than ROBs. The vertical clearance required for DFFCIL route.6530+275=6805mm

10.2.3 Planning of Road over bridges and Road under bridges-

While planning and design of Road over bridges, Road under bridges, LHS, and Railway bridges, Policy circulars issued by Ministry of Railway, RDSO, NRHQ office Baroda House and Construction Headquarter office, from time to time regarding Preparation of GADs of ROBs/RUBs, expediting the work of ROBs, use of non-standard spans, Inspection of Steel Girders, and other misc. circular should be taken into consideration. The Guide Lines for preparation of GAD is attached as Annexure 10.01.
A) Planning of ROB-
(Ref. BS112- RDSO guidelines for planning of ROB)

1. Planning of Layout of piers: A question that invariably comes up when discussing layout of piers is whether it is mandatory to provide piers at railway boundary. Provision of pier in railway land shall be decided on techno-economic considerations. It may be noted that with small sub structure height, in most cases in ROBs, longer spans will in general be costlier than medium length spans. However, long term interests of Railways must be guarded while planning the piers. The following may be kept in mind in this respect:

i. Piers shall not be planned where there is a possibility of current tracks shifting due to realignment, yard remodeling etc. or where future tracks might come. Provision for future track(s) shall be considered for most locations outside yards. Since the alignment of the future track(s) is not always known, various possibilities for the same may be examined. If it is feasible, space for minimum one track on either side of existing tracks may be kept. For terminals and major yards, and their approaches, keeping land free from obstructions might be desirable as the entire layout might get changed during remodeling or fresh planning.

ii. Piers may be planned in railway land near the edges if it does not affect the number of tracks that can be laid at that location.

iii. Piers may be planned along with the other structures already constructed on railway land like piers of other bridge/ major structures which are not likely to be removed.

iv. Piers may be planned if the railway land availability at a location is more than that available at adjoining locations and which, thus, will not affect the planning of the Railways.

v. While planning location of piers/abutments, location of existing Masts and infringements should be kept in mind.

2. Planning span lengths: Following aspects may be kept in mind while planning of spans:

i. Decision on the span lengths shall be taken keeping railway operations in mind and, after that, as per techno-economic considerations.

ii. Shorter spans will necessitate more number of piers and will require more land to be permanently occupied. Longer spans become costlier and difficult to launch. Optimization between these two factors shall be done.

iii. As a general principle, symmetrical arrangement of spans with respect to existing tracks is desirable. Guidelines regarding arrangement of spans are annexed as Annexure 10.07.

iv. As per Guidelines of Railway Board, in rare case where it is unavoidable to use non-standard spans, the design will be approved by the RDSO after having been proof checked by any of the IITs(Annexure 10.08).
v. Prior Administrative approval of CAO (C) for adoption of Non-Standard span for ROB shall be obtained. Annexure 10.09.

Planning of foundations: Deep foundations are, in general, costlier as compared to the open foundations. The ROBs don't have water flowing around them, so scour is not a concern and the depth of foundation can be kept smaller also. If the soil conditions dictate or there is some other advantage like ease of construction, reduction in duration of caution order, etc. than we go for deep foundations like piles. If such constraints are not there, open foundations shall be adopted, if feasible from bearing capacity considerations. Provision of sheet piling should be taken into consideration for safe execution of foundation work near track. Guidelines reg. Estimates of ROB is annexed as Annexure 10.05.

3. Planning of sub structure: Normal construction methodology followed in majority of ROBs involves providing RCC sub structure in the ROBs. At locations where space available is less, lots of extra care is required at site during concrete casting to ensure safety of train operations. This problem can be tackled by imposing suitable speed restrictions and/or working in blocks. At such locations, it would, therefore, be worth considering the option of providing precast concrete or steel sub structure. Steel sub structure can be clad in precast concrete to give it a better look. Shape of Pier/pier cap of Railway portion should be preferably same as that of pier/pier cap of state approach for better aesthetics.

4. Planning of girders: As far as possible, girders as per RDSO design shall be adopted for spans above railway tracks. In case the site conditions warrant use of girders other than RDSO's standard drawings, reasons for doing the same shall be recorded and approval of Chief Bridge Engineer shall be obtained for the same. As per Railway board letter no 2015/CE-IV/ROB/78Pt.dated15.01.2020, the Nonstandard spans are to be approved by RDSO. (Annexure 10.08)

5. Skew arrangement: Lots of demands for design of skew girder Road Over Bridges are faced by the railways, especially for national highways where owing to higher speeds, road authorities are reluctant to introduce any curves in the road alignment. Sometimes skew arrangement is required at congested sites where change of alignment is not possible. Demands for skew angles as high as 70 degrees have been noticed. It must be noticed that skew girders have the supports quite away from the natural line of transfer of loads and as a result the girders are subjected to high torsional loads as well as extra bending moments on the obtuse corner. The acute corners are subjected to uplift as a result of the asymmetry of the load due to the skew girders. Larger skew angles are not desirable as capturing the proper behavior of girder at larger skew angles is not easy. Providing sufficient torsional restraint is also difficult. Therefore, efforts shall be made to get to square alignment, if possible, or to reduce skew angles to within limits.
Advantages of reducing skew angles:

- It is easier to provide the square alignment girders and chances of mistakes in fabrication as well as assembly are less.
- Behaviour of skew girders under seismic loads is inferior to the square arrangement. The skew arrangements are under “not desirable” arrangement from bridges in the various code.
- The behaviour of square spans and skew girders with less than 20 degrees skew angle is more logical and easily understood. Errors of design are likely to be lesser.
- Square girders can be adopted for lower skew angles up to 20 degrees and the fabrication is easier in such cases.

6. Methods for reducing skew angles (Providing square girders, if feasible) in Road Over Bridges: Various strategies can be tried individually or in combinations to reduce the skew angle as much as possible. Choice of strategy/ combination thereof will depend on site conditions. The strategies and constraints in adopting the same are discussed below:

a) Providing longer spans: If space constraint is not there, providing longer span can help in reducing or eliminating skew angle. In such a case, the sub structure is skew to railway alignment but the ROB girders are square or at lesser skew angle. In case of NHAI the Railway Board Letter No 2015/CE/IV/ROB-RUB/MISC/49 dt 29.10.2019 should be considered.

Constraints:

- The span is longer, so the depth of girder might go up theoretically. (Does not happen practically as some margin is kept to take care of the extra bending moments and torsion due to skew).
- The piers are not parallel to railway land boundary. So, if the piers are being built in railway land, the width of land rendered unusable for future is increased.
- Standard design of longer span required shall be available. If it is not available, the design will have to be done afresh.

b) Constructing sub structure in skew to railway land boundary: It is not mandatory that the sub structure shall be parallel to railway land boundary even though it is desirable to reduce the railway land permanently rendered unusable. If the space constraint is not there, the sub structure can be C.L. of road Railway Land boundary constructed in skew to the railway land boundary, thus reducing the skew angle of the girders to within 20 degrees.
Constraints:

i. The piers are not parallel to railway land boundary. So, if the piers are being built in railway land, the width of land rendered unusable for future is increased.

ii. The skew piers can violate the Schedule of Dimensions of existing or future tracks. This needs to be checked.

c) Constructing Skew bed block: Land is a precious resource and at lots of locations, railways might require the entire railway land boundary for its current and future operations and the land on approaches might also not be available. In this situation, both the options a) and b) discussed above will not be feasible. Option b) might not be desirable if the standard girder design is not available for the longer length contemplated. In such situations, an option can be to construct the foundation and the sub structure parallel to railway land boundary occupying minimum width, but to reduce the skew angle of the girder, the bed block can be made in skew. In this approach, the land is not wasted and the extra width in bed block is provided above the Schedule of Dimensions so that maximum space is useable, without affecting the train operations.

Constraints:

The cantilever length of pier cap is increased. The depth of pier cap can increase.

The skew piers can violate the Schedule of Dimensions of existing or future tracks. This needs to be checked.

d) Altering shape of Pier Cap: The lateral clearance requirement as per Schedule of Dimensions (SOD) is lesser at more height above the rail level compared to lesser heights. Therefore, the pier wall/columns can be built at lesser distance from center line of track as compared to the bed block. In order to reduce this lateral distance, few steps can be taken.

i. The most obvious step is to construct a tapered pier cap, to suit the requirement of the section modulus as per shape of bending moment diagram. Due to the tapered shape, pier cap can be constructed closer to the running line than a rectangular one.

ii. One innovation suggested by Northern Railway construction organization is to construct the pier cap at a level higher than the conventional height without changing the road level. For this, the girders shall be provided in pockets made in the pier cap rather than at the top of the pier on a pedestal. The bearings can be provided in this pocket and thus the height from rail level to the bottom of the pier cap can be more than that in conventional pier caps without affecting the clearance below the girders or the road level. The height of the end diaphragms shall be reduced so that jacking can be done from outside the pockets. The schematic arrangement is shown below:
iii. Providing fish bellied girders: Another method for increasing the height of pier cap from ground is to construct fish bellied girders as shown below.

Disadvantage: Fish bellied girders are slightly difficult to fabricate and require splice in bottom flange as well as web.

e) Providing portal across the track: A very good method to reduce the skew angle is to rest the girders on portal provided across the track rather than on the piers directly. This method is used by Metros to cross the roads and other obstructions. Casting the beam of the portal over running track is very difficult and shall be avoided. To solve this issue and also to ensure that the road level is not increased unnecessarily, beam of the portal can be a steel beam and the girders of the road over bridge shall be connected to the web of this beam. This arrangement can utilize the standard RDSO girders by eliminating the bearing stiffener and the bearings under the girders. The bearings in this case shall be provided under the cross girder of the portal. The arrangement of the piers for the portal shall be as per the drawing.

The portal beam shall be provided over the piers such that the beam is normal to the road alignment. Bearings (Spherical/POT-PTFE) shall be provided under the portal beam as shown in drawing.

Conclusion: The Road Over bridge construction is an important activity and all efforts shall be made for speedy execution of works. It is hoped that these guidelines for standardization of structural planning of ROBs will help decision making in this respect.

B) Planning of Road under bridge-

Major factors to be considered in subway/underpass designs and construction are:

Pre-Feasibility issues:

In the pre-feasibility report, minimum number of sites required for conducting feasibility study is identified. Issues like land acquisition problem, nature of crossing, likely foundation depth, length of approaches, length of bridge, firmness of banks, suitability of alignment of approach road, etc., are required to be examined and relevant data to be collected. Identification of feasible alternative sites and approach alignments may be made with the aid of topographical maps, road project maps, field survey maps etc. as available.

Feasibility Issues: A choice shall be made on the relative merits between the two viz. Subway site and alignment of approaches. Final choice shall require discussions with the concerned authorities such as PWD, MOST, City Corporation and/or any other client before preparation of feasibility Report. The feasibility and location of providing the subway/underpass shall be thus ascertained.

Post Feasibility issues:

a) Analysis of data: The data collected and investigation results should be analysed to determine the following:
i) UFL
ii) LWL
iii) LBL
iv) Erodibility of bed/scour level
v) Likely foundation depth
vi) Safe bearing capacity
vii) Engineering properties of sub-soil
viii) Artisian conditions
ix) Settlement characteristics
x) Vertical clearances
xi) Horizontal clearance
xii) Free board for approach road
xiii) Severity of environment with reference to corrosion (severe/moderate)
xiv) Data pertaining to seismic and wind load
xv) Availability of suitable construction material
xvi) Requirement of model study
xvii) Soil properties of earth cushion just below the track

b) Stability of the structure against uplift due to buoyancy as a whole and also during construction. The structure should be checked for overall stability against uplift. The calculations for such a determination depend upon the level of the water table assumed. The highest water table level is arrived from the study of data collected over a reasonably long period in the past at the proposed site. In the absence of such data, the maximum water table level may be set at a depth of 0.5 metre from the existing ground level.

However, decision regarding the water table level shall be made on the basis of discussion among all concerned parties. The methods to be adopted to overcome any uplift have to be indicated in the design philosophy. These methods generally fall into two major categories viz. those which increase the weight of the structure such as iron ore filling and those which anchor the structure such as providing ground anchors. When ground anchors are proposed, the suitability of the soil conditions have to be ascertained by additional tests, if necessary. When the weight of the structure is to be increased, the availability and economy of the heavier fill materials should be investigated.

Artisian condition, if any, should be studied for finalisation of the foundation location and type of foundation.
c) **Water tightness** of the structure to prevent seepage. Underground structures, e.g., subways are highly susceptible to water leakage and subsequent structural damage which reduces serviceability and durability of the structure. To ensure water tightness, the structure may be designed as uncracked, or more prudently, with limited crack widths. Crack widths may be limited to values acceptable to all the concerned parties, say 0.2mm and the same may be achieved by limiting the strain in steel and by providing smaller diameter reinforcing bars at closer spacing’s etc. These details need to be agreed upon by all concerned parties. Additional water proofing may be needed and detailed. Alternatively use of water pressure release system may be resorted to where feasible. The length of the Box should be 7.0m to 14.0m to avoid joints.

d) **Drainage** of subways is an important consideration. Wherever possible, gravity led drainage should be given preference. However, gravity assisted drainage should be augmented where required by providing a sump-pump facility. This will entail the incorporation of facilities such a sump house etc. in the overall plan of the structure.

e) **Construction** aspect such as excavation, traffic diversion scheme etc., the design philosophy for subways and underpasses should include details of the excavation procedure to be arrived at after a detailed analysis of nature of the soil, economy and suitability of the scheme envisaged in construction, traffic diversion programmes, location of existing underground services etc. Special precautions which need to be taken during excavation, such’ as safety of neighboring structures, movement of pedestrian and vehicular traffic etc. have to be mentioned in detail. Proposed methods of dewatering during construction is also a major aspect which should be dealt with-in the design philosophy. In case of less earth cushion below the track. Provision of protection screen/sheet just below the track should be considered, before start of Box pushing. width of Box preferably should not be more than that required for Two Lane Road, to keep chance of soil collapse minimum, during box pushing.

f) **Existing services** and future provision, if required. A stripplan showing existing service facilities such as telephone lines, electric lines (high tension and low tension), underground cables, underground water lines, sewer lines, etc. is required to be prepared. The strip plan should also show the position of relocation of such service facilities.

g) **Ventilation** consideration. Provision for ventilation in case of subways should be based on acceptable levels of pollution and should be detailed in the design philosophy, keeping in view comfort of the public.

h) **Lighting** and other utilities. Lighting of subways should also be detailed in the design philosophy. Glare-free lighting luminaire to achieve a lux level of 100 lux or as decided in consultation with concerned authorities, should preferably be adopted. Lighting levels in subways/underpasses should be critically examined under daylight conditions to achieve acceptable gradient between the bright outside and the relatively dark inside. The design philosophy for electrical
systems should also indicate the type of wiring, provision of standby supply, etc.

i) **Statutory Clearances** from other authorities. Information about other authorities whose clearance is required for the project should be collected. Interaction with these authorities to ascertain their specific requirements would help in collection of any additional data and preparation of the project in a well-planned manner.

j) **Aesthetic consideration**: For aesthetics, attention should be focussed on producing a clean, simple, well-proportioned structural form. In most cases, achieving the desired visual quality may add little to the overall cost of the structure. Landscaping the site to achieve visual agreement between the structure and the environment should be considered especially in case of urban locations.

k) **Liasoning with state authority for ROB and RUB** - Active Liasoning should be initiated with the state authorities at the very outset when planning to start a ROB construction. This liasoning should include discussions for Level-Xing Closure or Diversion as the case may be. A clear consent from the District administration in the form of NOC for construction of ROB and permission for closure or temporary diversion should be taken. Also, it should be amply made clear to the district administration that the commissioning of the ROB shall only take place after the closure of the Level-Xing as per extant instructions. Besides this active liasoning should also be initiated with the state authorities for shifting of the utilities, drains, water /electricity lines if any at the earliest.

10.2.4 **Checklist for Road Over Bridge and Road Under Bridge**

A detailed checklist for preparation of Road over Bridges and Road under Bridges is enclosed on the following page for immediate referencing while preparation of the GAD of a ROB or a RUB. The Procedure for approval of GAD is annexed as Annexure 10.02.
### 2.3 - GAD Preparation -

**a) CHECK LIST OF ROAD OVER BRIDGES and ROAD UNDER BRIDGES**

<table>
<thead>
<tr>
<th>A.</th>
<th>DRAWING SPECIFICATIONS (All para refer to IRWM unless specified)</th>
<th>Complied/ Not Req'd</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Drawing is prepared on standard paper size i.e. A0-841-1189mm (Important/Major Bridge works) A1-594-841mm (Other Bridge works)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Drawing is prepared on Auto Cad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Borders provided as per BIS, SP-46-1988</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Title block placed at Right Bottom Corner as per para 904</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Folding marks made on drawing as per standard shown in relevant code.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Drawing is to the Scale as per Para 905 IRWM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Drawing is on Good Quality Tracing paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Drawing has been properly rolled and has no folding/cut marks. Edges have been protected with tape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Colour scheme and line types/thickness are as per para 907 of IRWM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Reference to sanction (PB No.) mentioned on Drawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Only standard abbreviations should be used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Font size for text is 2.5-3mm and for headings 4-5mm.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 10.2.5 DESIGN PHILOSOPHY

#### 1.0 Design service life

The intended minimum design service life of various elements forming part of project shall be 100 years in accordance with relevant clause of
2.0 Description of structure

The details of proposed ROBs along the sketch in A3 size.

3.0 Design basis & design criteria for structures

The main design criteria shall be to evolve design of a safe structure having good durability conforming to the various technical specifications and sound engineering practices. The design of structural components shall conform to the criteria laid down in the latest edition of the IRC codes of practice, standard specifications, guideline/circular of MORTH, IRC and BIS published up to the date.

3.1 Geotechnical Parameters

Sufficient information about the arrangement & behaviour of the underlying materials and their physical properties for adopting and designing the structural foundation is essential. At all structures Soil exploration through field investigation and laboratory testing of the substrata shall be done to arrive at required parameters for designing safe and economical foundations.

3.2 Type of Superstructure

Based on the span lengths and site requirements type of superstructure shall be proposed. For ROBs Steel composite plate girder & RCC deck slab type superstructure shall be considered. The depth of superstructures shall be decided based on the structural considerations and also keeping in view the minimum vertical clearances above the rail top levels.

3.3 Substructure and Foundation

For ROBs mostly framed type substructure with a number of circular columns and rectangular pier cap shall be proposed supported on open foundation / bored cast in situ pile foundation.

3.4 Expansion Joints

Single Strip Seal Expansion Joints shall conform to Specifications for Road and Bridge works as per MORTH and IRC.

3.5 Bearings

Normally Spherical/POT-PTFE bearings (Fixed/ Guided/ Free) shall be proposed under superstructures as per IRC:83 (Part III and Part IV) and shall conform to MORTH’s Specifications.

3.6 Drainage Scheme

It is proposed to provide a minimum cross slope of 2.5% for drainage from where the water will be discharged to below.

3.7 Earth Retaining Structures

RCC retaining wall/RE wall shall be provided for retaining the earth.

3.8 Exposure Condition
The condition of exposure has to be considered as the geographical condition of that area for the purpose of design. The values shall be modified for elements in contact with earth and water as stipulated in relevant clause of IRC:112

3.9 **Concrete Clear Covers:**

Minimum clear cover to the reinforcement bar shall be as relevant clause of IRC:112

4.1 **Material properties**

4.1.1 **Compressive Strength**

Durability provisions for structures shall be as per “moderate” conditions of environment in accordance with IRC: 112. The following grades of concrete have been proposed for the various components of structures:

- Substructure - M35 (minimum)
- Superstructure PSC - M45
- Superstructure Steel Composite - M35/M40

4.1.2 **Poisson’s Ratio**

Poisson’s ratio for uncracked concrete shall be taken as 0.2 and for cracked concrete as per relevant clause of IRC 112.

4.1.3 **Thermal Expansion Coefficient**

\[ \alpha = 12.0 \times 10^{-6}/^\circ C \]

4.2 **Reinforcement**

Thermo-mechanically treated bars of grade 500D conforming to IS: 1786 will be adopted

4.3 **Structural Steel**

4.3.1 For Structural Steel (conforming to IS:2062)

Preferably high grade steel of Grade E 350 and above is to be used.

5.0 **Design Load**

5.1 **Superimposed Dead Loads**

(i) **Wearing Coat**

Total weight of wearing coat for design purposes shall be considered as 2.0kN/sq.m.

(ii) **Crash Barrier**

Vehicular Crash Barriers on both sides of the carriageways shall be provided as per IRC specification The cross sectional area of the cast-in-situ crash barrier works out to be 0.4 m2.

(iii) **Hand railing**

R.C.C wall type hand railing on ends of both sides of the...
The cross sectional area of the hand railing works out to be 0.4 m².

### 5.2 Live Loads

The live load on carriageway shall be considered as per IRC: 6 according to the width of the carriageway.

### 5.3 Longitudinal Forces

As per relevant clause of IRC: 6, bridge structural elements shall be designed for longitudinal forces arising due to Tractive Effort, Braking Force and Frictional Resistance offered to movement of free bearings. The bridge should also be designed for seismic and wind forces.

### 5.4 Centrifugal Forces

For the road bridges situated on a curve, centrifugal forces shall be calculated as per the provisions of relevant clause of IRC:6.

### 5.5 Earthquake Load

The seismic analysis shall be carried out in accordance with relevant clause of IRC: 6

### 5.6 Vertical Seismic Force

The vertical seismic shall not be considered in zone III as per clause 219.3 of IRC: 6. However, for stability check and bearing design vertical seismic shall be considered as per clause 219.3 of IRC.

### 5.7 Seismic Combinations

As per relevant clause of IRC: 6, the seismic combinations shall be taken. Seismic arresters shall be provided as per relevant clause of IRC-6.

### 5.8 Wind Loads

Wind Load shall be computed as per relevant clause of IRC: 6.

### 5.9 Earth Pressure Forces

Earth pressure forces are calculated as per the provisions of Cl. 214 of IRC: Live load surcharge shall be considered as per the provisions of relevant clause of IRC:78 i.e. equivalent of 1.2m height of fill.

### 5.10 Temperature

As per the maximum and minimum temperature Isopleths figures are given in relevant clause of IRC: 6.
5.11 Vehicle collision Load

Vehicle collision load shall be considered as per relevant clause in IRC: 6. The vehicle collision load shall not be considered for abutments or on the structures separated by a minimum distance of 4.5m from the edge of the carriageway.

6.0 Load Combination

The various load combinations are considered as per relevant clause of IRC: 6. All members shall be designed to sustain safely the IRC critical combination of various loads and forces that can coexist. Various load combinations as specified in Annexure of IRC-6 with relevant load factors and increase in permissible stresses shall be considered in the design as per IRC: 6, IRC:22, IRC:24 and IRC:78.

6.1 Ultimate Limit State (For Verification of Structural Strength)

Loads are required to be combined to check the equilibrium and the structural strength under ultimate limit state. The equilibrium of the structure shall be checked against overturning, sliding and uplift. It shall be ensured that the disturbing loads (overturning, sliding and uplifting) shall always be less than the stabilizing or restoring actions. The structural strength under ultimate limit state shall be estimated in order to avoid internal failure or excessive deformation. The equilibrium and structural strength shall be checked under basic, accidental and seismic combination of loads.

Under Ultimate limit state, structural strength for the following load combinations are required to check to avoid internal failure and excessive deformation

<table>
<thead>
<tr>
<th>Service Stage</th>
<th>ULS COMBINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DL+SIDL+LL(leading)</td>
<td></td>
</tr>
<tr>
<td>DL+SIDL+LL(accompanying)+WL(leading)</td>
<td></td>
</tr>
<tr>
<td>DL+SIDL+LL(accompanying)+Seismic</td>
<td></td>
</tr>
</tbody>
</table>

| Construction stage                      |                 |
| DL+SIDL+WL+ construction LL            |                 |
| DL+SIDL+Seismic + construction LL      |                 |

Load factors to be considered for the above load combinations have been given in table 2.

### Table 2

<table>
<thead>
<tr>
<th>Limit State</th>
<th>Loads</th>
<th>Symbol</th>
<th>Basic Comb</th>
<th>Seismic Comb</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULS COMBINATION</td>
<td>Dead Load</td>
<td>DL</td>
<td>1.35</td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td>Superimposed Dead Load</td>
<td>SIDL</td>
<td>1.35</td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td>(except surfacing)</td>
<td>(fixed)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Superimposed Dead Load</td>
<td>SIDL</td>
<td>1.75</td>
<td>1.75</td>
</tr>
<tr>
<td></td>
<td>(surfacing)</td>
<td>(variable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Live Load (leading)</td>
<td>LL</td>
<td>1.5</td>
<td>0</td>
</tr>
</tbody>
</table>
## Live Load (accompanying) | LL | 1.15 | 0.2 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic Load (service)</td>
<td>SL</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Seismic Load (construction)</td>
<td>SL</td>
<td>-</td>
<td>0.75</td>
</tr>
<tr>
<td>Wind Load (leading)</td>
<td>WL</td>
<td>1.5</td>
<td>-</td>
</tr>
<tr>
<td>Wind Load (accompanying)</td>
<td>WL</td>
<td>0.9</td>
<td>-</td>
</tr>
</tbody>
</table>

### 6.2 Serviceability Limit State

Loads are required to be combined to satisfy the serviceability requirements. The serviceability limit state check shall be carried out in order to have control on stress, deflection, crack width. The Rare combination of loads shall be used for checking the stress limit. The Frequent combination of loads shall be used for checking deflection. For crack width calculation quasi permanent load combination shall be considered for prestressed with unbounded tendons & RCC members, and frequent combination will be used for prestressed members with bonded tendons.

The permissible stresses for prestressing and reinforcement shall be considered as per relevant clause of IRC:112.

#### a) Road Under Bridge-

Design of RUB will be done as per IRS codes i.e. Railway Bridge rules, Railway Substructure code and Concrete Bridge Code. Loading standard will be as per Railway Bridge Rules. It may be ‘25t:2008’ loading and DFC loading as the case may be. Earth pressure and surcharge due to track & train load will be as per IRS substructure code.

RUB/LHS are generally made of RCC boxes. These are designed as closed frames supporting on earth having a particular sub-grade constant. Loading dispersion pattern on segmental box is different from the loading on continuous box length.

When the RUB/LHS is provided by placing precast box segments, it is designed for earth pressure, track & train surcharge on the sides of box. Vertical loads includes load of track and train distributed on the box without any dispersion through top slab along the barrel length of box.

When the RUB/LHS is provided by box pushing method, there is a earth filling of minimum 1.0m height on the box. The box in this case is designed for weight of earth fill + wt. of track + load of train with impact, dispersion through earth fill is taken into account. for design of box. Method of design will remain the same. Frame is analysed by using various soft wares like STAAD Pro. Limit state method as per IRS Concrete Bridge code is adopted taking respective partial factors of limit state.
Prestressed concrete girder is ideally suitable for long span bridge construction on straight span and the present trend outside railways is to adopt Prestressed concrete for long span strayed bridge which are aesthetically superior and economical in comparison with steel bridge. But in Northern Railways, keeping in view of the lesser number of Railway spans in ROBs (maximum 3 to 4 generally), PSC girder are considered for spans less than 25m generally and that too for non-track span as PSC girder construction and subsequent launching is more cumbersome. Steel is given preference for the track span as it is easier to fabricate and launching also requiring lesser block time. A self-explanatory comparison in between PSC, RCC and Steel girder is given below.

1. The X- Section of PSC section is more efficiently utilized as compared to RCC section as in a RCC beam the concrete in the compression side of the neutral axis alone is effective and the concrete on the tension side is ineffective. But in a Prestressed concrete beam the entire section is effective.

2. PSC members possess improved resistance to shearing forces due to effect of compressive prestress. Use of curved cables, particularly in long spans helps to reduce the shear forces developed at the support section.

3. Use of High strength concrete and steel in PSC members results in lighter and slender members as compared to RCC members. High strength concrete is needed to resist high stresses at the anchorages and High strength steel is needed to transfer large prestressing forces.

4. Due to utilization of concrete in the tension zone, an extra saving of 15-30% in concrete is possible in comparison with RCC. The savings in steel are even higher i.e 60-80% mainly due to high permissible stresses allowed in high tensile wires. However generally upto 14.0m spans where there is no restriction on the height clearance of bridge, RCC girders can be preferred over PSC.

5. Although there is considerable saving on the quantity of materials used in prestressed concrete members in comparison with reinforced concrete members, it is not much significant due to additional cost incurred for the high strength concrete, high tensile steel, anchorages, and other hardware required for the production of prestressed members. However, there is overall economy in using prestressed concrete, as the decrease in dead weight reduces the design loads and the cost of foundations.
6. PSC girders require little maintenance in comparison to steel girders. PCS girders require scheduled inspection and are almost maintenance free.

7. The cost wise PSC girder is cheaper than the steel girder. The cost of carriageway with steel composite girder is 2.5 times (Approx.) the cost of carriageway with PSC girder for similar spans.

8. The Ministry of Surface Transportation (MOST) roads wing has issued standard drawings for Road Bridge for standard PSC girder span of 30.0M, 35.0M, 45.0M with and without footpaths.

9. Northern Railway has approved some standard type of PSC girder for carriageway 7.5/8.5/9.5/11.0/12.5m and for span from 15.0 to 40.364 m.

10. Technique for Inspection, construction, launching, quality control is well explained in clause No.-609,610, 611, and 612 in IR Bridge Manual for reference

b) **Checklist for Design of PSC Superstructure**

1. Checking of dimensional drawing with the approved GAD. (Length of span, width of superstructure, skew angle, width of carriageway, number of girders, And Spacing of girder.

2. Checking of properties of Long Girder, X Girder & Deck Slab. (Cross sectional area and Moment of Inertia depending upon the size and shape of the element considered

3. Loads (Self Weight of Girder, Cross Girder, Deck slab, SIDL including Wearing Coat, Crash Barrier, railing, Median and different positions of Live Load for 70R, Class A and Tracked vehicle are checked as per IRC-6.

4. Bearing type and arrangement fix/ free is checked.

5. Checking of Grillage from STAAD Model. (All the above points have been correctly applied)

6. Checking of Moments / Shear force of Main Girder from STAAD Model.

7. Shrinkage stress and temperature stresses are checked as per IRC6.

8. Checking of Prestressing cables number, type of cable, arrangement, coefficient, cable coordinates, sequence of prestressing & days at which they are to be prestressed.

9. Checking of stresses in girder at the time of prestressing (Tensile &Compressive stress).
10. Checking of Residual stresses in girder after applying all Loads (Tensile & Compressive stress) as per IRC 112.

11. Checking for ultimate limit state (Basic & Seismic combinations).

12. Checking for upward deflection of girder after applying of prestressing force.

13. Checking for Bow action of girder due to eccentric cable if any.

14. Checking for untension reinforcement of long girder as per IRC 112.

15. Checking for shear connector as per IRC 112.

16. Checking for End Anchorage of girder as per IRC 112.

17. Checking for lifting Hook of girder as per IRC 112.

18. Check for Hogging & Sagging moments of End X Girder from the STAAD file and the reinforcement is provided for it.

19. Check for Sagging moments of Intermediate X Girder from the STAAD file and the reinforcement is provided for it.

20. Check for span moments & support moments for both ULS & SLS check of deck slab from the STAAD file and the reinforcement is provided for it.

21. For checking Bearing Loads Seismic Zone is to be confirmed from IRC 6.

22. Bearing load due to DL, SIDL, Live Loads & seismic loads and wind loads from STAAD file is verified.

23. Design and all the drawings are to be signed by the design consultant and duly proof checked from the proof checking institution, also drawings are to feasibility checked from field officials.

c) **Checklist for Design of Steel Superstructure**

1. Dimensions should be matched with the approved general arrangement drawing.

2. Grade of structural steel and reinforcing bars.

3. Bearing type and arrangement of bearing is checked.

4. Seismic zone is confirmed from IRC: 6.

5. All relevant checks as per IRC: 24 like spacing of girders, depth of web, width of outstrand, etc. should be checked.
6. Properties are checked for steel only, long term and short term as per relevant codes.

7. Net section properties are also calculated at the splice location.

8. Properties calculated above are matched with the properties in STAAD model.

9. Loads (Self weight of girder, deckslab, SIDL including wearing coat, crash barrier, railing and median and different positions of live load for 70R, Class A, SV Loading, Congestion factor wherever applicable and tracked vehicle with impact factor) are checked as per IRC:6. Girders should be checked considering fatigue.

10. Shrinkage and temperature stresses are calculated.

11. Permissible bending compressive, tensile stresses and shear stress should be taken as per IRC 24.

12. Actual bending stresses for different load combination mentioned in design basis note also are compared with permissible stresses at the various sections of the span and splice locations for outer and inner girders.

13. Actual shear stress is compared with permissible shear stress at support.

14. Stud shear connectors are checked for ultimate flexural consideration and fatigue consideration.

15. Girders are checked for launching stage also.

16. No. of bolts in top and bottom flanges are calculated considering friction capacity, shear and bearing of bolts as bolt value and force is calculated using stress at splice location as calculated and gross area of top and bottom flange main plate.

17. For web, bolt value is taken as minimum of friction capacity of bolt or bearing strength of plate and web splice is designed to resist shearing forces and moments in the web.

18. Stresses for End cross girder should also be checked in jacking condition and for horizontal forces if pin bearing provision is there.

19. Cross bracings are to be designed for 2.5% of the force in compression flange addition to the wind force and permissible stresses are calculated as per IRC: 24 as also mentioned in design basis note.

20. Single line analysis is done for deck slab for different combinations of live loads with dead load and SIDL.
d) Design of slabs and T-beams-

General:

1. RCC T-beam and deck slab system is adopted for span nearly 10mtrs to 15 mtrs.

2. The no. of girders depends upon width of deck slab required. Normally longitudinal spacing is taken as 2.5 m to 2.75m center to center.

3. The depth of beam is nearly taken as L/12 from economy and deflection consideration, where L is effective span of bridge.

4. The thickness of RCC slab is normally taken as 200mm to 300mm depending upon spacing of girders.

5. Design of T-beam deck slab system is analyzed with the help of STAAD pro software.

6. In addition to self-weight of beam slab, wearing coat, crash barrier footpath etc. the deck slab is designed for the type of live loads and no. of loads depending upon carriageway width as per IRC 6.

7. The property of T beam depends upon effective width of flanges, center to center distance of main beams and effective span.

8. The effective span is taken as per IRC 112 guidelines.

9. Support condition- The support condition at one end is considered as fixed for horizontal forces and the other end is considered as free.

10. Calculation of loads- The self-weight of slab and beam is calculated by STADD pro. Itself and SIDL (1) and (2) i.e. FPLL, etc. will be applied as a member load on beams. Moving loads are applied with specified intervals in a particular direction. The worst condition of loads is placed at a critical interval of 500mm.

11. Various combinations of loads are taken in STAAD pro. The maximum moment and forces are taken from STAAD pro. Output.

12. Design- Design on RCC beam slab is done as per IRC:112 as per limit state method using excel sheets. For calculating longitudinal reinforcement of beam, the forces i.e. bending moment, torsion is taken from STAAD output and steel is calculated as per IRC:112 and for calculating the shear reinforcement, shear force is taken from output file.

13. For design of slab, the wheel loads are placed at critical position of slab. The wheel load is distributed on the slab. The dispersion
width of slab for particular location of wheel load is calculated for design of slab in case of span and cantilever separately.

14. The bending moment and shear force is calculated accordingly, by taking the one slab as one-way. The steel is calculated for a moment at various locations. Main reinforcement is provided perpendicular to the main beams and the distribution reinforcement is provided along the main beams.

e) **Design criteria for Bow String girders**-

As per railway board’s Letter No. 2015/CE/IV/ROB/78(pt.) dt. 04.06.2019, only standard bow string girders span should be used. Annexure 10.06.

1. Design basis - Design of this girder is done as IRC 24, IS800, IRC22, and IRC21. Loading is as per IRC6

2. Step in design is as follows -

**STEP 1: Load Calculation**-

Following loading is to considered -

i) Self-weight of frame
ii) Dead load of concrete deck (slab+ concrete shuttering)
iii) SIDL (due to wear coat and crash barrier)
iv) Live load with impact (IF= 1.15)
v) Footpath live load
vi) Wind load
vii) Seismic load

**STEP 2: Analysis of Arch**-

Steel frame of this girder is analysed using STAAD pro software for all combination of loadings.

**STEP 3: Design of Arch Tube Section**-

Following stress to be computed -

i) Axial compressive stress (as per relevant clause of IS 800)
ii) Shear stress due to Fyy (as per relevant clause of IS 800)
iii) Shear stress due to Fzz (as per relevant clause of IS 800)
iv) Shear stress due to Mxx (torsion)
v) Bending stress due to Mzz (as per relevant clause of IS 800)
vi) Bending stress due to Myy (as per relevant clause of IS 800)
vii) Check for combined $F_{xx}$ (compression) + $M_{yy}$+$M_{zz}$ (as per relevant clause of IS 800)

viii) Check for combined $F_{yy}$+$F_{zz}$+ $M_{xx}$+$M_{yy}$+$M_{zz}$ (as per relevant clause of IS800)

**STEP 4: Analysis of Hanger**

Steel frame of this girder is analysed using STAAD pro software for all combination of loadings.

**STEP 5: Design of hanger Tube Section**

Following stress to be computed-

i) Axial tensile stress (as per relevant clause of IS 800)

ii) Shear stress due to $F_{yy}$ (as per relevant clause of IS 800)

iii) Shear stress due to $F_{zz}$ (as per relevant clause of IS 800)

iv) Shear stress due to $M_{xx}$ (torsion)

v) Bending stress due to $M_{zz}$ (as per relevant clause of IS 800)

vi) Bending stress due to $M_{yy}$ (as per relevant clause of IS 800)

vii) Check for combined $F_{xx}$ (tension) + $M_{yy}$+$M_{zz}$ (as per relevant clause of IS 800)

viii) Check for combined $F_{yy}$+$F_{zz}$+ $M_{xx}$+$M_{yy}$+$M_{zz}$ (as per relevant clause of IS800:1984)

**STEP 6: Analysis of TOP Tie**

Steel frame of this girder is analysed using STAAD pro software for all combination of loadings

**STEP 7: Design of Top Ties Tube Section**

Following stress to be computed-

Axial compressive stress (as per relevant clause of IS 800)

Shear stress due to $F_{yy}$ (as per relevant clause of IS 800)

Shear stress due to $F_{zz}$ (as per relevant clause of IS 800)

Shear stress due to $M_{xx}$ (torsion)

Bending stress due to $M_{zz}$ (as per cl. relevant clause of IS 800)

Bending stress due to $M_{yy}$ (as per cl. relevant clause of IS 800)

Check for combined $F_{xx}$ (compression) + $M_{yy}$+$M_{zz}$ (as per relevant clause of IS 800)

Check for combined $F_{yy}$+$F_{zz}$+ $M_{xx}$+$M_{yy}$+$M_{zz}$ (as per relevant clause of IS800)
STEP 8: Analysis of Longitudinal Beam –
Steel frame of this girder is analysed using STAAD pro software for all combination of loadings

STEP 9: Design of Bottom Side Main Girder-
Following stress is to be computed-
i) Axial tensile stress (as per relevant clause of IS 800)
ii) Shear stress due to Fyy (as per relevant clause of IS 800)
iii) Shear stress due to Fzz (as per relevant clause of IS 800)
iv) Shear stress due to Mxx(torsion)
v) Bending stress due to Mzz (as per relevant clause of IS 800)
vii) Check for combined Fxx(tension) +Myy+Mzz (as per relevant clause of IS 800)
viii) Check for combined Fyy+Fzz+ Mxx+Myy+Mzz (as per relevant clause of IS800)

STEP 10: Design of bottom Cross main Girder-
i) Stress due to shrinkage of concrete.
ii) Check for Stress due to bending.
iii) Check for stress due to shear.

STEP 11: Design of joints
i) Arch hanger joints-
Stress calculation at critical locations-
a) Due to horizontal force
b) Due to in plane moments
c) Due to moments perpendicular to plane
d) Resultant stress
ii) Hanger bottom longitudinal joints-
Stress calculation at critical locations-
a) Due to horizontal force
b) Due to in plane moments
c) Due to moments perpendicular to plane
d) Resultant stress
10.2.6.2 Design of Sub-Structure

A) DESIGN CRITERIA-

1. Soil capacity (in case of open foundation) theoretical/verified through plate load test by actual testing. Theoretical pile capacity based on soil parameters and Initial test pile capacity results verified through actual/Routine test pile at site in case of pile foundation. Initial test pile will be tested for accessing the capacity of pile based on the soil parameters. Pile foundation will be designed and executed accordingly. Routine test of a pile of a pile on a pile group will be done to confirm the actual capacity of the working pile.

2. Natural Ground/Spot levels at the location of all piers at 50m on either side of the pier

3. PWD details required in case of common piers:

- Total Span (c/c of exp. jt) on both side of common piers
- Effective Span (c/c brg.)
- Total Carriageway width
- No. of Girders
- No. of Bearing
- C/C of bearing (transverse)
- Distance from c/l Exp.Jt. to c/l of Brg (Longitudinal eccentricity)
- Type of Bearing & arrangement of Brg
- DL reaction on each bearing
- SIDL reaction on each bearing (crash barrier/ railing/w.c)
- Maximum Live Load reaction on each bearing & corresponding live load reactions on other bearings
- Seismic Zone considered in the design
- Pedestal Size
- Dimension and reinforcement details of seismic arrester.
- Type and depth of girders without deck slab
- Deck slab and wearing coat depth
- Dimensional details of Superstructure with drawings.
- Jack Positions (for replacement of bearings)
- Seismic arrester size and position

If curve is there in approach span, then provide the following details:

a) Curve details i.e. transition length, location of transition and circular curve
b) Cross slope at various required locations
c) Widening of carriageway as per layout
d) Super elevation, speed on curve, deflection angle, radius of curve

Note: PWD should keep free bearings on both common piers.

4. The design notes and drawing should be signed by designer with full name and contact number and by proof checking agency with signature, full name and contact number. A certificate from the proof checking agency on his letter head stating that the design and drawing of the bridge (substructure and superstructure) has been checked by me in all aspects and found in order and is safe for execution as per the latest IRC codal provisions must be submitted.

5. The feasibility of the design and drawings should be checked in all respect at site before submission.

6. The feasibility should be endorsed by the Dy.CE/C field on the drawing.

7. Salient features of the bridge also be given in cover page stating: span (clear/centre to centre), long and transverse eccentricity; skew angle, seismic zone, nos. and spacing of girders, depth of girder, FRL (finished road level) etc.

8. Design basis note stating the codes referred method of design used and load combinations used for design/permissible stresses in concrete for different component of substructure.

9. In design note the formula used should be supported by clause No and code referred.

10. The soft copy of the STADD files, design, and drawings must be submitted with the design note.

11. The stress summary and summary of all the components should be prepared stating the allowable and actual stress calculated or the reinforcement calculated/provided and should be signed by the designer and proof consultant.

12. The detailed and summary of loads & forces applied in STADD frames should be clearly mentioned in a page before STADD files.

13. Load combination: load combinations should be considered as per latest codal provisions of IRC 6.

B) Suitability of Open Foundation In Lieu Of Pile Foundation-

The bearing capacity values in most of the areas of Northern Railway has been found to vary on an average between 12 to 20 tonnes per metre square, barring a few exceptional cases here and there. And the design of an open foundation just requires the Bearing Capacity detail whereas Pile Foundation design involves design and testing of a test Pile at the outset to further finalise the pile group which shall take a minimum of 2 to 3 months and delay work commencement at site. Also, a routine load test is to be carried out to further assess the performance of the pile group which delays the finalisation of the pile cap and other designs almost by 6 month time.

Open Foundations are very easy to construct as compared to Pile
 Foundations, thus being favoured by contractors and thus also leading to speedy construction and completion of ROB projects in 9-12 months over Northern Railway wherein earlier, the ROBs with Pile foundations were being completed in 2 to 3 year time span.

Besides the ease in design and execution, being the prime mover, there a few other equally pivotal factors which favour the provision of open foundations against pile foundations, leading to adoption of open foundations as a preferred choice exhaustively over Northern railway.

Open Foundations have an inevitable and visible economical edge over pile foundations as the difference in cost of open and pile foundations is very high and it has been worked out that the cost of an open foundations is almost equivalent to the cost to a pile cap and can be built out of only the cost of a pile cap, leaving aside the additional cost of the pile group. Comparatives were drawn over numerous cases over Northern Railway and it was concluded that Pile Foundation is almost two times the cost of open foundation at the same location. Provision of sheet piling required for safe execution of Open Foundation.

There is a huge saving of cost in the Railway portion and in the approaches.

The open foundation construction and execution is visible for inspection and its integrity is not questionable unlike a pile foundation which is not visible for open inspection after construction. Though there are available modes of integrity testing of piles these days but their reliability still remains questionable. Hence an open foundation is a dependable alternative for adoption.

Open foundations have thus become the best preferred choice over the Pile Foundations which had become the default choice in the past, all over Northern Railways, though in exceptional cases where the soil or the site conditions do not permit open foundations, CAO/C has been given powers to provide exemption by Railway Board. Even for these isolated works or foundations were provision of pile foundation was inevitable, separate agencies were appointed for casting of the test pile and arriving at the pile load capacity concurrent with the tendering of the main work, so that the pile group design is available for immediate work commencement with the award of the work.

To further achieve speed in execution and reduce design, standard open foundation prototypes were prepared, which could be given to the field Deputy Chief Engineers before calling of tenders for almost exact assessment of quantities and immediate commencement of work at site with immediately available drawings, thus reducing the time of design to almost nil.

C) Design of pile foundation-

1. Calculation of loads- DL, SIDL, FPLL of both spans
   i) Reaction due to DL, SIDL except wearing coat, SIDL of wearing coat, FPLL, CWLL of both spans at each bearing are calculated.
   ii) Live load reactions at each pier for maximum longitudinal moment, maximum transverse moment case and maximum reaction case.
   iii) Wind load calculation- total transverse force, total longitudinal force and upward/downward wind force are calculated for both
spans, Wind load for sub structure and for wind load for LL.

iv) Seismic loads- longitudinal seismic force for spans (r1), longitudinal seismic forces for sub-structure, transverse seismic force for both spans (r2), transverse seismic forces for sub-structure, vertical seismic load is calculated.

2. Vertical and horizontal pile load capacity is taken from the initial pile load test.

3. Summary of vertical loads of both spans are tabulated. These loads are considered due to dead load, SIDL except surfacing, SIDL of surfacing, FPLL, CWLL.

4. Summary of horizontal loads are being tabulated for frictional/shear rating of spans, braking forces and centrifugal forces.

5. Loads/weight of on sub-structure and soil on foundation are calculated.

6. Base pressure check is performed for vertical and horizontal loads for various combination of normal and wind case.

7. Summary of loads at base of foundation for vertical loads and horizontal loads with seismic forces instead of wind are prepared in tabulated for various combinations.

8. Load combination are taken as per relevant clause of IRC: 6-2014. In each combination as specified in IRC :6 and from design of pile group consisting total nos. of pile and their position, the reaction at each pile is calculated for pile group. The maximum reaction should not be greater than vertical pile load capacity and the horizontal force should not be greater than horizontal pile load capacity.

9. Design of pile- Design of pile is done as per IS: 2911

i) Design parameters- grade of concrete, grade of steel, fck(characteristics compressive strength of concrete), fcd (design compressive strength of concrete) etc.

ii) From IS: 2911(part-1) the actual maximum moment is calculated by considering stiffness factor as per relevant clause. Reduction factor as per Annex-c is applied. Reinforcement is provided for carrying maximum moment.

iii) The actual moment capacity of pile is calculated from interaction curve for circular column for verification of structural strength and moment capacity.

iv) The check is done for serviceability limit state (SLS). Combination for SLS is taken for minimum and maximum reaction on pile. Stress in concrete and steel should not be greater than allowable stress respectively.

D) Soil investigation for foundation for ROB’s-

The soil investigation shall be carried out in accordance with relevant clause of IRC 78.
Items to be considered for different types of soils is as under-

<table>
<thead>
<tr>
<th>S. N</th>
<th>Type of foundation</th>
<th>Soil investigation</th>
<th>Reference/authority</th>
</tr>
</thead>
</table>
| 1.   | Common             | i) soil reports of adjoin PWD portion and also foundation details of nearby road/railways bridges may be examined and taken for reference.  
     |                    | ii) Initially, one borehole of approximate 25m to 30 m depth including SPT should be done to know soil stratification, to study the feasibility of open foundation and also level of foundation at which open foundation can be placed. Further tests should be carried out according to type foundation decided after analysis of data for this borehole.  
     |                    | iii) if open foundation is not feasible due to less bearing capacity/site constraints, personal approval of CE/C should be obtained for providing deep foundation. The case to be routed through design office. | relevant clause of IS:1892  
     |                    |                    | relevant clause of IS: 1892  
     |                    |                    | CAO/C letter No. CAO/C/ Misc/2014 dt. 11.03.14 |
| 2.   | Open               | A) for non-cohesive soil-  
     |                    | i) Results of plate load test shall be preferred over results obtained from laboratory tests  
     |                    | ii) Plate load test with specified size of plate and at specified depth should be done and bearing capacity should be finalized in consultation with design cell.  
     |                    | iii) with finalized bearing capacity, if open foundation is feasible, boreholes of 15m to 18m depth should be done at each pier/abutment location  
     |                    | iv) grain size analysis, specific gravity, moisture content, unit weight and shear strength test be carried out. Other tests as required during course of investigation may also be carried out. | relevant clause of IS: 1892  
     |                    |                    | relevant clause of IS:1888  
     |                    |                    | relevant clause of IS:1892, IS: 1888 and of IRC :78  
     |                    |                    | relevant clause of IS:1892  
     |                    | B) for cohesive soils-  
     |                    | i) boreholes of 15m to 18m depth should be done at each pier/abutment location.  
     |                    | ii) grain size analysis, specific gravity, moisture content, unit weight, shear strength, liquid limit, plastic limit, consolidation, UCS/traixial test should be carried out. Other tests as required during course of investigation may also be carried out | relevant clause of IS :1892-1979 |
| 3. | Deep | i) Soil investigation including SPT and report having data from borehole under each pier/abutment and depth from borehole up to 1.5 times the width of footing from bottom of foundation (generally from 25m to 30m) should be carried out. Additional boreholes, if required based on analysis of acquired data, should be carried out | relevant clause of IRC:78 |
| a) pile | | i) Theoretical capacity of pile of suitable length at different depths should be worked out keeping in view the soil report, dia. Of pile and expected loads on piles in consultation with design office. | Relevant clause of IRC:78-2014 and of IS: 2911 (part 1 sec 2) |
| | | ii) Test pile shall be designed and got approved based on soil report and expected loads on piles. | Relevant clause IS: 2911-1985(part 4) and cl.1113.1 of MOST specifications on road and bridges. |
| | | iii) Initial pile load test- Nos. of test- 2 nos. (Minimum each on either side of Rly. Track/requires as per site) shall be carried out | |
| b) well | | i) depth and dia. of well along with bearing capacity of soil at foundation level should be got calculated keeping in view the soil report and expected loads on wells in consultation with design office. | Relevant clause of IS: 1892 and cl.1202.2 of MOST specifications on road and bridges. |

### 10.2.6.3 Design of bearings

A) **Spherical Bearings**

Spherical bridge bearing, also called spherical bearing, spherical bearing pad, is designed to ensure vertical and horizontal forces transferring under control which is a connection device between superstructures and substructures. It consists of steel plate enclosed with edge sliding guide and stainless steel panel for sliding controlling, under the stainless steel panel is a PTFE sheet/Low friction material, which is recessed into the steel to a depth and contains a special lubricant to ensure permanent lubrication of the sliding surfaces. Then there is a stainless steel panel with a convex bottom face to facilitate rotations. The bottom component is concave steel plate that covered with a recessed PTFE sheet to transfer whether horizontal or vertical forces safely.

**Spherical Bearings should be used for larger spans having heavy loads.**

**Classification**

The spherical bridge bearings are classified into three types according to different sliding direction.
I. Fixed type. Provide rotations capacity from any direction only.

II. Guided type (Uni-directional sliding). Rotation plus movement in one direction.

III. Free sliding (multi-directional sliding). Rotation plus movement in all directions.

**Maintenance of spherical bearing**

During using, the spherical bearing needs to be inspected and maintained regularly. And the inspection items are as following:

I. Checking whether the anchor bolt is cut and the rubber sealing is cracking and aging.

II. Checking whether the relative displacement of the spherical bearing is uniform and record the displacement one by one.

III. Clean the debris and dust around the spherical bearing, while at the same time, using the cotton cleans surface of the stainless steel.

IV. Loose the anchor nut regularly, clean and oil the anchor nut to avoid rust, and then fasten the anchor nut.

V. Check the height changing of the spherical bearing to confirm the abrasion condition of the PTFE slide. And when the height of spherical bearing changes over than 3 mm, the rubber sealing should be removed to inspect the condition of the PTFE slide.

VI. Painting the steel components of the spherical bearing regularly to avoid rust destroy (except the stainless steel slide).

**B) POT-PTFE Bearings**

**General**

POT bearing was developed in 1959 as an alternative to heavy steel sliding bearings. It consists of a circular non-reinforced rubber-pad fully enclosed in a steel pot. The rubber is prevented from bulging by the pot walls and it acts similar to a fluid under high pressure. From the discussion on various bearings, it has been observed that most of the bearings have the limitation of either load or movement capacity.

The load range and movement capacity of various types of bearings are given as follow-

<table>
<thead>
<tr>
<th>Type</th>
<th>Load range (T)</th>
<th>movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sliding</td>
<td>20 – 133</td>
<td>± 25 mm</td>
</tr>
</tbody>
</table>
The above bearings are adequate for smaller spans having the requirement of load and movement, within the range prescribed in the above table. But what to do for the larger spans having more load and more movements? In fact, the problem of load can be solved by providing more bearing area or providing more number of bearings so that load is shared by many bearings. However, this idea of ‘sharing’ can’t be extended to movement because the number of ends can’t be more than two. Therefore, it is the requirement of movement which is more critical than the load requirement and we require some other type of bearing where the horizontal movement should not be the limiting factor. Since necessity is the mother of invention, a special category of bridge bearing was developed known as ‘POT and PTFE’. PTFE is a short form of Poly Tetra Fluoro Ethylene.

C) Suitability of POT-PTFE over Elastomeric Bearings

In POT bearing, two most important synthetic materials i.e. Elastomer & PTFE are utilised. Elastomer has an excellent property of providing translation and rotation without any moving parts. In POT-PTFE bearing, the latter part is utilised by completely encasing the elastomer pad in steel casing or POT. PTFE has an excellent property of having very low coefficient of friction and in the free end, a sliding component is added on top of POT, comprising stainless steel and PTFE for translation. The rotation, therefore, is provided by elastomer due to differential compression and translation by steel and PTFE. Elastomeric bearing, otherwise, considered to be an ideal bearing, could not be used in larger spans because of some drawbacks.

These drawbacks of elastomeric bearing which lead to development of POT – PTFE bearing are given below:

i. The ordinary elastomeric bearing can’t be used as a fixed bearing.

ii. The translation allowed by the elastomeric bearing is restricted by its thickness.

iii. In order to have more value of ‘δ’, the thickness of the elastomer pads will have to be increased but the same can’t be increased beyond a limit as thicker elastomer pads are rather unstable.

iv. There is a limit to the vertical load also which the elastomeric pad can safely withstand. Large vertical loads result in greater amount of compression and bulging.

v. Large rotation creates the danger of off-loading of one edge and over stressing the other.

D) Design Aspects of POT-PTFE Bearings

Basic elements of a POT bearing are:

POT or a shallow cylinder
an elastomeric pad
a set of sealing rings

**General Guidelines** –
Provisions apply for temperature ranges of -10°C to +50°C. –
POT bearing of dia. up to 1500 mm are within scope of these specifications. –
Tensile load can’t be applied to bearings. –
Rotation up to 0.025 radians only considered.
Confined elastomer used in metal POT is unreinforced. It allows only rotation by virtue of differential compression. The popular property of elastomer i.e. translation due to shearing strain is not used here in POT-PTFE bearings due to confinement.

**LIST OF REFERENCES**-
1. IRC; 83 (Part III and part IV): Standard specification & code of practice for road bridges, part III- 1987 Elastomeric bearings, Indian Roads Congress, New Delhi, India.

**10.2.7 Design of ROAD UNDER BRIDGE**

**10.2.7.1 DESIGN OF U TYPE BOX GIRDERS**-

a) **RCC boxes segment construction for cut and cover method**-
For segmental box for cut and cover method, the only difference in design is the barrel length for one segment is taken nearly 1.5m. The load of track at formation level is for 3m width. So that whole load coming on box is borne by two segments i.e. 1.5x2=3.0m because through dispersion is not possible due to discontinuity of barrel length. Guide Lines for barrel length and construction of pre cast RCC Box bridges (LHS/RUB) by cut and cover method is attached Annexure as 10.03 and 10.04.

b) **RCC boxes for box pushing method** -

c) **RCC boxes for air pushing/pulling method** -

The following steps are to be taken in consideration for both methods as described in (b) and (c)

**STEP 1: FIXING OF INITIAL STRUCTURAL DIMENSION**-
Thickness of top slab and bottom slab should be taken as 1/10 to 1/12 of the span.

Thickness of walls should be taken as 1/12th of span but it is normally taken as thickness of slab.

**STEP 2: LOADING CONSIDERATION**-
Loading on top slab-

a) Wt. of earth filling, if box is below the road level.

b) Wt. of wearing coat

c) Wt. of crash barrier and footpath and parapet.
d) Moving load as per requirement of bridge, as per IRC 6.

i. force on walls-

a) earth pressure due to earth fill will be as per coulombs theory depending upon depth of fill.

b) Surcharge due to live load will be taken as 1.2mtrs height of earth fill.

c) Ttractive effort/braking force will be applied on top corner is equal to 20% of live load.

ii. bottom slab-

a) load on bottom slab depend upon use of box opening.

iii. supporting condition of box-

a) Bottom slab will be divided into small members normally 1mtr each along the span.

b) The condition of support will be applied as per the subgrade reaction; it will depend upon bearing capacity and settlement of soil underneath.

**STEP3: Analysis of Box-**

Analysis is done by using STAAD pro software considering all possible combination of loading.

Combination of loads is as follows-

a) There is no live load on box; live load is only on approach.

b) 1 side approach and full span is loaded.

c) Both approaches and full span is loaded.

d) For load combinations appropriate safety partial factor for limit state design to be taken.

**STEP 4: Design of Box-**

Form the analysis two forces are important, bending moment and shear force.

i. Bending moment will be taken at face of wall.

ii. Shear force shall be taken at a distance’d’ from the face of wall.

iii. The design of RCC will be made as limit state method taking concrete mix as M35 minimum and grade of reinforcing steel is FE 500.

10.2.7.2 Approach road and retaining walls for LHS-

1. The LHS are normally provided for rickshaw, scooter, cycle etc and same class of vehicles.
2. The gradient of approaches for LHS should not be steeper than 1 in 20, preferably 1 in 25.

3. Retaining wall of LHS is normally of U-shape. The bottom of retaining wall also works as floor of approach road.

4. Design consideration- the retaining wall is designed for earth pressure and surcharge of 1.2 mtr height of earth.

5. The thickness of retaining wall at the top is taken as 250mm and bottom thickness of wall is taken as 1/10th of height of wall, from economy considerations.

6. The maximum steel is provided for cantilever wall at the top of base slab being maximum bending moment at this point.

7. The horizontal steel which is only distribution steel is provided as per requirement of IRC code.

10.2.8 STAGES IN EXECUTION OF ROB WORKS-AN OVERALL VIEW

<table>
<thead>
<tr>
<th>Stage I-2 Months</th>
<th>Submission of Design&amp; Drawings for approval by Design Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Submission of DBN(Design Basis Note) if Consultant’s Design, Format enclosed-(Format -A)</td>
</tr>
<tr>
<td>2.</td>
<td>Checklist for Design Submission-(Format -B)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STAGE II-1.5 to 2 Months</th>
<th>Submission of CRS Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Submit CRS application on the basis of approved GAD, TAD, detailed structural drawings, modus-operandi for carrying out the work, along with the proposal for shifting of level crossing and diversion plan, if necessitated for construction of ROB, within a period of 30 days of submission of necessary documents by NHAI and charges, if any.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STAGE III-1Month</th>
<th>Submission of Quality Assurance Documents by Contractor/Agency to Deputy Chief Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The Contractor to submit his Quality Assurance Plan(QAP) for the entire project to concerned Deputy Chief Engineer for Approval.</td>
</tr>
<tr>
<td>2.</td>
<td>The Contractor to submit his Method Statement based on the Quality Assurance Plan(QAP) to concerned Deputy Chief Engineer for Approval.</td>
</tr>
<tr>
<td>3.</td>
<td>Submission of QAP for concrete construction to concerned Deputy Chief Engineer for Approval (Format Enclosed)-(Format-D)</td>
</tr>
<tr>
<td>5.</td>
<td>Submission of QAP for steel fabrication to concerned Deputy Chief Engineer for Approval (Format enclosed)-(Format-E)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STAGE IV-7Months</th>
<th>Execution at work site</th>
</tr>
</thead>
</table>
1. Checklist before commencement of Concrete at site-(Format-F)
2. Checklist for Girder Fabrication-( Format -G)
3. Checklist for Girder Welding-( Format -H)
4. Checklist for Girder Assembly-( Format -I)
5. Safety precautions and measures to be observed during execution-(Format -J)

**TOTAL TIME OF COMPLETION-12MONTHS**
STAGE I
Submission of Design & Drawings for approval by Design Office

1. Submission of DBN (Design Basis Note) if Consultant's
   Design, Format enclosed-(Annexure-A)

2. Checklist for soil exploration for substructure
   (Annexure-B)

3. Checklist for Design Submission
   (Annexure-C)

02 months

STAGE II
Submission of CRS Application by Railway

1. Railways to submit CRS application on the basis of approved GAD, TAD,
   detailed structural drawings, modes-operandi for carrying out the work, along with
   the proposal for shifting of level crossing and diversion plan, if necessitated for
   construction of ROB

1.5 to 2 months

STAGE III
Submission of Quality Assurance Documents by Contractor/Agency to Deputy Chief Engineer

1. The Contractor to submit his Quality Assurance Plan(QAP) for the entire project to concerned
   Deputy Chief Engineer for Approval

2. The Contractor to submit his Method Statement based on the Quality Assurance Plan(QAP) to
   concerned Deputy Chief Engineer for Approval.

3. Submission of QAP for concrete construction to concerned Deputy Chief Engineer for
   Approval (Format Enclosed)-(Annexure-C)

4. Submission of QAP for steel fabrication to concerned Deputy Chief Engineer for Approval
   (Format enclosed)-(Annexure-D)

01 month

STAGE IV
Execution at work site after STAGE-III

1. Checklist before commencement of Concrete at site-(Annexure-F)
2. Checklist for Girder Fabrication-(Annexure-G)
3. Checklist for Girder Welding-(Annexure-H)
4. Checklist for Girder Assembly-(Annexure-I)
5. Safety precautions and measures to be observed during execution-(Annexure-J)
6. Technical records to be maintained at site - (Annexure-K)

TOTAL TIME OF COMPLETION-12MONTHS

7 months
1. Introduction

1.1 Design Service Life

The intended minimum design service life of various elements forming part of project shall be 100 years in accordance with relevant clause of IRC: 112.

2.0 Description of Structure

The details of proposed ROBs along the sketch in A3 size.

3.0 Design Basis & Design Criteria for Structures

The main design criteria shall be to evolve design of safe structure having good durability conforming to the various technical specifications and sound engineering practices. The design of structural components shall conform to the criteria laid down in the latest edition of the IRC codes of practice, standard specifications, guideline/circular of MORTH, IRC and BIS published up to the date.

3.1 Geotechnical Parameters

Sufficient information about the arrangement & behaviour of the underlying materials and their physical properties for adopting and designing the structural foundation is essential. At all structures Soil exploration through field investigation and laboratory testing of the substrata shall be done to arrive at required parameters for designing of safe and economical foundations.

3.2 Type of Superstructure

Based on the span lengths and site requirements type of superstructure shall be proposed. For ROBs Steel plate girder & RCC deck slab type superstructure shall considered. The depth of superstructures shall be decided based on the structural considerations and also keeping in view the minimum vertical clearances above the rail top levels.

3.3 Substructure and Foundation

For ROBs mostly framed type substructure with number of circular columns and rectangular pier cap shall be proposed supported on open foundation / bored cast in situ pile foundation.

3.4 Expansion Joints

3.5 Single Strip Seal Expansion Joints shall conform to Specifications for Road and Bridge works as per MORTH and IRC.

3.6 Bearings

Normally Spherical/POT-PTFE bearings (Fixed/ Guided/ Free) shall be proposed under superstructures as per IRC:83 (Part III and part IV) and shall conform to MORTH’s Specifications.
3.7  Drainage Scheme

It is proposed to provide a minimum cross slope of 2.5% for drainage from where the water will be discharged to below.

3.8  Earth Retaining Structures

RCC retaining wall/RE wall shall be provided for retaining the earth.

3.9  Exposure Condition

The condition of exposure has been considered as "Moderate" for the purpose of design. The values shall be modified for elements in contact with earth and water as stipulated in relevant clause of IRC:112

3.10  Concrete Clear Covers:

Minimum clear cover to the reinforcement bar shall be as per relevant clause of IRC: 112.

4.0  Material Properties

4.1.1  Compressive Strength

Durability provisions for structures shall be as per "moderate" conditions of environment in accordance with IRC: 112,

The following grades of concrete have been proposed for the various components of structures:

Substructure - M35 (minimum)
Superstructure PSC - M45
Superstructure Steel Composite - M35/M40

4.1.2  Poisson’s Ratio

Poisson’s ratio for uncracked concrete shall be taken as 0.2 and for cracked concrete as per relevant clause of IRC 112.

4.1.3  Thermal Expansion Coefficient

\( a = 12.0 \times 10^{-6} / ^\circ\text{C} \) as per relevant clause, IRC 6.

4.2  Reinforcement

Thermo-mechanically treated bars of grade 500D conforming to IS: 1786 will be adopted.
4.3 Structural Steel for Structural Steel (conforming to IS: 2062) Preferably high grade steel is to be used.

5.0 Design Load

5.1 Superimposed Dead Loads

Wearing Coat

Total weight of wearing coat for design purpose shall be considered as 2.0kN/sq.m.

Crash Barrier

Vehicular Crash Barriers on both sides of the carriageways shall be provided as per IRC specification. The cross-sectional area of the cast-in-situ crash barrier works out to be 0.4 m².

Hand railing

R.C.C wall type hand railing on ends of both sides of the carriageway shall be provided. The cross-sectional area of the hand railing works out to be 0.4 m².

5.2 Live Loads

The live load on carriageway shall be considered as per IRC: 6 according to the width of the carriageway.

5.3 Longitudinal Forces

As per relevant clause of IRC: 6, bridge structural elements shall be designed for longitudinal forces arising due to Tractive Effort, Braking Force and Frictional Resistance offered to movement of free bearings.

5.4 Centrifugal Forces

For the road bridges situated on a curve, centrifugal forces shall be calculated as per the provisions as per relevant clause of IRC: 6.

5.5 Earth Quake Loads

The seismic analysis shall be carried out in accordance with relevant clause of IRC: 6-2014.

5.6 Vertical Seismic Force

The vertical seismic shall not be considered in zone III as per relevant clause of IRC: 6. However for stability check and bearing design vertical seismic shall be considered as per relevant clause of IRC 6.

5.7 Seismic Combinations

As per relevant clause of IRC: 6, the seismic combinations shall be taken. Seismic arrestors shall be provided as per relevant clause of IRC-6.

5.8 Wind Loads
Wind Load shall be computed as per relevant clause of IRC: 6.

### 5.9 Earth Pressure Forces

Earth pressure forces are calculated as per the provisions of relevant clause of IRC:6. Live load surcharge shall be considered as per the provisions of relevant clause of IRC:78 i.e. equivalent of 1.2m height of fill.

### 5.10 Temperature

As per the maximum and minimum temperature Isopleths figures are given in relevant clause of IRC: 6.

### 5.11 Vehicle collision Load

Vehicle collision load shall be considered as per relevant clause in IRC: 6, the vehicle collision load shall not be considered for abutments or on the structures separated by a minimum distance of 4.5m from the edge of the carriageway.

### 6.0 LOAD COMBINATION

The various load combinations are considered as per relevant clause of IRC: 6. All members shall be designed to sustain safely the IRC critical combination of various loads and forces that can coexist. Various load combinations as specified in Annexure B of IRC-6 with relevant load factors and increase in permissible stresses shall be considered in the design as per IRC: 6, IRC:22, IRC:24 and IRC:78.

### 6.1 Ultimate Limit State (For Verification of Structural Strength)

Loads are required to be combined to check the equilibrium and the structural strength under ultimate limit state. The equilibrium of the structure shall be checked against overturning, sliding and uplift. It shall be ensured that the disturbing loads (overturning, sliding and uplifting) shall always be less than the stabilizing or restoring actions. The structural strength under ultimate limit state shall be estimated in order to avoid internal failure or excessive deformation. The equilibrium and structural strength shall be checked under basic, accidental and seismic combination of loads.

Under Ultimate limit state, structural strength for the following load combinations are required to check to avoid internal failure and excessive deformation.

<table>
<thead>
<tr>
<th>Service Stage</th>
<th>Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- DL+SIDL+LL(leading)</td>
</tr>
<tr>
<td></td>
<td>- DL+SIDL+LL(accompanying)+WL(leading)</td>
</tr>
<tr>
<td></td>
<td>- DL+SIDL+LL(accompanying)+Seismic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construction stage</th>
<th>Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- DL+SIDL+WL+ construction LL</td>
</tr>
<tr>
<td></td>
<td>- DL+ SIDL+ Seismic + construction LL</td>
</tr>
</tbody>
</table>

Load factors to be considered for the above load combinations have been given in table 2.

<table>
<thead>
<tr>
<th>Limit State</th>
<th>Loads</th>
<th>Symbol</th>
<th>Basic Comb</th>
<th>Seismic Comb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead Load</td>
<td>DL</td>
<td>1.35</td>
<td>1.35</td>
<td></td>
</tr>
</tbody>
</table>
6.2 Serviceability Limit State

Loads are required to be combined to satisfy the serviceability requirements. The serviceability limit state check shall be carried out in order to have control on stress, deflection and crack width. The Rare combination of loads shall be used for checking the stress limit. The Frequent combination of loads shall be used for checking deflection. For crack width calculation quasi permanent load combination shall be considered for Prestressed with unbounded tendons & RCC member, and frequent combination will be used for prestressed members with bonded tendons.

The permissible stresses for prestressing and reinforcement shall be considered as per chapter 12 of IRC: 112.
Checklist of Soil Exploration for Substructure

Type of Foundation:

(A). Open foundation:

1. Make a Single borehole for each pier of depth in the range of 20.0mtrs to 25.0mtrs and also carry out SPT for guidance regarding soil parameters.

2. Decide the depth for provision of the Open Foundation on the basis of the soil strata study obtained from the Bore Log.

3. Check the bearing capacity at the decided depth at the site by PLATE LOAD TEST.

4. Fix the bearing Capacity based on the results of the Plate load test and submit the design for the open foundation, for the approval by Northern Railway Design Office.

(B). Pile Foundation:

1. Make Boreholes for each pier of depth in the range of 25.0mtrs to 35.0 mtrs.

2. Undertake SPT and a detailed soil properties analysis to determine the depth and capacity of the pile

3. Submit the soil report along with the design of the INITIAL TEST PILE for approval of the initial test pile and the pile capacity.

4. Testing of initial test pile for VERTICAL LOAD & LATERAL LOAD TEST.

5. Submission of the test results to the Design Office of Railway for the finalization of pile load capacity and the pile group.

** NOTE – All the tests shall be performed as per relevant IS codes.
### Checklist for Submission of ROB Design

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
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<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
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</tbody>
</table>

- Design basis report of the bridge stating the salient features of bridge i.e span, skew angle span arrangements, longitudinal eccentrics, depth of girders, type of superstructure R.C.C., PSC, composite, type of bearings arrangement with sketch showing fixed/free ends, curvature if any and the details of parameters codes, load combinations cases, wind, seismic zone etc. duly proof checked by IITs, NIT/approved consultants for this purpose before submitting the detail design.

- Soil report of the railway bridge site with bore hole at each railway pier and abutment location and also shown on sketch showing the bore holes locations w.r.t to pier/abutment positions. The recommendations of the soil consultant for the open foundation/pile foundation if applicable clearly stating the pile length with safe loads for two three alternates.

- The feasibility of the structure or components must be checked in all respects by field unit before submitting the design to this office and signed by the field unit and authorized signatories of NHAI.

- The drawing must be submitted in preferably A-I size only in prescribed/standard format.

- The design/drawing of the test pile is to be submitted if applicable for the approval as per the codal provisions duly proof checked by IITs INIT/approved consultants.

- The combinations for the various loads with partial safety factors as per the IRC 6 for ULS as well as SLS, are to be prepared as defined/approved in the design basis report. The ductile detailing of the pier/wall should be done as per the IRC- 112-2011.

- The software/staad files hard copy as well as soft copy must be submitted with the design note used in design for help in checking the design.

- PSC Superstructure has to be as per IRC-112.

- Composite Superstructure has to as per IRC-24.

- Stress summary should be prepared for each component of the bridge i.e. pile or open foundation as applicable, pile cap/foundation slab and beam, pier, pie cap, stating the actual stresses vs permissible stresses or steel provided vs steel required.
A certificate from the proof checking agency on his letter head stating that the design and drawing of the bridge has been checked by me and found in order as per the latest IRC codal provisions.

**Format – D**

### QAP for Concrete work in Bridge Construction

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item of Check</th>
<th>Characteristic Check</th>
<th>Reference document</th>
<th>Inspection Detail</th>
<th>Extent of Inspection</th>
<th>Type of Record Maintained</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Field Lab Setup</td>
<td>Equipments:</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>- Sieve set for coarse aggregate.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Sieve set for fine agg.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Digital weighing machine.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Electric oven.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Cube moulds 150 x 150 x 150 mm.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>- Slump core.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Silt measuring jar.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Specific gravity meter.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Cube testing machine.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Water measuring pans from ½ ltr to 5 ltr capacity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Materials
<table>
<thead>
<tr>
<th>A. Cement</th>
<th>Rly.</th>
<th>B. Coarse Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rly. 100 % Weigh ing slips origi nal bills. Test repor ts</td>
<td>IS- 8112 for OPC 43 grad e. IS- 269 for 33 grad e IS- 1226 9 for 53 grad e IS- 1489 for PCC .</td>
</tr>
<tr>
<td>B. Coarse Aggregate</td>
<td>Contra ct/ Rly. Engine er 100 % 100 % Test on change of sou rce. -- Grad ing regis ter. Lab repor ts. -- do— -- do— --do—</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS 383 Tabl e-2. --do- --do— (Separ ately for 20 mm &amp; 100 mm)</td>
</tr>
</tbody>
</table>

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413
### C. Fine Aggregate

- Deleterious materials.
- Water absorption
- Grading zone.
- Silt contents.
- Specific gravity.

<table>
<thead>
<tr>
<th>Contra ctor Rly.</th>
<th>100 %</th>
<th>IS 383 Table 4.</th>
</tr>
</thead>
</table>

### D. Admixtur e

- Brand as recommended in design mix.
- Specific gravity.
- Date of manufacturing.
- Lab Tests:-
  - Solid contents.
  - Ash contents.
  - Relative density.
  - Chloride contents.
  - PH value.
  - Compatibility test with cement.

<table>
<thead>
<tr>
<th>Contra ctor Railway.</th>
<th>100 %</th>
<th>Man ufact ures speci ficati on repor t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contra ctor</td>
<td></td>
<td>To be compared with manufact ures specifications.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS 9103</td>
</tr>
</tbody>
</table>

- Origin al challen.
- To be check ed.
- As per manufact ures certifi cate.
- Lab report s.
- -do-
- -do-
- -do-
- -do-

<table>
<thead>
<tr>
<th>Lab test value.</th>
<th>100 %</th>
<th>Lab report s.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To be measured.
To be measured.
| E. Steel Reinforcement | • Manufacture (SAIL). | • Manufacture's test report. | 100% | 100% |
| | • Condition of rust, oil, paint etc. | • Weighment slip. | Lab report in file | |
| | • Physical appearance. | • Origin al bill. | 100% | 100% |
| | • Binding wire. | Approve d labs report. | | As per IS 1786. |
| | • Cover blocks. Lab tests:- | | | |
| | • Mechanical proportions. | • Mechanical proportions. | | |
| | • Yield strength. | • Yield strength. | | |
| | • Elongation. | • Elongation. | | |
| | • 0.2% proof stress. | • 0.2% proof stress. | | |
| | • Bond test. | • Bond test. | | |
| | • Rebound test. | • Rebound test. | | |
| | • Chemical analysis. | • Chemical analysis. | | |

| F. Water | Lab tests | -do- | - | - | -do- | IS 3025. |
| | | | | | | |
| 3. Shuttering | • Staging. | As per design/drg. | Contra ctor Railwa y | 100% | 100% |
| | • Thickness of plates. | Code for swelling | | |
| | • Alignment. | As per IS 456. | | |
| | • Level. | To be checked as per drgs. with steel tape. | | |
| | • Joints for water tightness. | | | |
| | • Surface. | | | |
| | • Shuttering oil. | | | |

| 4. Production of concrete | | | | |
| A. RMC (Approval of Plant) | • Plant Setup. | -- | Rly. | 100% | Batchin g slips aggreg ate test reports. | IS-4926 2003. |
| B. Site production. | Batching plant. Daily working:-  
Weigh batcher.  
Water contents.  
Admixture.  
Moisture adjustment.  
Measurement of slump. | To be inspected & approval to be given. Rly.  
Contractor Rly (SSE/W)  
XEN/AEN/C  
Dy. CE/C | 100% (initial) in between frequently 100% 100% (on every visit) 10% |
|---------------------|---------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| c. Approval of trial mix and design mix | approver to be given. Rly.  
Contractor Rly (SSE/W)  
XEN/AEN/C  
Dy. CE/C | 100% | IS 10262(2009) |
<table>
<thead>
<tr>
<th>S.N</th>
<th>Componen/</th>
<th>Characteristic</th>
<th>Type of Check</th>
<th>Documents</th>
<th>Fabrication Q/C</th>
<th>Inspection Details</th>
<th>Format of Record</th>
<th>Acceptance Norm</th>
<th>Signature and Remarks (if any)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t/</td>
<td>Check</td>
<td></td>
<td></td>
<td>Verification of documents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td></td>
<td></td>
<td></td>
<td>TPI/RLY</td>
<td>100 %</td>
<td>Fabrication records</td>
<td>IS:2062</td>
<td>Grade - B</td>
</tr>
<tr>
<td></td>
<td>Raw Material</td>
<td>Steel Plates</td>
<td>Structural Section</td>
<td>a) Identification &amp; correlation with mill test certificate from supplier</td>
<td>Challan, Mill Test Certificate</td>
<td>As per Mill TC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Steel Plates</td>
<td>Structural</td>
<td>Section</td>
<td>b) Physical Condition - Pitting, Rusting, Straightness, Rolling defects etc.</td>
<td>Mill test certificate</td>
<td>As per mill TC</td>
<td>Complete visual inspection</td>
<td>TPI/RLY</td>
<td>100 %</td>
</tr>
<tr>
<td>1.1</td>
<td>Steel Plates</td>
<td>Structural</td>
<td>Section</td>
<td>c) Mechanical test - UTS, Yield stress elongation, % reduction area impact &amp; bend test.</td>
<td>Lab test at fabricator works shop &amp; manufacturer’s Test Certificate</td>
<td>Challan, manufacturer’s Test Certificate</td>
<td>TPI/RLY</td>
<td>Random per lot</td>
<td>Inspection of inspection officials and fabricators records</td>
</tr>
<tr>
<td></td>
<td>d) Chemical Test Max C, Mn, Si, P, Cr, Cu, Co Equivalent</td>
<td>Independent Lab Test &amp; manufacturer test Certificate</td>
<td>Challan, manufacturer’s Test Certificate</td>
<td>TPI/RLY</td>
<td>Random per lot</td>
<td>Inspection of inspection officials and fabricators records</td>
<td>IS:2052</td>
<td>IS:228</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e) Ultrasonic Test - for plates</td>
<td>Lab test at fabricator works shop &amp; manufacturer’s Test Certificate</td>
<td>Challan, manufacturer’s Test Certificate</td>
<td>TPI</td>
<td>100 % for plates above 12 mm &amp; 50% for plates 12 mm or less</td>
<td>Inspection of inspection officials and fabricators records</td>
<td>IS:2052</td>
<td>IS:8500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>f) Dimensional</td>
<td>Measurement</td>
<td>Challan</td>
<td>Measuremen t of Dimensions</td>
<td>TPI</td>
<td>100 %</td>
<td>Fabricator records</td>
<td>IS:1852</td>
<td></td>
</tr>
</tbody>
</table>
### 1.2 HSFG Bolts, Nuts & Washers

<table>
<thead>
<tr>
<th>a) Dimensions as specifications</th>
<th>Visual / measurement</th>
<th>Challan, Manufacturer's Test Certificate</th>
<th>Verification of reference document &amp; measurement</th>
<th>As per requirement</th>
<th>IS:3757 IS:6623 IS:6649</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) Mechanical Test, Tensile strength, hardness, Impact test, Decarburization &amp; Surface Integrity test</td>
<td>Lab test at Independent Laboratory &amp; manufacturer test Certificate</td>
<td>Challan, Manufacturer's Test Certificate</td>
<td></td>
<td>Random per lot 0.5 %</td>
<td>Inspection of Inspection officials and fabricator records IS:1367</td>
</tr>
<tr>
<td>c) Chemical Test - Min. &amp; Max. P/s</td>
<td>Independent Lab Test &amp; manufacturer test Certificate</td>
<td>Challan, manufacturer's Test Certificate</td>
<td></td>
<td>Random per lot 0.5 %</td>
<td>Inspection of Inspection officials and fabricator records IS:1367</td>
</tr>
</tbody>
</table>

### 1.3 Welding electrodes / wire flux etc

<table>
<thead>
<tr>
<th>As per Specification</th>
<th>Any test as required</th>
<th>Challan, manufacturer's Test Certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Test Tensile &amp; Bend</td>
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</table>

### 2 Manufacturing Process

#### 2.1 Layout of Components & Joints

<table>
<thead>
<tr>
<th>a. Nominal</th>
<th>Dimensions</th>
<th>Measurement with steel tap and gauges</th>
<th>Approved Drawings</th>
<th>Measurement of dimensions</th>
<th>Authorized Inspecting agency</th>
<th>100%</th>
<th>Inspection of inspection officials</th>
<th>Relevant IS code and approved drawings</th>
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</thead>
<tbody>
<tr>
<td>b. Camber</td>
<td>Dimensions</td>
<td>Measurement with tested steel tap and gauges</td>
<td>Approved Drawings</td>
<td>Measurement of dimensions</td>
<td>Authorized Inspecting agency</td>
<td>100%</td>
<td>Inspection of inspection officials</td>
<td>Relevant IS code and approved drawings</td>
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</tr>
<tr>
<td>c.</td>
<td>Master (Replica of Jig)</td>
<td>Dimensions intersection lines, pitch gauge, Dia of holes and no. of holes</td>
<td>Measurement with tested steel tap and gauges</td>
<td>Approved Drawings</td>
<td>Measurement of dimensions</td>
<td>Authorized Inspecting agency</td>
<td>100%</td>
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<td>Inspection of inspection officials</td>
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<td>Relevant IS code and approved drawings</td>
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<tr>
<td>d.</td>
<td>Jigs template and fixtures</td>
<td>Dimensions intersection lines, pitch gauge, Dia of holes and no. of holes</td>
<td>Measurement with tested steel tap and gauges</td>
<td>Approved Drawings</td>
<td>Measurement of dimensions</td>
<td>Authorized Inspecting agency</td>
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<td>Record of jigs and fixtures as per performa issued by RDSO</td>
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<td>Relevant IS code and approved drawings</td>
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<tr>
<td>2.2</td>
<td>Cutting straightening edge preparation and milling</td>
<td>Dimension freedom from defects</td>
<td>Visual / measurement</td>
<td>Inspection of Inspection Officials and fabricator records</td>
<td>Authorized Inspecting agency</td>
<td>Random</td>
<td>Inspection of inspection officials and fabricator drawings</td>
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<td>Relevant IS code and approved drawings</td>
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<td>2.3</td>
<td>Welding</td>
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<tr>
<td>a.</td>
<td>Submission of WPS</td>
<td>Review of WPS</td>
<td>Visual / measurement</td>
<td>IS : 9595, AWSD 1.1 IS : 817</td>
<td>Verification of docs.</td>
<td>Authorized Agency</td>
<td>100%</td>
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<td>IS:9595, AWSD 1.1 IS:817</td>
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<td>b.</td>
<td>WPQR</td>
<td>Witness as per established WPS</td>
<td>Welding and DT / NDT test at approved lab</td>
<td>Approved WPS</td>
<td>Verification of docs.</td>
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<td>IS:7310, Part-1/ASME Sec-IX</td>
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<tr>
<td>c.</td>
<td>Inspection &amp; welding i.e. after welding</td>
<td>a) visual Inspection, fillet size, leg length</td>
<td>Visual, DP test, Macro/etching test</td>
<td>Approved Drawings &amp; WPS</td>
<td>Visual inspection</td>
<td>Authorized Agency</td>
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<td></td>
<td>Approved drawings</td>
<td></td>
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<tr>
<td></td>
<td>b) NDT at all butt welds</td>
<td>USFD test</td>
<td>IS : 3600</td>
<td>Witness of test</td>
<td>Authorized Agency</td>
<td>100%</td>
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<td>As per IS:4260 IS:3600/A SME Sec-V, VIII</td>
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<td>Drilling works for Bolting</td>
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<tr>
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<td>Dimensions</td>
<td>Measurement</td>
<td>Approved Drawings</td>
<td>Random checking of dimension by measurement</td>
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<td>Drilling through approved Jigs</td>
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<td>Relevant IS code and approved drawings</td>
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<td></td>
<td>Visual</td>
<td>Visual</td>
<td>IS Code and contract agreement</td>
<td>100 % visual check on paint applications</td>
<td>Authorized Agency</td>
<td>Random</td>
<td>Fabricator records</td>
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<tr>
<td>b.</td>
<td>Application of paint on hidden surfaces</td>
<td>Visual</td>
<td>Visual</td>
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<td>Relevant IS code and approved drawings</td>
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<thead>
<tr>
<th></th>
<th>Painting work</th>
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<tbody>
<tr>
<td>a.</td>
<td>Sand blasting</td>
<td>Procedure</td>
<td>Random checking of dimension by measurement</td>
<td>Authorized Agency</td>
<td>Random</td>
<td>Fabricator records</td>
<td>As per IRC-24a</td>
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<tr>
<td>b.</td>
<td>Dry film thickness</td>
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<td></td>
<td>Primer – 1 coat</td>
<td>Finish – 1 coat</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Shop assembling work</th>
<th></th>
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<tbody>
<tr>
<td>a.</td>
<td>Shop assembling work</td>
<td>Fill up of members</td>
<td>Visual</td>
<td>Approved drawings</td>
<td>Visual check on paint applications</td>
<td>Authorized Agency</td>
<td>Random</td>
</tr>
<tr>
<td>b.</td>
<td>Dimensions</td>
<td>Measurement</td>
<td>Approved drawings</td>
<td>Visual check on paint applications</td>
<td>Authorized Agency</td>
<td>Random</td>
<td>Inspection of Inspection officials</td>
</tr>
<tr>
<td>c.</td>
<td>WQR</td>
<td>Witness of welder test</td>
<td>Welding and DT / NDT test at lab</td>
<td>As per code requirement</td>
<td>Verification of docs. and test reports</td>
<td>Authorized Agency</td>
<td>100 %</td>
</tr>
</tbody>
</table>

2.4 NDT of Critical fillet welds Web # flange

2.5 IS.3658 Witness of test

3.0 Authorized Agency 100% DP test report

As per IS:3658
### 4 Welding Operation

<p>| | | | | | | |</p>
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<tr>
<td>a.</td>
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<tr>
<td>i)</td>
<td>Current conditions</td>
<td>Measurement of Amperage and electrode</td>
<td>Visual with Ammeter and Voltmeter</td>
<td>AS per PQR</td>
<td>Verification of docs. and test reports</td>
<td>Authorized Agency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To control distortions</td>
<td>Visual and Measurement</td>
<td>AS per approved PQR</td>
<td>Verification of docs. and test reports</td>
<td>Authorized Agency</td>
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<tr>
<td>b.</td>
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<tr>
<td>ii)</td>
<td>Sequence of welding</td>
<td>E-7018 TC</td>
<td>Baking</td>
<td>Maintain Document</td>
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<td></td>
<td>MIG Wire</td>
<td>TC</td>
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<tr>
<td>c.</td>
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# CONCRETE POUR CHECKLIST

<table>
<thead>
<tr>
<th>1. Preliminary</th>
<th>Y</th>
<th>N</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>a) Description</td>
<td></td>
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</tr>
<tr>
<td>b) Lot Number/s</td>
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<tr>
<td>c) Previous Lots Conform</td>
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<tr>
<td>d) Casting Program Accepted</td>
<td></td>
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<tr>
<td>e) Curing Method</td>
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<table>
<thead>
<tr>
<th>2. Formwork and False work</th>
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</thead>
<tbody>
<tr>
<td>a) Formwork Dimensions in Accordance with design</td>
<td>Y</td>
<td>N</td>
<td>REMARKS</td>
</tr>
<tr>
<td>b) Forms Clean, Smooth and Watertight and Free of deleterious material</td>
<td></td>
<td></td>
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<tr>
<td>c) Formwork within Dimension Tolerances</td>
<td></td>
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<tr>
<td>d) Forms Meet Line and Level Requirements</td>
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<table>
<thead>
<tr>
<th>3. Reinforcing Steel</th>
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</thead>
<tbody>
<tr>
<td>a) Steel Located/Fixed in Accordance with drawings</td>
<td>Y</td>
<td>N</td>
<td>REMARKS</td>
</tr>
<tr>
<td>b) Reinforcing Clean and Free of Deleterious materials</td>
<td></td>
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<tr>
<td>c) Critical Cover Checked at all locations</td>
<td></td>
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<tr>
<td>d) All Splices to Reinforcement at Approved locations</td>
<td></td>
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<tr>
<td>e) All Welds in Accordance with INDIAN CODES</td>
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<thead>
<tr>
<th>4. Concrete Delivery</th>
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<tbody>
<tr>
<td>a) Number of Batches</td>
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</tr>
<tr>
<td>b) Batch Time (From Delivery Docket)</td>
<td></td>
<td></td>
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<tr>
<td>c) Arrival Time at Site</td>
<td></td>
<td></td>
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<tr>
<td>d) Finish Time</td>
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<thead>
<tr>
<th>5. Concrete Testing</th>
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<tbody>
<tr>
<td>a) Approved Testing Authority Name:</td>
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<tr>
<td>b) Ambient Temperature</td>
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</tr>
<tr>
<td>c) Actual Concrete Temperature</td>
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<tr>
<td><strong>d)</strong> Target Slump/. Actual Slump</td>
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<tr>
<td><strong>e)</strong> Amount of Admixture added</td>
<td></td>
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<tr>
<td><strong>f)</strong> Amount of water added</td>
<td></td>
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<td></td>
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<tr>
<td><strong>g)</strong> Number of Cubes sample Taken</td>
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</tr>
<tr>
<td><strong>h)</strong> Target Strength</td>
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### 6. Concrete Placement

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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>a)</strong> Placement Method (Pump, Tremie, others)</td>
<td></td>
</tr>
<tr>
<td><strong>b)</strong> Sufficient Personnel for Finishing etc.</td>
<td></td>
</tr>
<tr>
<td><strong>c)</strong> Approved Vibration Method</td>
<td></td>
</tr>
<tr>
<td><strong>d)</strong> Back up Vibrators on Hand</td>
<td></td>
</tr>
<tr>
<td><strong>e)</strong> Reinforcement Cover Maintained During Pour</td>
<td></td>
</tr>
<tr>
<td><strong>f)</strong> Formwork Stable During Placing and Vibration</td>
<td></td>
</tr>
<tr>
<td><strong>g)</strong> Concrete Placed and Compacted Within (time in minutes)</td>
<td></td>
</tr>
<tr>
<td><strong>h)</strong> Forms Free of Foreign Matter Prior to Pouring</td>
<td></td>
</tr>
<tr>
<td><strong>i)</strong> Concrete Finished to Approved Tolerances</td>
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**Checklist for Girder Fabrication**

<table>
<thead>
<tr>
<th>Item</th>
<th>Y/N</th>
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<tbody>
<tr>
<td>Calculate the quantity of steel plates Angles &amp; channel as per approved drawing.</td>
<td></td>
</tr>
<tr>
<td>Procurement of steel plate Fe 250 Gr-B or any other specified grade, from Primary Manufacture as per specifications.</td>
<td></td>
</tr>
<tr>
<td><strong>Follow all the checks on the raw materials, Structural steel plates, HSFG Bolts nuts n washers, electrodes as per the QAP.</strong></td>
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</tr>
<tr>
<td>Visually check all steel plates, angles &amp;channel</td>
<td></td>
</tr>
<tr>
<td>Stack the procured material on a plane surface.</td>
<td></td>
</tr>
<tr>
<td><strong>Layout of Components &amp; Joints, Jigs template and fixtures, Cutting straightening, edge preparation and milling as per the QAP.</strong></td>
<td></td>
</tr>
<tr>
<td>Grinding all surface of plate and Clean the work surface by removing loose scales, rust, oil, dirt, paint, etc.</td>
<td></td>
</tr>
<tr>
<td>Cutting steel plates as per approved drawing.</td>
<td></td>
</tr>
<tr>
<td>Preparing all templates for gusset plate, splice plates.</td>
<td></td>
</tr>
<tr>
<td>Fixing plates or stiffeners at right angles or angles as per drawing.</td>
<td></td>
</tr>
<tr>
<td>Tack welding plates by electric arc welding.</td>
<td></td>
</tr>
<tr>
<td>To place the tacked plate/girder part on the welding frame.</td>
<td></td>
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</tbody>
</table>
Checklist for SAW (Submerged Arc Welding)

<table>
<thead>
<tr>
<th>Item</th>
<th>Y/N</th>
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</thead>
<tbody>
<tr>
<td>Travel speed of trolley- (Most important variables affecting penetration and welding size).</td>
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<tr>
<td>Voltage</td>
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<tr>
<td>Wire feeding speed</td>
<td></td>
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<tr>
<td>Current rating</td>
<td></td>
</tr>
<tr>
<td>Use of extension piece at start and end of welding to achieve full welding size throughout the length.</td>
<td></td>
</tr>
<tr>
<td>Very high speed, decreases penetration and increase tendencies for under-cut, arc below, porosity.</td>
<td></td>
</tr>
<tr>
<td>Very slow speed, produces bead shape that are subjected to cracking, excessive open area exposure for the welding operator rough bead &amp; slag inclusion.</td>
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<tr>
<td>Electrodes checked</td>
<td></td>
</tr>
<tr>
<td>Distance between contact tip to base metal</td>
<td></td>
</tr>
<tr>
<td>Welding head which feeds flux and filler material (electrode) to the welding joint, whether Ok or not.</td>
<td></td>
</tr>
<tr>
<td>Flux hopper which stores flux and controls the rate of flux deposition on the welding joint whether ok or not</td>
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</tbody>
</table>

Note-The design parameters for welding to be provided by NHAI and to be checked by Field Deputy Chief Engineer. Checklist for MIG (Submerged Arc Welding)

<table>
<thead>
<tr>
<th>Item</th>
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<td>Electrode wire dia</td>
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<td>Current</td>
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<td>Arc voltage</td>
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<td>Wire feeding speed</td>
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<td>Travel speed manual</td>
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<tr>
<td>Shielding gas flaw rates</td>
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<tr>
<td>After completing the welding, the assembled girder part is lifted and placed to some other place.</td>
<td></td>
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</tbody>
</table>
Note-The design parameters for welding to be provided by NHAI and to be checked by Field Deputy Chief Engineer.

**CHECKLIST FOR GIRDER ASSEMBLY**

<table>
<thead>
<tr>
<th>Item</th>
<th>Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>After completion of tests on all the girder parts we shall begin the girder assembly.</td>
<td></td>
</tr>
<tr>
<td><strong>Drilling through approved Jigs and painting of hidden parts as per QAP</strong></td>
<td></td>
</tr>
<tr>
<td>Drill in web, top &amp; bottom flange end of girder part as per drawing.</td>
<td></td>
</tr>
<tr>
<td>Clean surface and apply one primer coat and one coat of painting.</td>
<td></td>
</tr>
<tr>
<td>Girder parts assembled on a plane platform and checked vertically and horizontal in plane.</td>
<td></td>
</tr>
<tr>
<td>All girder pieces assembled and jointed by splice plates as per drawing by HSFG bolt and the bolts tightened.</td>
<td></td>
</tr>
</tbody>
</table>
SAFETY PRECAUTIONS AND MEASURES TO BE OBSERVED DURING EXECUTION OF ROB WORKS IN RAILWAY AND ADJOINING AREAS.

1. Construction Activities and Safety:

   (a) The ‘Methodology of Working’ shall be incorporated in GAD and Temporary Arrangement Drawings.

   (b) The activities of work to be taken up during the Railway traffic block/under speed restriction etc. should be clearly mentioned in such drawings.

   If at any stage of execution, any discrepancy is found in the drawing with respect to the site condition affecting safety or some new activity of work is required to be done, the same should be brought to the notice of Railway Engineer and such works should be done only after approval by Railways. In such cases, scheme may be modified and if required fresh CRS sanction shall have to be obtained.

1.1. The works required to be done under traffic block protection, are to be carried out only in the presence of Railway Engineering officials. The Railways supervisor has to certify safe conditions for passage of trains before resumption of traffic.

   The works to be done under traffic shall be carried out under provision of the presence of banner flag and protection of engineering flagman. If considered necessary, the Railway flagman may be posted on account of the contractor.

2. Following important activities of works shall be carried out under supervision of 9 Railways nominated Supervisor:

   a) Excavation at foundation/Ground level near to Railway track.

   b) Concrete casting and/or masonry very close to Railway track.

   c) Erection of temporary structures near to running lines.

   d) Casting of structures like girder/slab over Railway track.

   e) Stage-Pre-stressing of girders when placed across Railway tracks properly supported.

   f) Launching of precast/pre-assembled girders across Railway tracks.

   g) Any work of lifting, side shifting and slewing of girders over the Railway track.

   h) Dismantling of temporary structures, shutters, scaffolding etc. adjacent to and above the Railway track.

3. For carrying out activities of casting, erection, launching, handling and dismantling as listed above, the Contractor’s Engineering shall furnish the Construction Programme in advance to Railway Supervisor Engineer. No such work should be taken up in absence of the Supervising Railway Engineer. For the activities which are to be done in presence of the Railway
Engineer, prior intimation shall be given in writing and acknowledgement obtained from Railway's representative. Such activities of work shall not be carried without the presence of Railway Engineer.

4. To ensure 'Safety' during construction activities, Railway Engineer may direct the Contractor/Supervisor Engineer or their nominated representative for safe working procedures/instructions, notwithstanding the contractual or MOU conditions prevailing between/amongst Railways/other departments like NHAI/Contractors/Concessionaire.

All the records of Quality Assurance/Quality control, testing of the materials and satisfactory completion of an activity shall be maintained as site by the contractor's Engineer and Supervising Engineers. On the basis of these records, Railways' Engineer shall do stage-wise clearance of the works at following stages:

i. Completion of foundation
ii. Completion of substructure
iii. Completion of superstructure

Without such stage clearance, the work in next stage of construction shall not be allowed by the Railway Supervisor, unless proper system of check and exercise is followed at the site.

5. Normally, the high beam PSC girders are designed with wider top flange and shorter bottom flange with very high beam which makes the girder unsuitable during lowering, slowing and launching time.

6. During launching of girders and subsequent adjustments for placement of bearing special attention and precautions are required at site to be followed rigorously without resorting to shortcut practices or leaving the work at site to untrained or inexperienced engineers. Normally, end diaphragms are not casted for the extreme both side girders. These shall to be casted min. 300mm. on both sides for all 'I' beam girders to provide temporary supports for ensuring stability.

Or

For side adjustments and bearing placements below 'I' section girders, end brackets made of steel angles should be provided for all 'I' beams sequentially to avoid side tilting of individual girders. End brackets shall be removed only after placing girders on bearing and casting of diaphragms.

7. During lowering, the jacks shall be operated duly keeping wooden packing of various thicknesses fixing the amount of lowering to the barest minimum, so that even if the jack fails, the wooden packing will take load and further stability of girder is not endangered.

8. Temporary crib support staging shall be interlaced with clamps and angles. Adequate base width shall be maintained in proportionate to the height of stage, which is very essential for avoiding the oblong effect during launching of girders. During launching by RH girder method the movement of the PSC girders shall be controlled both from front and rear with synch mechanism having simultaneous operation, so that the speed of the launching is always under the control. Spare hydraulic jacks shall always be kept at side.

Lowering of girder shall always be carried out at one end only. Further, other end should be adequately secured by wire ropes, end brackets, etc. Thereafter, the alternate process shall be continued.
9. As far as possible launching of girders by temporary staging shall be avoided, and launching by heavy capacity cranes, wherever feasible, shall be adopted.

10. Steel girder launcher if used for launching of PSC girders, should be pre-tested for the critical loading (likely to be encountered during actual launching) before deployment on the approaches regarding its strength as well as amount of permissible deflection using actual test PSC girder as a testing load. Connections at supports shall be inspected and certified prior to actual launching, it shall be adequately secured to the base support system on the pier cap.

2. General Construction Safety:

2.1. General Safety Precautions as applicable for bridge/civil works shall be adopted in field.

2.2. Working near running line: Safe practices at site and at all times non-infringement to moving trains shall be ensured. Road vehicles, material trolleys, dollies with any tendency to roll off towards the running lines to be checked by providing chains, locking arrangements, blocks etc. shall be ensured and the site in charge of the Contractor shall be primarily responsible, secondary responsible being of Supervisor’s Consultant.

2.3. Testing of cranes, lifting jacks and other equipment’s. All equipment’s like cranes, lifting jack shall be tested, duly calibrated and certified prior to use at construction site.

2.4. Construction workers at site shall be provided with personal safety gear like reflective vest, helmet, leather shoes, gloves, eye-wear-approved as per construction industry standards. For persons working at pier top/girder level, temporary supports, hand railing, protection with help of ropes, slings and temporary railings shall be provided.

2.5. Routine Safety Checks, validity of test certificates for load bearing equipment’s especially for cranes outsourced from third party shall be ensured prior to deployment.

10.3 Annexures:

<table>
<thead>
<tr>
<th>10.3 Annexures:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Annexure - 10.01 - Guidelines for GAD</td>
</tr>
<tr>
<td>(ii) Annexure- 10.02 -Procedure for approval for GAD of ROB/RUBs</td>
</tr>
<tr>
<td>(iii) Annexure- 10.03 – Barrel length of precast RCC box bridges (LHS/RUB) by cut and cover method</td>
</tr>
<tr>
<td>(iv) Annexure - 10.04 – Construction of LHS by cut and cover method</td>
</tr>
<tr>
<td>(v) Annexure - 10.05 – Estimate for ROBs</td>
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<td>(vi)</td>
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<td>(vii)</td>
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<tr>
<td>(viii)</td>
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<td>(ix)</td>
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</tbody>
</table>
Annexure-10.01

NORTHERN RAILWAY

Headquarter Office,
Baroda House, New Delhi,

Dated: 11.09.2013

No. 260-W/969/GAD Progress/Br./S & D

Sr. DEN/C/DLI, MB, FZR, UMB & LKO

Sub: Guidelines for GAD

Rly. has been entrusted with the construction of a large no. of ROB. It has been observed that GAD being prepared by the field units has numerous deficiencies which is causing delay in approval / finalization of GAD. Some of these deficiencies are listed below for general guidance:

1. Railway land is a very scarce resource and therefore, it is of paramount importance to utilize the available railway land most optimally. First and foremost, the railway boundary should be correctly indicated, after due verification, in the GAD. It is desirable to avoid locating piers / abutment, (including foundation) inside the railway land by selecting suitable spans.

2. Alignment of ROB should preferable be at right angle to the track / railway land. If this is not possible then the skew angle should be minimum.

3. General arrangement and lay out to be shown along with dimensions and clearances. Design details should not be part of GAD. The design of girders, piers, foundation, abutment etc. should be carried out separately considering the prevalent site conditions, so that cost / design are optimized.

4. Mention of consultant / concessionaire name etc. on the GAD should be avoided.

5. Size of the drawing should be A-1 with standard signature template.

6. GAD should be prepared on Auto CAD.

7. Instructions circulated by Rly. Board / N.Rly. like provision of stair case, service lane, pedestrian footpath etc. should be included in the GAD.

8. Check list has also been pruned down and revised check list is enclosed for guidance.

DA: As above

-Sd-
(N K Sinha)
Chief Bridge Engineer/N.Rly

Copy to: (i) CAO/C for information & necessary action.
   (ii) CAO/C/USBRL for information & necessary action.
   (iii) DRM FZR, UMB, NDLS.MB & LKO for information & necessary action.
### Check list for examination of GAD of ROB/RUB and Limited Height Subway

<table>
<thead>
<tr>
<th>S.N</th>
<th>Points to be Checked</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A) GENERAL INFORMATIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Space provided for Marking HQ GAD /Dig No.</td>
<td>IRWM 904(a)</td>
</tr>
<tr>
<td>2</td>
<td>Name of the work and sponsoring agency if any along with its consent/signature</td>
<td>IRWM 904(a)</td>
</tr>
<tr>
<td>3</td>
<td>Location of LC No. / Existing Bridge No. its km, adjoining stations, local name if any and section. If on DFC route be specifically mentioned.</td>
<td>IRWM 904(a)</td>
</tr>
<tr>
<td>4</td>
<td>Scale of the Drawing.</td>
<td>IRWM 904(a)</td>
</tr>
<tr>
<td>5</td>
<td>300 mtr of track alignment on either side be shown on both sides.</td>
<td>Rly. Bd’s letter No. 98/CE-1/Misc/ 10/ Pt. dtd.26.8.98</td>
</tr>
<tr>
<td>6</td>
<td>Centrelines of the proposed alignment as well as the piers are marked on a grid with respect to some common reference axis.</td>
<td></td>
</tr>
<tr>
<td><strong>B) NOTES ESSENTIALLY BE WRITTEN ON GAD.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All dimensions are in millimetres.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GAD governing codal provisions to be mentioned</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Designs should be done after site investigations to ensure safely along with adequate drainage.</td>
<td>Rly. Bd’s letter No. 2001/ CE-I/Misc /NH/4/Pt-III dtd. 28.06.10</td>
</tr>
<tr>
<td>4</td>
<td>CRS Sanction to be obtained as per the norms where required.</td>
<td>SOD 10 (III)</td>
</tr>
<tr>
<td>5</td>
<td>Provision has been made for 275 mm extra vertical clearance for 60 kg rail and concrete sleeper.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Facilities for inspection of ROB to be provided</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>All admissible levies to railway be ensured prior to the approval of GAD</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2 mtr high RCC wall to be provided 50 mtr long on both side of ROB at Northern Railway Boundary to avoid tress passes. Footpath for pedestrians on both sides of ROB on the Deck protected by sufficient high Railing / RCC wall (2 mtr. High.) Provision of staircase provision of service lane etc. should be included in the GAD.</td>
<td>308-W/0/Genl./ Br. (S&amp;D) Pt-II, dtd. 13.7.12</td>
</tr>
<tr>
<td>9</td>
<td>Necessary MOU / Agreement should be drawn with Authority i.e. NHAI/State Govt. (only for Govt. officials) prior to / during the execution of work</td>
<td>Engg. Code IRC-1816(a)</td>
</tr>
<tr>
<td>10</td>
<td>Suitable note in connection with feasibility For constructing Limited Height Subway along with ROB.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>State Govt. shall ensure closure of L Xing soon after the bridge is commissioned.</td>
<td>Rly. Bd’s letter No. 2011/C-IV/Misc /48 / Land dtd. 17.3.12</td>
</tr>
</tbody>
</table>
For closing of LC gate a separate plan will be prepared

No. of Col. & DIA of columns are tentative subject to final design mentioned on GAD.

GAD Approved subjected to the following observations :-

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<tbody>
<tr>
<td>433</td>
<td>12</td>
<td>For closing of LC gate a separate plan will be prepared</td>
</tr>
<tr>
<td>433</td>
<td>13</td>
<td>No. of Col. &amp; DIA of columns are tentative subject to final design mentioned on GAD.</td>
</tr>
</tbody>
</table>
| 433 | 14 | GAD Approved subjected to the following observations :-

<p>| | | |</p>
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<th></th>
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</table>
| 433 | 433 | GAD Approved subjected to the following observations :-
| 433 | 433 | a) All dimensions including foundation details, Girder’s Depth & Width, Piers & Abutments, Sub Structure & Super structure details should be finalised after detailed design based on soil investigation and duly approved by Competent Authority.
| 433 | 433 | b) The spacing of Girders and Structural details are to be decided as per design requirement keeping the finished top of ROB’s slab at the same level.

C) FOLLOWING INFORMATION BE SHOWN ON GAD

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</table>
| 433 | 433 | C) FOLLOWING INFORMATION BE SHOWN ON GAD
| 433 | 433 | a) SITE PLAN

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<table>
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<tr>
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<th></th>
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</thead>
</table>
| 433 | 433 | a) SITE PLAN
| 433 | 433 | 1 North Direction  IRWM 906 (a-1)
| 433 | 433 | 2 Railway IP or OHE mast on either side of ROB  Rly Bd’s letter No.9 & CE/I/Misc/10/Pdtd. 26.8.93
| 433 | 433 | 3 Level Crossing gate number class (Engg / Traffic) alongwith TVU etc. exact location of level crossing gate with respect to Railways IPs or OHE mast.  IRWM 906 (a-iv)
| 433 | 433 | 4 Name of stations on either side of POB  IRWM 906 (a ii)
| 433 | 433 | 5 Width of existing road along with nomenclature of road and name of village / towns on either side of crossing  IRWM 906 (a x)
| 433 | 433 | 6 Overall width of proposed ROB / RUB, LH Subway  Rly Bd’s letter No.2008/CE-I/Estt./4/BRO (Const.) dtd. 5.3.10
| 433 | 433 | 7 Location of proposed abutment and piers.  Rly Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98
| 433 | 433 | 8 Location and approximate size of all structures, installations and signaling gears etc. which will need to be dismantled and resitted -do-
| 433 | 433 | 10 Layout plan of temporary diversion of road traffic with details of temporary level crossing if necessary for execution of the work  Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98

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| 433 | 433 | b) PLAN

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</table>
| 433 | 433 | b) PLAN
| 433 | 433 | 1 Overall width of ROB, carriage way, foot paths & separators.  Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98
| 433 | 433 | 3 Angle of crossing & skew angle.  RDSO LETTER No. CBS/DRO dtd. 15.4.10
### c) LONGITUDINAL SECTION (ELEVATION)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clear spans and overall spans.</td>
<td>Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98</td>
</tr>
<tr>
<td>2</td>
<td>Ground levels at the location of abutments and piers</td>
<td>-do-</td>
</tr>
<tr>
<td>3</td>
<td>Formation levels, Roads level</td>
<td>-do-</td>
</tr>
<tr>
<td>4</td>
<td>Rail levels of tracks indicating higher rail</td>
<td>-do-</td>
</tr>
<tr>
<td>5</td>
<td>Existing tracks and future tracks</td>
<td>-do-</td>
</tr>
<tr>
<td>6</td>
<td>Vertical clearance from the higher rail level to the bottom of girder</td>
<td>SOD Chapter-I Part 10 (III) &amp; Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98</td>
</tr>
<tr>
<td>7</td>
<td>If track is in curve the Degree of Curve be also mentioned</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Road Gradient</td>
<td>Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98</td>
</tr>
<tr>
<td>9</td>
<td>Road radius on approaches.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Clear horizontal distance at rail level of abutment and piers from the nearest track should be shown.</td>
<td>Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98</td>
</tr>
</tbody>
</table>

### d) CROSS SECTION

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The tentative length and height of abutments and piers.</td>
<td>Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98</td>
</tr>
<tr>
<td>2</td>
<td>Width of carriage way, median and foot paths</td>
<td>Engg. Code 1816(III) &amp; Rly. Bd’s letter No.2008/CE-I/Estt/4/BRO Const. dtd. 05.3.10</td>
</tr>
<tr>
<td>3</td>
<td>Anti-crash barriers and railings</td>
<td>Rly. Bd’s letter No.98/CE-I/Misc./10/Pt. dtd. 26.8.98</td>
</tr>
</tbody>
</table>

### LIMITED HEIGHT SUBWAY

D) Additional information for Limited Height Subway (Proposal at Rly. Cost)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Undertaking of DM for closure of LC?</td>
<td>Rly. Bd’s letter No.2006/CE-I/AC/I/Safety dtd. 15.2.10</td>
</tr>
<tr>
<td>2</td>
<td>Drainage Arrangement has been made by local Civil Authorities.</td>
<td>-do-</td>
</tr>
<tr>
<td>3</td>
<td>Provision of Height Gauge.</td>
<td></td>
</tr>
</tbody>
</table>
No.260-W/1306/GAD Policy/Br./(S & D)
Dated: 10-02-15

C.A.O./Consn.  
Northern Railway  
Kashmere Gate, Delhi

DRMs,  
Northern Railway  
DRM's office,  
LKO, DLI, MB, UMB & FZR

Sub: Procedure for approval of General Arrangement Drawing (GAD) for ROB/RUBs.

Ref: Guidelines issued vide this office letter no.260-W/969GAD/Progress/Br./S&D-II dated 11.9.2013 (copy enclosed).

At present approval of GAD for ROB/RUBs takes a very long time leading to average time of about 4 years for completion of these works. In order to streamline the entire procedure and expedite the completion of these works, it has been decided, with the approval of competent authority, that the following procedure shall be followed henceforth for approval of GAD for ROB/RUBs:

Stage-I: Before sanction of the work

1. On getting a request for deposit work or for initiating a work on cost sharing a joint feasibility report (JFR) will be prepared by sectional Sr. DEN/DEN, Dy. CE/Consn. and sponsoring agency/State Govt. Sectional Sr. DEN/DEN shall be the coordinating officer for fixing the date for joint inspection after mutual consultation, the joint inspection and preparation of JFR. This joint feasibility report will be signed by all these officers.

Stage-II: Preparation of GAD after sanction of the work

1. After the work is sanctioned as deposit work or in Works Programme, detailed GAD will be prepared by the Railway executing agency (Division or Construction as the case may be), based upon this feasibility report and incorporating any other change developed in the meantime.

a) In cases where division is the supervising or the executing agency, the GAD after preparation and signing by the concerned Sr.DEN/DEN and Sr.DEN/C will be sent to NRHQ for approval of CBE.
b) In cases where Construction is supervising/executing, the GAD will be prepared by concerned Dy. CE/C and got signed by sectional Sr.DEN/DEN in division and also CE/Const. before sending to CBE for approval. Sr. DEN/C shall be co-ordinating officer at divisional level for piloting the GAD.

2. In cases where the ROB/RUB is crossing through yard and piers / abutments are falling in railway land, the GAD will also be got signed by Sr.DOM.

3. The final GAD shall be approved by CBE.

4. The executing agency shall send the copies of approved GAD to State Govt./sponsoring agency, concerned divisional branch officers (i.e. S & T, Electrical and Operating) and retain the original GAD.

5. The entire process in stage-II should be completed preferably within one month and in no case more than 45 days.

DA: As above

-Sd-
(S.K. Lohia)
Chief Bridge Engineer

1. Chief Secretary, Haryana, Punjab, UP, Uttarakhand, Himachal, Delhi, J & K and Rajasthan.

2. Sr. DEN/C/N.Rly./LKO, DLI, MB, UMB & FZR.
Annexure-10.03

Northern Railway
(Construction organization)

Const.Headquarters office,
Kashmere Gate, Delhi

No. 1-MISC/DOP/BRIDGES


Sub: Barrel length of precast RCC Box Bridges (LHS/RUB) by cut and cover method.

Ref: This office letter of even No dated 22.01.2016.

Vide letter under reference, guidelines were circulated regarding barrel length of precast RCC Box segments. It was instructed to provide five segments for single line track and eight segments for double line track. It is observed that many field units are not following the guidelines and are providing number of segments more than as instructed. I have viewed it very seriously.

The number of box box segments should be finalized after taking ground levels and keeping in view the height of embankment from the existing ground level to the formation level at the time of preparation of GAD. If the number of segments are required more as per site requirements, the same shall be got approved from concerned Chief Engineer.

This should be implemented in all ongoing and future works with immediate effect.

-Sd-
(B.D. Garg)
Chief Administrative Officer/Const.

All CE/Cs

Copy to: All Dy CE/Cs.
No.: 1-MISC/DOP BRIDGES
Dated: 30-09-2015

The Dy. CE/CSE Road, CSB, CSB-II, SSB, TKJ, STCN,
LKO-I, II, III, MB, CDG-I, II, UMB, JUC, DJAT,

Sub:- Construction of LHS by cut and cover method.

Standard GAD has already been issued i/c with above stated work by this office.
Detail drawing of splayed wing wall and retaining wall for different heights and in
precast/cast-in-situ options is being issued with this letter. It is pertinent to note that length
of splayed wing/return wall shall be provided as is bare necessary for retention of earth
slope behind. In inhabited areas where there is restriction of available land width, types of
walls as shown in this drawing or any other counter fort type walls issued earlier, shall be
used with prior permission of chief engineer. However, in non-inhabited areas where there
is no restriction of available land width and slopes are almost self sustaining, breast walls
shall be used.

DA: As above.

(R. P. Khurana)
Dy. CE/C/D-I

Copy to:-
1. Secy to CAO/C for information of CAO/C, please.
2. The CE/C/NW, CE/C/E, CE/C/C, CE/C/Spl, CE/C/NC, CE/C/Survey for
   Information, please.

438
NORTHERN RAILWAY

Headquarters Office,
Kashmiri Gate,
Delhi-06

No.Dy.CE/C/G-II/Misc-Estimate

Dated: 25.07.2014

Sub : Estimate for Road Over Bridges.

The estimate for Road over bridges is made of two parts:-

(i) Cost of approaches for which the estimate is given by State Govt.

(ii) Cost of Railway portion of the bridge where the cost estimation is prepared by the Railways.

These two estimates are combined together by Railway’s Dy.CE/Consl.

in the field. There is need to economise the cost of construction of approaches as well as bridge portion. In case of Railway bridge portion,
large number of initiatives have been taken to control the cost but cost of the approaches is not getting due scrutiny at any level in the Railways.

Therefore, now it has been decided that when the cost estimate for the approaches is given by State Govt., GAD for the approaches should also
be obtained and scrutinized. The arrangement adopted for approaches should be economical and at the same time serve the functional
requirements. Approaches with viaduct are normally costlier followed with RE wall/retaining wall and earth filled with proper slopes. However,
where there is space constraint or problem of the land, approaches with RE wall/retaining wall or viaduct are the only solution. This needs to be examined and discussed with State Govt. / other authority. The estimate given by State Govt/others authorities should be scrutinized vis-a-vis GAD
by Dy/CE’s.

These instructions to be followed with immediate effect.

This has been approval of CAO/C.

(S.C.JAIN)
CE/C/Spl.

All Dy.CE/Cs: to ensure compliance.

Dy.CE/C/G-II: to ensure compliance at HQ level.

Copy to:-

1. Secy. to CAO/C- For information of CAO/C please.
2. CE/CE/East, NW, NC, Central & Survey – For information & follow-up.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No. 2015/CE-IV/ROB/78 (Pt.)

New Delhi Dt: 04.06.2019

Principal Chief Engineer,
& Chief Administrative Officer (Con.),
All Zonal Railways,
MD, DFCCIL,
CMD, RVNL,
CMD, IRCON.

Sub: Failure of non-standard Bow string girder bridge (ROB).
Ref: (i) Board’s letter of even number dated 21.05.2018
(ii) Board’s letter of even number dated 04.06.2018

Failure of Bow string girder bridge (ROB) has been reported by North Central Railway. The approval of bow string girder (non standard) was given by Railway in 2015. The design of the ROB was proof-checked by IISC/Bangalore and the construction of the ROB was completed & commissioned in 2018.

The said bridge has now failed at joints within 4-6 months of its service. This puts a big question mark on the system of proof checking from outside agencies (even from premier institutes of India). In this particular case, non standard girder has been adopted, whereas, drawing of RDOSO standard girder of nearest span was already available. As such, the standard girder could have been adopted with minor modification in pier location at site. Similar failure has also been reported by Northern Railway. Both CBEs had confirmed telephonically of having adequately protected the track at these 2 locations. Detailed report be submitted by CBE/NCR & NR towards these failures.

Instructions were already issued to Zonal Railways (ref. (i) & (ii)) that “only RDOSO standard span” will be used. It was expected that Zonal Railways are following the instructions.

Para A(6), B(2) & B(3) of MoU between MoR and MoRTH dated 10.11.2014 also stipulates regarding use of RDOSO standard spans:

"Para A (6): MoRTH/NHAI should construct only viaduct in Railway Portion and pier/abutment should be located just out-side/at the railway boundaries to the extent possible based on available standard RDOSO’s span.

Para B (2): Ministry of Railways has developed a web-based programme for online submission for getting expeditious approval of various drawings related to
ROBs/RUBs within 60 days. This programme includes all the RDSO standard span drawings, check list to be followed for preparation of GAD and standard M.O.I.

Para B (3): To avoid unusual occurrence during launching of railway spans, Railway will supervise and facilitate launching of girders across railway bridge portion, without any supervision charges.

However, while position has been taken from different Zonal Railways through Whatsapp, it is observed that number of non standard bow string girders exists in Railway system. The position of girder as conveyed by Zonal Railways is as under:

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Zonal Railway to recheck/re-verify the above position and these girders are to be immediately checked from safety point of view & remedial action taken. Status be informed to this office latest by 15.06.2019.

Following decisions are reiterated for immediate implementation:

i. Only RDSO approved standard span bow string girder will be adopted.
ii. In rare to rare case, if it is unavoidable to use non standard span, then the design should be finally cleared by RDSO only. Railway Board should be intimated for use of this non standard design.

The above can be easily implemented at the initial stage of approval of GAD (by CBEs of your Railway).

(Subodh Kumar)
Director CE/BkS-II

Copy to: GMs of Zonal Railways for information.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No. 2015/CE-IV/ROB-RUB/Misc./49
New Delhi dt: 29.10.2019

Principal Chief Engineer,
All Zonal Railways,

Chief Administrative Officer [Con.],
All Zonal Railways,

Sub: Issues related to MoRTH/NHAI.
Ref: This office letter of even number dated 23.07.2018.

On the issue of the length of span of ROB within Railway boundary following decision were taken during meeting held on 23.07.2018 between ME & DG/MoRTH:

i. “For ROB being constructed in Railway yard or near year, pier/sub-structure should be located just out-side / at the railway boundaries to the extent possible.

ii. At other locations, if future requirement of track is not justified/can be accommodated within 45m, as far as possible road span over track should not exceed 45m.

iii. In case of dispute between CBE and MoRTH/NHAI, the matter shall be decided by GM of Zonal Railway considering the future requirement of Railway and site feasibility”.

Copy of minutes of the meeting under reference is again enclosed. NHAI represented to PED/Bridges that they are facing difficulty in finalization of drawings as per above guidelines.

Zonal Railways are advised to ensure finalization of drawings as per above guidelines. No delays on this account should occur.

DA: As above.

(Subodh Kumar)
Director CE/B&H-II
e-mail: direktar2@gmail.com

Copy to: (i) DG/MoRTH for information please.
(ii) Chairman/NHAI for information please.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2015/CE-IV/ROB-RUB/Misc/49

New Delhi, dated 23.07.2018

Minutes of the meeting held in the chamber of Member Engineering with
DG/MORTH and Member Admin NHAi on 17.07.2018 & 18.07.2018

Following were present during the meeting:

(A) From Railways:
Shri M.K. Gupta, Member Engineering, Railway Board
Shri A.K. Singhal, Executive Director CE/B&B, Railway Board

(B) From MORTH/NHAi:
Shri B.N. Singh, DG/MORTH (17.07.2018)
Shri R.K. Chaturvedi, Member (Adms.), NHAi (18.07.2018)

I. Issues of MORTH/NHAi
1. Earlier reference has been made by MORTH and NHAi to permit piers in Railway land for ROBs. As per Para A(6) of MoU between Ministry of Railways and Ministry of Road Transport and Highways signed on 10.11.2014 (Regarding Construction of Road Over/Under Bridge on National Highway Corridors on existing level crossings).

"MORTH/NHAi should construct only viaduct in Railway Portion and pier/abutment should be located just out-side/at the railway boundaries to the extent possible based on available standard RDSCO's span. No earthen embankment should be constructed within railway boundaries. Similarly, wherever need, Railway will also cross Right of Way of National Highway through over bridge or under bridge".

On the representation of MORTH, clarification was issued on 08.03.2017 which is as under:

"Only viaduct should be provided in Railway portion and span arrangement should be as per standard RDSCO design. For the cases where Standard RDSCO Design for longer spans are not available, railway will permit multiple spans within Railway boundary on case to case basis. This can be decided by Railway (CBE) in consultation with Operating Department considering the future requirement and site situation. While taking decision, Railway's interest should be safeguarded. In case of any difference in opinion General Manager is the final authority".

DG/MORTH and Member/NHAi requested for considering reasonable length of the span of ROB within Railway boundary. It has been decided that for expansion of Railway infrastructure, provision of future tracks has to be kept while constructing ROBs. Therefore, to facilitate faster & economical construction at ROBs by
MoRTH/NHAI and to avoid any ambiguity, the following course of action to be followed:

(i) For the ROBs being constructed in Railway yard or near yard, pier/abutment should be located just outside/at the railway boundary, to the extent possible.
(ii) At other locations, if future requirement of track is not justified/can be accommodated within 45m, as far as possible road span or track should not exceed 45 m.
(iii) In case of dispute between CBE and MoRTH/NHAI, the matter shall be decided by GM of Zonal Railway considering the future requirement of Railway and site feasibility.

II. Issues of Railway

1. It has been pointed out by Railway that para A(7) of MOU is not being strictly followed by field units. The said Para states as under:

"Along with the construction of ROB, MoRTH/NHAI shall construct a Subway to facilitate movement of pedestrian and vehicular traffic across the railway track to facilitate closure of level crossing by Railways. Construction of Subway within Railway Premises should be done under the supervision of Railways without any supervision charges. If subway is not possible, then suitable POB with ramp should be provided. Wherever subway/POB with ramp is not feasible at site, then in all such cases suitable footpath of appropriate width along with staircase should be provided on ROB."

MoRTH/NHAI assured that the para A(7) of MOU will be followed by field units and Subway/POB with ramp of adequate size (5m width & 2.75-3m height) must be provided for passage of light vehicle depending upon site condition. In case of subway, proper drainage system to be provided.

2. The issue of construction of ROB on diverted alignment has also been raised. As per present practice the locations, where ROB is being constructed on diverted alignment for closure of level crossing is not getting materialized.

MoRTH/NHAI assured that at these locations, ROB/POB with ramp will be constructed as mentioned in (ii) 1 above and level crossings will be closed.

Minutes are approved by DG/MORTH also.

[A.K. Singh] 25-3-18
Executive Director/R&B

Copy to: (i) Secretary, MORTH for information and necessary action.
(ii) DG/MORTH for information and necessary action.
(iii) GMs of All Zonal Railway for information and necessary action.
Sub: Design procedure for non standard spans in construction of ROBs on Indian Railway.


In construction of ROBs, generally two types of girders are being used for super structure: composite steel plate girder & bow-string girder. RDSO has standardized design & drawing of possible combination of spans, so that, it can be directly used while deciding the span arrangement for ROBs. Since, past few years, it has been observed that Zonal Railways and other executing units are adopting other than standard spans in span arrangement of ROBs. It has also been observed that in general the deviation from standard is minor i.e., standard span arrangement can be adopted with minor adjustment only. It may be appreciated that adoption of non-standard span un-necessary increases the work load at each and every level.

To ensure use of standard span in construction of ROBs, a number of instructions have been issued from Board vide ref. (i) & (ii) above. However, following guideline is reiterated for strict implementations by Zonal Railway and other executing units:

i. Only RDSO approved standard spans will be adopted.

ii. In rare cases, where it is unavoidable to use non-standard spans, CE&BE of the Zonal Railway should record reasons as to why standard spans cannot be adopted and what corrective actions/initiatives are to be taken to reduce the population of non-standard spans in future. CE&BE will send the design and drawings for approval of RDSO, only after having been satisfied for the use of non-standard spans in the concerned case. The design is be submitted to RDSO after having been proof checked from any of the IITs.

(Sudeck Kumar)
Director CE/R&H-II

445
Northern Railway
(Construction Organisation)

Headquarter Office
Kashmere Gate, Delhi
Dated: 26.08.2019

Deputy Chief Engineer/Const.
Northern Railway,
LKO-I, LKO-II, LKO-III, LKO-IV, LKO-V, LKO-VI, UMB, JUC, CDG-I, CDG-II, MB,
JAT, TKJ, S&TC/TKJ, CSB-I, CSB-II, SE Road-I, SE Road-II, SSB.

Sub: Prior administrative approval for adoption of Non-Standard Span of ROB.
Ref: Railway Board’s letter no 2013/CE-III/BR/RDSO/Misc. dated 11.08.2014

Railway board vide above referred letter stipulated that adoption of non standard span of ROB shall require approval of CAO (C). In this regard, it is advised, as far as possible, standard spans should be used for ROB. Henceforth in case use of non standard span is unavoidable for a particular work of ROB, concerned Dy CE/C shall prepare the GAD and submit to Construction HQ office for prior administrative approval of CAO (C) (for adopting non-standard span), giving detailed justification. No GAD of ROBs proposed with non standard span shall be forwarded by field units to Division, without the prior administrative approval of CAO(C).

It is also advised where adoption of non standard span become unavoidable, possibility of adopting already approved non standard design should be explored to save the effort and time required in structural design. A list of approved design of Non-Standard span has been sent on e-mail of all Dy CE/Cs for information. The updated list of approved design of non standard spans may be checked from design office of Construction HQ, Kashmere Gate, Delhi, before finalizing the GAD. However, in such cases also, where previously approved design of non standard span is adopted, prior administrative approval of CAO (C) for adopting non standard span shall still be obtained before forwarding the GAD to Division for approval.

This has approval of Competent Authority (CAO(C)).

(Hemant Kumar)
Dy.Chief Engineer/D-III

Copy to:
1. Secy. to CAO/C for kind information of CAO/C
2. CE/C/Central, NC, East, NW, SPL, Survey, CPM/LKO and CPM/CDG for information & necessary action please
Government of India
Ministry of Railways
(Railway Board)

No. 2013CE-MFB/RDSO/Rec.

New Delhi, dated 11-JU-2014

Principal Chief Engineer,
All Indian Railways.

Chief Administrative Officer (Con)
All Indian Railways

Sub: Use of Standard drawings on railway system.

Ref: This office letter of even No. dated 4/5/2014.

Vide this office letter under reference above, railways were advised that standard drawings available with RDSO be used as far as feasible while planning any work and in case, non standard drawings are required to be used, specific approval from RDSO may be obtained giving detailed reasoning/justification for not using the standard drawings. The intentions was to get benefit of better designs so as to avoid unnecessary duplication of works and wastage of time in designing the non standard drawings.

2.0 On the above issue, many railways have represented to review the instructions stating that they are having large no. of targeted works relating to new line, realigning, ROB, RUB etc in which using non standard drawings are unavoidable and getting specific approval from RDSO will take time to finalise the plans and may result in delay in execution of targeted works.

3.0 In view of above, the matter has been reviewed and it has been decided that railways should use standard drawings for superstructure as far as feasible. However, in case, non standard drawings are unavoidable then railway may use the same with the specific approval of concerned CAO(C)/PCE. While accordiing approval of the same, CAO(C)/PCE should record the specific reasoning/justification for using non standard drawing. A copy of the drawing along with related design data may be furnished to RDSO.

V/Dr. J. V. Dwivedi

Director Civil Engg./B&B
Railway Board

Copy for Information and necessary action to:

1. Chief Bridge Engineer, All Indian Railways
2. CMD, Rall Vikas Nigam Ltd, New Delhi
3. Executive Director/BSR/RDSO, Lucknow
4. Executive Director/Structure/RDSO, Lucknow
CHAPTER- 11

BUILDINGS

11.1 ARCHITECTURE

Architecture broadly pertains to Planning and designing form, space ambience to reflect functional, technical, social, environmental & aesthetic considerations.

It requires the creative manipulation & co-ordination of materials & technology and of light & shadow.

11.1.1 While Planning and Designing: -

11.1.1.1 Form, Space and Ambience:

The building design shall provide sufficient circulation elements to allow for the free and safe flow of users without disrupting the movement through others flow. The structure should fulfill the desired requirements in scientific and efficient manner conforming to the existing norms.

11.1.1.2 Aesthetics

The quality of building materials and finishes shall be used to formulate identity using form, color, and lighting as tools to create pleasing aesthetic solutions. Planning the building aesthetically good in all respects including front and side looking with latest available maintenance free material.

11.1.1.3 Colour Scheme

There should be consistent use of similar colors for like type spaces (i.e. waiting areas, entrance areas, etc.). Colors for architectural finishes shall be consistent and/or complimentary with those used in existing buildings and previously approved by Indian Railways. The best colour scheme of the building as demanded /matching with the adjacent structures of the area1.

11.1.1.4 Orientation

Orientation of buildings is a very important factor which is directly connected to the standards of thermal comfort and ventilation within building. It is guided by natural elements like sunlight and its intensity, direction of the wind, seasons of the year and temperature variations. Orientation is determined by climatic factors of wind and solar radiation. Orientation principles depend upon climatic conditions. For northern railway having mostly dry and hot climatic conditions, Orientation is the one of most desirable building features. In this region, the buildings should be oriented from solar point of view so that as a whole it should receive the maximum solar radiation in winter and the minimum in summer. Longer walls of building should face north & south. Non-habitat rooms can be located on outer faces to act as thermal barrier. Preferably, the kitchen should be located on the leeward side of the building to avoid circulation of hot air and smell from the kitchen.

11.1.1.5 Landscaping

Landscape architecture is a fully developed super specialization in architecture, which has more or less supplementary function, it essentially deals with the surroundings of a building except in cases of afforestation and creation of gardens
and parks. Greenery is always a very welcoming sight, and landscaping enhances the beauty of a structure. It has physical and psychological repercussions on man. Pollution control, thermal control and increase in rainfall are the physical aspects, while the effect of the green colour and its shades is psychologically calming to the human mind. The only drawback is that the end result of landscaping is fully felt only after passage of time, as trees/shrubs take their own time for growth. Another advantage of good landscape is that once it is fully developed, the effect keeps on changing with the size of trees, and seasons lead to interesting change of colours of leaves and flowers. Landscape deals with living and non-living objects. It is not merely plantation of trees and shrubs, but involves creating an entire environment which comprises living objects and nonliving materials. In the olden days, it was considered more as an art form which was used to enhance and enrich the main structure.

11.1.2 To achieve

11.1.2.1 Functional

Building shall be designed to achieve full weather protection to every user of the building. The building should fulfil the functional requirement of the intended users.

11.1.2.2 Technical

Building should be planned in such a manner so as to achieve best possible method of construction with economy.

11.1.2.3 Social

While planning the building, the social local sentiments, if any needs to be taken care of.

11.1.2.4 Environmental

The building should comply with all applicable environmental laws. The aspects of environmental acceptability, sustainability and energy efficiency should be considered. Materials used should be ecofriendly. The building should be energy efficient. Rain Water Harvesting, use of Solar Panels for electricity and Waste Management are options to reduce the energy requirement for the said building. Green/landscaped area should be increased and coordinated with the pedestrian and vehicular traffic.

11.1.2.5 Heritage Consideration

The Archaeological Survey of India (ASI) under the provisions of the Ancient Monuments and Archaeological Sites and Remains Act, (AMASR Act) 1958 protects monuments, sites and remains of national importance. It needs to be checked whether the affected monuments/structures are protected by AMASR Act,1958 and if they are protected, then subsequent action should be in conjunctions with provision of this act.

Besides the above mentioned legal aspect, it will be desirable that the appearance of proposed building does not diminish the heritage value of the place. The building should incorporate and reflect the local heritage in its aesthetics.

11.2 DEVELOPMENT CONTROL NORMS

These are regulations defined by Building Bye-Laws which provide control norms for building/buildings, excluding the internal arrangement.

11.2.1 Set Backs
This is clear distance between the building line to the nearest boundary line. It varies as per the type of structure, areas and size of building, height of building. e.g for ORH building at Tilak Bridge these are 15m on front side and 9m on side and rear sides.

11.2.2 Ground Coverage

It is the ratio % of the area covered at Plinth level to the Total Plot area. In case of high rise building, the ground coverage can be kept lower in other case the maximum ground coverage should be utilized. For any area, the % of ground coverage is defined by local bye laws. e.g in Delhi area it is 30% for Railway facility related structures as per MPD 2021.

11.2.3 Floor Area Ratio (FAR)

Depending upon the prescribed FAR of a prescribed zone for the given building, the flexibility of ground coverage and height of the building can be decided. e.g in Delhi area it is 100 for Railway facility related structures as per MPD 2021.

11.2.4 Height of Building

This is the vertical distance between the general ground level to the top roof level. The buildings having height more than 15m are considered high rise buildings. For High Rise Buildings clearances/NOCs is required to be obtained from authorities such as Fire Department, AAI, etc.

11.2.5 Parking Norms

Parking space shall be provided as per the applicable local norms. As per NBC, for a car, the minimum parking space required is 2.75m x 5m in a common parking space. Space for scooter/two wheeler and bicycle to be not less than 1.25m² and 1.00m² respectively.

Area for each equivalent car space inclusive of circulation area is 23m² for open parking, 28m² for ground floor covered parking and 32m² for basement.

In case of ORH at Tilak Bridge, the parking norms followed is 1ECS per 75 SQM of Plot area.

11.2.6 Access- Entry/Exit

The access to the structure should be clear, smooth, easy, identifiable, speedy and well defined. For this adequate parking space, road width, road surface, signages, etc should be properly planned. The building should provide ease of access for all users by minimizing physical and psychological impediments to their use of the building. The positioning and character of the building access points will have a critical influence in satisfying this requirement. The building design must comply with the requirements of Indian Disability Acts (IDA) that prescribe the specific configurations and requirements for public facilities to accommodate persons with physical impairments. (Annexure 11.01)

11.2.7 Services and Utilities

Depending upon the type of building, the requirement of various services such as: electricity, gas, water, sewage, telephone, internet, etc. is required to assessed and to be incorporated at planning stage itself.

11.2.8 Plinth Level
Plinth level should be adequately higher than road level. It should be atleast 45cm above the adjacent road/ground level. While deciding the plinth level, the level of nearest main road, adjacent buildings and general topography of the area should also be considered.

11.2.9 Drainage

It should be planned in such a way that effective and efficient disposal of all wastes are ensured from the building.

There should no back flow of waste water from external sewer or other sources. Easy access to all services for proper maintenance should be provided.

11.2.10 Façade

The facade of the building needs to be developed in conformity of the importance of the building and area, heritage value, historical considerations, adjacent structures, aesthetic etc. Considerations should be given to both traditional as well as contemporary material to achieve these goals.

11.2.11 Ventilation

Employ design strategies to provide fresh air intakes that enhance the health and productivity of the Railway Buildings. The aspects of Natural ventilation should be provided. If required air filtration can also be used.

11.3 CONCEPTUALIZATION & PLANNING OF THE PROJECT

- Preparation & Finalization of Scheme in consultation with user departments.
- To obtain complete brief regarding the details of requirements & site conditions through discussions with user departments.
- Site survey and preparation of master plan of the area indicating the locations of existing structures, roads, landmarks, facilities, utilities & relevant features like drains, access roads parkings and any other facilities.
- Ascertaining the applicable Bye laws, preparation of site plan, preliminary floor plans/ configurations & elevations with various alternations and getting conceptual approval of the same from user departments. Preliminary cost estimate for the approved concept plan based on prevailing market rates and approved specifications.
- Planning, designing & preparation of detailed Architectural plans, interior designing and external/ internal services/utilities pertaining to construction of proposed buildings.
- Preparation of 3-D drawings and Model of suitable scale.
- Preparation of all necessary drawings for obtaining the local authorities/ bodies approval.
- Final approval of Conceptual and Architectural Drawings.

11.4 OTHER IMPORTANT ASPECTS

11.4.1 Rain water harvesting

Rain water harvesting to improve ground water table. All the surface flowing water can be collected and used for recharging the ground water.
11.4.2 **STP**
The sewage treatment plant shall be installed to treat the raw sewage. The generated sewage is collected and treated in house sewage treatment plant. The waste water will come from toilets, kitchens, and internal station drainage.

11.4.3 **Recycling of Treated water**
Recycled water can be used for flushing of WCs, cleaning, cooling towers, gardening etc.

11.4.4 **Waste Segregation**
Waste segregation means dividing waste into dry & wet. Dry waste includes wood related product, metal & glass. Wet waste typically refers to organic waste usually generated by eating establishments & are heavy in weight due to dampness.

11.4.5 **Solar Panel for Electricity generation**
The roof of the building can be utilized for installation of solar panels and the electricity so generated can supplement the power requirement of the building.

11.4.6 **Landscapes**
The art and practice of designing the outdoor environment, especially designing parks or gardens to harmonize with buildings & roads.

11.4.7 **Green Building Concept**
The ‘Green Building’ concept is gaining importance in various countries, including India. These are buildings that ensure that waste is minimized at every stage during the construction and operation of the building, resulting in low costs, according to experts in the technology.

- The techniques associated with the ‘Green Building’ include measures to prevent erosion of soil, rainwater harvesting, use of solar energy, preparation of landscapes to reduce heat, reduction in usage of water, recycling of waste water and use of world class energy efficient practices.
- A similar concept is natural building, which is usually on a smaller scale and tends to focus on the use of natural mate
- rails that are available locally.

11.5 **CLEARANCES/NOCS FROM LOCAL AUTHORITIES/BODIES**

- NDMC/MCD
- DUAC
- Fire
- AAI
- ASI
- Forest Deptt.
- Ministry of environments

11.5.1 **Local Connections Approvals:**

- Lift Authorities
• Electricity Authorities
• Water Supply & sewerage Authorities
• Telecommunication
• Many local authorities are now entertaining applications/drawings online only. IRSDC has a portal to submit application/drawings online and they are facilitating NR in getting these approvals on nominal charges.

11.6 FINISHES RECOMMENDED PRACTICES

The selection of materials and finishes for exterior of the building, floors, ceilings and walls should contribute to the aesthetics, comfort and safety of a building. It should be durable, maintainable, vandal-resistant, environmentally friendly, fire-resistant, cost effective, and visually pleasing. The finish material patterns, textures, and colors together with the building geometry, help define the architectural quality and identity of a building.

11.6.1 External Finishing

Claddings: Permanent Finishing material like stones, glass, metallic claddings can be provided on the elevations of the buildings. However, cleaning arrangements/ maintenance requirements should also be planned accordingly.

Vast use of ACP having polyethylene (PE) as a major component, in the exterior of public buildings, should be avoided.

Depending upon the importance of the structure, the texture painting is also a preferred economy way of external finishing.

11.6.2 Internal Finishing’s

Material finishes of elements, such as flooring, walls, structures, furniture, sanitary fittings, etc. within the public areas of the building where surfaces either come in direct physical contact of public or are visible to them should be highly durable, need low maintenance, less frequent cleaning, and be less amenable to catch dust or cobwebs. In common areas such as corridors, stairs, etc. hard flooring should be provided so that it is maintenance free and easy to clean. Granite, Kota stone can be preferred option. In rooms, halls, etc. vitrified tiles of light color shade can be provided on floors.

In public toilets, Udaipur Green Marble/granite and in residential toilets ceramic tile flooring can be provided. Glazed tiles can be provided on walls.

In pantry areas, kota or granite floorings can be provided as it is weather resistant and easy to clean.

11.6.3 Sanitary Fittings

• Preference to wall mounted WCs as compared to floor mounted WCs as the former one ensure more cleanliness and efficiently use space availability.
• Dual flush cistern for water closet to efficiently use the water and minimize the wastage of water
• Sensor taps for the wash basin in public toilets.
• Auto Sensor for urinal flushing.

11.7 FIRE PROTECTION

a) Fire Resistance and Smoke Generation: The material used should reduce hazard from fire. It should have minimum burning rates, smoke generation, and toxicity characteristics for building finishes, and consistent with requirements of Fire/Life Safety requirements.

b) Attachment: Eliminate hazard from dislodgment due to temperature change, vibration, wind, seismic forces, aging, or other causes, by using proper attachments and adequate bond strength.

c) Slip-resistant walking surfaces: Increase pedestrian safety, in compliance with accessibility requirements by using floor materials with slip-resistant qualities. Entrances, stairways, platform edge strips, and areas around equipment shall have high slip-resistant properties. ASTM C1028 defines the standard/specification of the materials to be used.

11.7.1 Fire Protection Systems Adopted in High Rise Building are as under:

- Sprinkler systems
- Underground & overhead fire reservoirs
- Fire hydrant systems.
- Fire pumps & ancillaries.
- Fire extinguishers.
- Smoke detectors
- Heat Detectors
- Indication Panels
- Auto Dial facility
- Access Control

11.8 Indian Railways/ Other Central Govt. Departments: Relevant Instructions/ Circulars On Construction of Buildings.

11.8.1 IRWM Para 201 says:

Sec.11 of Indian Railway Act No.24 of 1989, provide for the right to erect buildings on their own land by railways without having to obtain sanction of Municipal or cantonment authorities in whose area the site is situated. In urban areas, the Urban Development Authority must be consulted and rules framed by them followed. Municipal or Local authorities, may, however, be consulted, where appropriate, regarding water connection, sewer lines & sewerage disposals or similar matters.

In areas where bye-laws have been notified by the local authorities, it would be in the common interest to adopt such bye-laws as being good recommended practice.

In area where bye-laws have not been notified it will be desirable to adopt the provision of the National Building code of India-1983 Part-III.
11.8.2 Other Relevant Central Govt. references/Orders:

- Govt. Of India, Ministry of Works and Housing vide letter No- M11011/1, dt. 5th March'1977 exempted certain Central Govt. Departments including Railways from Building Bye-laws of Local Administration for “Operational Construction” whether temporary or permanent which is necessary for the operation, maintenance, development or execution of services.

- However, subsequently, Ministry of Urban Development vide letter No. K 20013/46/89-DDVA dated 12.03.1990 further clarified that though the operational buildings will be exempted from scrutiny with reference to building bye-laws of Local Administration, however, Central Govt. Departments will observe building bye-laws and will have to obtain completion certificate from the concerned local bodies who would issue the same after satisfying themselves that the concerned building confirm to the prescribed building regulations.

- The above letter further clarifies that no relaxation in the standard prescribed by the DUAC in the matter of approval of Plans from conceptual angle would be given. In the case of Union Territory of Delhi, the DUAC standards would apply to the Operational buildings of the railways falling within the jurisdiction of NDMC, MCD and those along the railway tracks.

11.8.3 Role of DUAC

During consideration of any structure for Architectural work, Delhi Urban Art Commission (DUAC) plays an important role. DUAC advice the Govt. of India in the matter of preserving, developing & maintaining the esthetic quality of Urban & environmental design within Delhi, and to provide advice & guidance to any local body in respect of any project of Building Operations or Engineering Operations, or any Development proposal which effects or is likely to affect the sky line or the aesthetic quality of surroundings. Ecology of heritage are more pressing concerns now, the difficulties of seeing the City as a whole in a situation where there is many decision making bodies, is more evident than before and there is urgent need to have a vision for the future of the Cities constituent elements.

GREEN BUILDING

A green building is one constructed with design and construction processes which significantly reduce or eliminate negative impact of buildings on the environment and occupants.

A. Objectives

i) Conserve nature and natural resources: Building construction involves damage to ecology through land use disturbance; energy intensive material and processes.

ii) Increase energy efficiency: Buildings consume about 50% of total energy. Energy consumption is growing at a rate higher than population growth rate.

iii) Improve indoor air quality: Construction materials such as paints and varnishes emit polluting gases like nitrous oxide and carbon dioxide.

B. Benefits

1. Reduced destruction to ecology
2. Efficient use of resources during construction
3. Reduced construction waste
4. Reduced energy consumption
5. Extensive use of renewable energy
6. Efficient water management
7. Better indoor air quality by use of non-toxic materials

C. **Economy**

Over a 40-year life cycle of building the energy costs exceed construction costs. Initially a green building may cost 10% - 40% more but energy cost would go down by 30% -65%. The break-even point is achieved depending upon the energy consumption.

D. **Strategies For Building Green Building**

Optimum use of nature for lighting and space conditioning. Energy efficient light fittings 'Intelligent features to reduce energy wastage should be extensively used along with use of renewable sources of energy. Moreover, efforts should be made to reduce material use in construction and to recycle the construction wastes along with efficient water management.

E. **BIOCLIMATIC ARCHITECTURAL PRINCIPLES:**

Followings are the factors which need to be selected carefully to make building “Green” & to finally achieve reduction in energy use in the order of 10%-30%. Details are as under:

1. Orientation
2. Thermal mass
3. Building Forms (surface to volume ratio etc.)
4. Position and size of window; shading and coatings
5. Selection of materials for wall, roof, windows including insulation
6. Thermal insulation of roof, wall and glazing
7. Landscaping
8. Solar water heater
9. Solar power
10. Earth tunnel
11. Solar chimney
12. Wind Tower
13. Cavity wall
14. Courtyard effect

11.9 **CONCLUSION**

The architecture and conceptual layout of a building should incorporate the values of user satisfaction, uniqueness, heritage and environmental excellence. The building should meet the goals of safety, durability, economy, sustainability, and
appearance as deliberated in detail as under:

1. Safety: Non-combustible construction with minimal smoke generation and minimum toxicity characteristics; slip-resistant; securely attached/bonded; reflective; non-abrasive; ADA-compliant.
2. Durability: Minimum life cycle requirements; graffiti- and vandal resistant.
3. Maintenance: Easily cleaned; easily removed and replaced; no exposed fasteners; allows easy access to building utilities; graffiti- and vandal- resistant.
4. Economy: Cost-effective selections and standardization throughout the system, with a range of approved materials and finishes.
5. Sustainability: Environmentally friendly products with minimal or no adverse impact on the environment.
6. Appearance: The quality of building materials and finishes shall be used to formulate building identity using form, color, and lighting as tools to create pleasing aesthetic solutions.

### 11.10 Annexures

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<tr>
<td>(i)</td>
<td>Annexure - 11.01 – The person with Disabilities (Equal opportunities, Protection of Rights and Full participation) Act, 1995 – Implementation of the provisions</td>
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Government of India  
Ministry of Railways  
(Railway Board)  
No.2012/LM(PA)/08/04/Policy/PwDs  
New Delhi, dated: 06.06.2013

The General Managers,  
All Zonal Railways.  
The General Manager (Con),  
Northeast Frontier Railway, Guwahati.  
Chief Administrative Officer (Con.),  
All Zonal Railways.


Zonal Railways were asked vide Board’s letter No.96/LM(B)/2/404 dt. 30.12.1998 to take action to implement the provisions of ‘The Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 1995 based on RDSO’s report of November, 1998. In this regard, RDSO has submitted the revised report on ‘Passenger Amenities for Passengers/Persons with Disabilities’. After considering the report, Board has approved the revised ‘Guidelines on Amenities to be provided at Railway stations and other Public Buildings for the Persons with Disabilities’. These revised Guidelines are enclosed. Railways are advised to take necessary action as per the revised Guidelines.

Please acknowledge receipt.

DA: As above  
Director (WCS)  
Railway Board

No.2012/LM(PA)/08/04/Policy/PwDs  
New Delhi, dated: 06.06.2013

Copy forwarded for information to:
(i) PA&CAOs, All Indian Railways.
(ii) The Principal Director of Audit, All Indian Railways.
(iii) Dty. Comptroller and Auditor General of India (Railways), Room No. 224, Rail Bhavan, New Delhi.

Copy to:
(i) ED/EEM, ED(T&C), ED/Works, ED/WP, EDCEL(G), EDCIP(E), EDCPE(ES), EDPM, ED/Tele, EDMD/Coaching, ED/L&A-I, ED/L&A-II.
(ii) F(II) I, F(II) II, TG-III, TG-IV, Electrical (G), Telecom, M(C) Branches, Railway Board.
(iii) MD/VICON, MD/RVNI, MD/RITES, RLDA, IRSDC, MRVC.
REVISED GUIDELINES ON ‘PASSENGER AMENITIES FOR PASSENGER/PERSONS WITH DISABILITIES’

1. Drop off zone:
   i. An area is to be demarcated as drop off zone for vehicles carrying passengers with disabilities and signages be provided near ramp.
   ii. It should have the proper signage painted on the ground and also on a signpost / board put near it.

2. Parking:
   For parking of vehicles of handicapped people / people using wheel chair, following provision shall be made:
   i) Surface parking for two car spaces shall be provided near entrance for the handicapped persons with the maximum travel distance of 30m from building entrance.
   ii) The width of parking bay shall be minimum 3600mm.
   iii) The information indicating that the space is reserved for handicapped people / wheel chair users shall be conspicuously displayed.
   iv) Guiding floor materials shall be provided.

3. Signages / Indicator:
   Appropriate identification of specific facilities within Railway Station premises / other public utility buildings for the handicapped persons should be done with proper signage. Audiovisual signals for visually impaired and those with hearing disabilities should be provided.

   The symbols / informations should be in contrasting colour and properly illuminated because people with limited vision may able to differentiate amongst primary colours.

   Signs should be designed and located, so that, they are easily legible by using suitable letter size (not less than 20mm high). For visually impaired persons information board in braille should be installed on the wall at a suitable height and it should be possible to approach them closely. To ensure safe walking there should not be any protruding sign which creates obstruction in walking. Public Address System may also be provided in busy public areas.

4. Approach to Buildings:
   Every station / public utility buildings shall have at least one entrance accessible to the handicapped persons and shall be indicated by signage. It should be Barrier free from parking place to the platform / reservation hall or entrance of the building.
i) Ramped Approach:

Ramped approach shall be provided to negotiate the plinth height of the station building. Ramp shall be finished with non-slip material. Minimum width of ramp will be 1800mm with minimum gradient at 1:20 and maximum gradient of 1:12 for a short distance up to 900mm. Maximum length of flight will be 5000mm.

ii) Stepped Approach / Stair Case:

For the handicapped who are not using wheel chair stepped approach with trend size of seat less than 300mm and maximum riser of 150mm shall be provided.

5. Ramp for Foot-over Bridges:

Ramps for Foot Over Bridges or sub-ways should be provided to facilitate boarding of trains at other than the main platforms by the persons with disabilities.

5.1. Overhead / Foot over bridges:

Handrails on the foot over bridges start after one step, there by making it difficult for persons with reduced mobility and PwDs to move up/down the steps. Considering difficulty of PwDs:

5.2. Handrails should be:

i. Circular in section with a diameter of 40-45mm;
ii. At least 45mm clear of the surface to which they are attached;
iii. At the height of 850mm-900mm from the floor,
iv. Extend by the least 300mm beyond the head and foot of the flight in the line of travel and grouted in the ground.

6. Steps and stairs:

i. Stair edges should have anti slide and bright contrasting colours strip: 50mm min.
ii. Warning blocks to be placed 300mm at the beginning and at the end of all stairs.

iii. Nosing to be avoided.

7. Protruding objects:

i. There can be bauldings and other signages on the poles etc., obstruct movement of persons with vision impairment and can cause injuries. To avoid this, all protruding objects shall be above 2100mm from the floor level.
8. Ticket Window:

Every station should have at least one ticket window for handicapped persons. The height of the counter from the floor level to the top should be not more than 800mm. Audio-visual signal should be provided at appropriate locations.

Disability includes blindness, auditory impairment, wheel chair borne passengers, etc. Passengers with blindness, auditory impairment, etc. can be handled at the counters having normal height. For the convenience of the wheel chair borne passengers, the counters handling such passengers could be designed in such a way that an additional opening is provided adjacent to the normal window at a height suitable for the chair borne passenger. The sitting arrangement of the booking clerk manning the counter may also be suitably designed so as to enable him to deal with both the counters/openings comfortably.

9. Toilets:

Every station should have at least one toilet with drinking water facilities for handicapped persons. The special features shall be as follows:

i) Vertical rail should be 835mm to 1295mm above the floor level.

ii) Pull rail of the door should be 1070mm above from the floor level as shown in the sketch.

iii) Height of WC shall be 500mm above the floor level the rim of wash basin shall be 780 mm above the floor level.
One urinal and shower suitable for disabled persons should be provided in one of the bathing cubicle inside waiting room at the station duly providing appropriate sign board outside.

Proposed Layout-Unisex Toilet Waiting Room
10. Shower area:

i. Should have seat / bathing stool (height 460mm-490mm) to facilitate easy transfer by wheelchair users.

ii. Should have grab rails at a height (700m-800mm) and position that allow for easy gripping by semi ambulant person and wheelchair users.

iii. Should be provided with telephone hand shower instead of fixed showers.

11. Lifts/elevators/Travellators:

The Para 3(f) & 3(g) of Policy circular for passenger amenities vide Board’s letter no. 2012/LM(PA)/3/5 dated 11.09.12 as reproduced below, shall be followed:
3(f): Escalators / Elevators (lifts) to be introduced at 'A1' category and escalators at 'A' category, 'C' category and stations of tourist importance under desirable amenities.

3(g): Travellator as ramp to be provided at 'A1' and 'A' category stations as desirable amenities.

The technical requirement including size, provision of Braille system, auditory signals shall be as per RDSO specification for lifts/elevator.

12. Telephone Facilities:

At least one public telephone should be accessible for usage by physically disabled persons:

i) Maximum height of the telephone should be 1300mm.

ii) Seat height should be 450mm from the floor level.

13. Canteen:

At least one counter should be made accessible to physically disabled persons. The height of service counter and eating table should be 300mm from the floor level.

14. Guiding / warning floor material:

The floor material to guide or to warn the visually impaired persons with a change of colour or material with conspicuously different texture which is easily distinguishable from the rest of the surrounding floor material is called as guiding / warning materials. The guiding / warning floor material is meant to give the directional effect or warning to the physically disabled person at critical places. This floor material should be provided in the following areas:

i) The access path from parking area to the building.

ii) Immediately at the beginning/end of walk way where there is a vehicular traffic.

iii) At the location with abruptly changing in level or ramp.

iv) Immediately in front of an entrance / exit and the landing.

v) For rest of the floor area, non slip material should be used.

vi) Kerb should be 25mm high and floor joint shall be flushed at all the places.

15. Use of Braille:

For visually handicapped persons, Braille symbol shall be used at the height of 800mm on right side of door entrance.

16. To guide persons with vision impairment:

i) All foot over bridges turning, to have Braille markings with signages either on the wall (as stated earlier) or
ii. A Braille Guide plate on the handrails (both sides) of staircase leading to the respective platforms.

17. May I help you / Assistance counters:

i. Tactile guiding path to be given from the ramp leading to the May I help You / Assistance Counter.
ii. Access symbol to be provided.

RPR staff/personnel may be given knowledge about sign language through workshops and counseling sessions.

18. Drinking water facility:-

There should be separate lowered drinking water tap for disabled persons and water fountain shall be with leg and knee space as per the figure.

19. General Waiting Room:

(i) A spacious and adequate sitting arrangement with enough aisle space shall be provided for persons with reduced mobility.

(ii) To locate the entrance doors, Rubber foot mats in front of each entrance is to be provided to guide visually impaired persons.
(iii) All foot mats to be embedded in the ground in a niche to avoid people from tripping on them.

20. Other counters / stalls:
At least one eatable / book and other service shall comply with the standards mentioned below:

Writing surfaces and public dealing counters should not be more than 800mm from the floor, with a minimum clear knee space of 650mm-680mm high and 280mm-300mm deep.

21. Platform and Railway Track:
All platform edges shall be provided with warning blocks (460mm before) to prevent persons with vision impairment from falling into tracks.
22. Platform crossing:

i. Route / pathway shall be identified for persons with locomotor disabilities for crossing the tracks.

ii. In absence of lifts for all foot over bridges, this pathway is identified and used by persons with locomotor disabilities.

iii. Ramp leading to crossing shall be of gentle gradient of 1:12.

iv. Till the time lifts are installed:
Rubber beading to detail (or other options which may be worked out keeping in mind safety rules) - to allow smooth passage over gap between the railways tracks for persons with locomotor disabilities.

Surface of the pathway shall be of uniform level and shall be maintained from time to time.

23. General Information / Requirement:

(a) Notice boards for availability of wheel chairs shall be displayed at strategic locations.

(b) All wheel chairs should be given general maintenance from time to time.

(c) Sufficient Number of wheel chair shall remain available for use by persons with reduced mobility and persons with disabilities.

(d) Licensed porters shall be sensitized to the needs of differently abled persons through workshops and counseling sessions.

(e) It should be ensured that after dropping the passengers, coolies do not bring wheel chair back from the stair cases causing damage, wear and tear.

(f) RPF staff/personnel may be given knowledge about sign language through workshops and counseling sessions.
CHAPTER 12

PLANNING FOR BNI AND NI WORKS AND COMMISSIONING

12.1 PLANNING FOR BNI&NI WORKS

General:

BNI/NI is the culmination of long journey of continuous working; it is just few steps short of our desired destination when we can have the fruits of our long & consistent efforts & can visualize the satisfaction of our achievements after successful completion of BNI/NI working. Construction Organization is primarily involved in BNI/NI working in connection with yard remodelings, new yard layouts in doubling, traffic facility works involving longer loops, additional loops etc. Safe& faster execution of BNI/NI works is the desire & requirement of one & all involved with train operations directly or indirectly. Hence, all relevant information, experiences for BNI/NI working besides Do's & Don'ts have been put at one place for ready reference by one & all. The chapter primarily covers the Engineering works during BNI/NI leaving aside the S&T and operating parts that can be referred separately from Operating manual, G&SR and instructions issued time to time from Zonal HQ/Railway Board for safe train operations during BNI/NI.

12.1.1 Introduction:

(BNI: Before NI; or PNI: Pre NI i.e. prior to NI)

- What/Why/How of NI:
  NI means temporary disconnection of points/signals/Axle counters & other signalling gadgets for any designated works.
  Generally, NI working is required for:
  - Overhauling of cabins/lever frames
  - Yard remodelling
  - Introduction of Panel/RRI working
  NI working not only slow down train operations; it is also less safe system vis-a-vis interlocked working. Details instructions are available in ‘Operating manual’ and G&SR for train operations during NI work.

12.1.2 Various stages during Planning/execution:

Ideally speaking, planning of BNI/NI starts with the conceptualization of yard plan. If we keep in mind the execution of BNI/NI while processing the yard plan for approval, half of the journey is completed successfully.
**Category ‘A’ Works:** BBNI works which can be done independently w/o affecting existing operations/signalling system on existing running lines. *(BBNI works: 2-3 months before BNI/NI).* These are the works which are not infringing in anyway with the existing signalling system; e.g. following works can be there in this category:

- **TRR/TSR** in the yard.
- Insertion of GJs, AT welding etc.
- Insertion of PSC sleepers in the lead portion of T/outs.
- Assembly of switch portion of T/outs on staging outside.
- Existing ST T/outs, if any, to be replaced by F/S T/outs with S&T assistance.
- **Deep screening** of proposed T/out locations.
- Leading of P.Way materials to exact/nearest locations.
- Linking of track to the extent possible.

- **Category ‘B’ Works:** Works which are to be done in running lines but not infringing with the signalling or existing operations can be done wherein *no dismantling* is involved. Theoretically speaking there is no such thing like BNI/PNI as most of the alterations on running lines literally affect the train operations in some way but to reduce the NI period, few alterations can be done on running lines in Just before NI (say 4-7 days before NI). Therefore, meticulous planning is required to identify the works which can be got executed in BNI wherein though there is *no dismantling or
infringement to existing signalling system but still there is a potential safety hazard & so these works to be done just before NI so as to reduce NI period which is relatively more restrictive in nature & potentially unsafe as ‘no signalled movement’ during NI period; e.g. Following works can be there in this category:

- New insertion of T/outs on running lines.
- Insertion of GJs, AT welding etc.
- GFN liners in track circuiting area (Generally it is one area which gets offside)
- TSR in track circuiting area.
- Works of insertion/Dismantling on blocked/surrendered lines (\textit{i.e depending upon the amount of works involved, few lines can be got blocked successively just before NI& all works on those lines can be got completed so as to commissioned these with NI}). This helps to reduce NI period greatly.
- To reduce NI period further, partial commissioning of NI is comparatively better \textit{e.g.} (earlier in Amroha yard on MB-GZB section &) recently in Raiwala yard on HW-DDN section, \textbf{new loop line No.1} was coming at the same location of existing H.L Platform.So, it was judiciously decided to take NI & commission the yard w/o commissioning new loop line No.1 but completing the panel work by inserting the end T/outs with GJs etc. The new loop line No.1 was commissioned 15 days later after Commissioning of NI after dismantling of existing H.L platform & linking of new loop line No.1; the benefit of \textbf{longer loop lines\&new longer P/forms} were available for smoother train operations.
- Category ‘C’ Works: which are \textbf{to be done in NI} only. Here comes those works wherein \textbf{dismantling of existing signalling od/Turnouts} etc. is to be done.


\textbf{12.1.3 Important things to be done:}

1. General attention prior to BNI works i.e. during BBNI period:
   - Gumti Plan: Plan for fixing of Gumti (water proof tent, table, chairs, water, men with crow bar, telephone, lighting etc.) at each station clearly mentioning dates on which Gumties will be required for operating staff.
   - Green Notice/TWR/Padlocks etc.
   - Staying arrangements: Vehicle/\textit{Transport}; \textit{Fooding}; Water
   - Testing of all GJs, marking of location of GJs; \textit{Joint marking} of all SRJs.
   - First round of \textit{identification of interfacial activities} (listed in para 12.1.3.2 below).
• **Day to day BNI/NI programme** clearly bringing out the traffic/power blocks with repercussion on train operations.

• **Additional ballast** required for points & crossings in running lines and crossovers, cut and connection locations should be arranged. **Rail panels** for cut & connections and rail panels cut to suitable sizes for lead portion of turnouts should be kept ready at suitable location near the site of laying. **Point/switch assemblies** along with point machines should also be made (on staging if required) ready after joint testing with S&T near the point of laying.

• **Leading** of all P.Way materials to exact/nearest location, *(special attention to rail pieces/fish plates-bolts/joggles plates).*

• **Walkie-Talkie sets** for communication between Engg, S&T and Optg. Officials so as to optimally utilize BNI/NI period. However, nowadays it is predominantly switched to mobile phone communication except stations having mobile network problem.

• Arrangement of sufficient Nos. of rail cutting m/c (Disc cutter, hack saw with adequate No. of Discs, blades & manpower), Rail drilling m/c (with drilling bits) hydra, JCBs and especially arranging K.oil/Petrol etc. in small 02 lit bottles to supply to farthest end by motor-cycle during block etc.

• Arrangement of **adequate** No. of **Black-smiths** is very-very crucial (besides P.Way track labour) as lots of **backlog of previous day** interfacial work with S&T gets clubbed creating stress as times passes by. All good **retired Black-Smiths contact Nos.** can be had to **mobilize them** for NI work besides taking concentrated assistance from O/Line on **programmed basis** instead of individual’s effort being done presently.

• Deputing staff (PWI/IOWs + labour) from outside to be **bare minimum**; once deployed, their staying, feeding, watering (tanker) to be taken care of properly.

• Depute dedicated IOW for **Dismantling** of any **cabin/structure/taking out signal foundation**, location box & **simultaneous filling the cavity** created by already filled up **sand bags**.

2. **General attention for BNI/NI works:**

• **Identification of balance interfacial activities** e.g.:

• GFN liners/TSR etc. in track circuited area.

• **Signalling foundation & signals** etc. to be removed.

• **Shifting/removal** of location boxes, **OHE mast** etc.

• Joint testing/marking of **GJs** well in time.

• Joint testing of all ‘switches assembled outside’.

• Fixing of **motor** point on existing T/outs – change of sleeper spacing etc.

• **Overhauling** of L-Xing, as if any, in the yard *(Notice for road closure etc.)*

• **Removal** of any **shunt signal** etc. infringing to SOD.
• **Adhere to 'Day to Day programme'** & clear everyday works so as to leave No back log.

• Make full Use of machineries e.g. hydra/JCB etc. for *T/out insertion* which becomes relatively better even than T-28 in most of the location due to alround/easier accessibility by hydra/JCB.

• **Form teams & assigned** duties to **various teams** by meticulously dividing the **entire work in zones**.

• 'Daily evening meeting' to review & to assign next day work (but of very *short duration* say about 15-20 minutes).

• **Mobile No./Name** of all officials (Dy.CE/XEN-AEN/PWIs/IOWs /blacksmiths etc.) to be prepared &*circulated* on *whatsapp* besides hard copy.

• One *motorcycle/ three wheeler/Auto* to be hired, if feasible at site, to transport *rail cutting/drilling m/c, K.oil/petrol* etc. or to transport B/smith etc. from one point to another in the long yard else lot of precious time got wasted on these petty issues.

• **Small folder** with *'Day to day NI programme'*; Contact Nos.; A-4/A-3 yard plan to be kept ready & given to **all officers** at least.

3. **Important tips for smooth execution of BNI/NI works:**

   Even at the cost of repeating, few critical points are *summarized* which may greatly help in executing the BNI/NI work smoothly.

   • Hiring of *retired Blacksmiths* (besides arranging from other Units/Div.).

   • **Adequate Nos. of rail cutting/rail drilling machines with sufficient discs/blades/drills etc.**

   • **01/02 Push Trolley** for faster movement from one end to other in long yard.

   • **Hire 01 motorcycle/auto** esp. for NI for faster movement of rail cutting/raildrilling/black smiths/K.oil/petrol from one end to other.

   • **Arranging** of adequate No. hydra/JCB/tractors (Nowadays this becomes essential as even *switch portion* can be *laid completely* with the help of Hydra & shortage of P.waylabour can be compensated by deploying more hydra/JCBs.

   • *'Filled up sand bags' for filling cavity created by signal foundation* or any *buried C.C foundation* encountered.

   • Dedicated IOWs for **dismantling** any cabin/structure.

   • **Prior Notice** to road closure for L-Xing, as if any, in yard &*include* in the scope of work.

   • Leave *'no back log' of blacksmith work*; make proper teams i.e. for attention of previous day work & for the days work separately.

   • Have **bare minimum** no. of outside officials be it PWIs/IOWs/labour.
• **Staying/Transport/fooding/watering** arrangement of officials deputed from outside.

• Enquire/Discuss the **probable timings of T/Blocks** so as to arrange **logistics** i.e. lunch etc. of labour accordingly- imp. aspect.

• ‘**Interfacial activities’** to be got identified & signed jointly e.g. GFN liners/TSR/GJs to be done, OHE mast, S&T signal, location/Jn. Box to be removed/shifted & reviewed time to time to see **balance activities**.

• **Walkie-Talkie sets** must for better co-ordination.

• **Carpenter** for various identified misc. works e.g. **distance blocks** etc. can be **hired** directly from market & paid through special imprest instead of calling **carpenter/painter** from outside & paying huge amount for TA besides added burden of arranging their staying/fooding etc.

• Besides leading of P.Waymaterial, **leading/collection of adequate ballast** is must at desired locations. Also, arranging **fish plates, F/bolts, jogged F/plates** is very-very crucial activity.

• **Welding teams** to be kept ready & assigned work beforehand to optimally utilise them in T/Block.

• **Dedicated PWI/Staff** for arranging/cancelling the **Traffic Block**.

• ‘**Daily evening meetings’** to review & to assign next day works.

• **Whatsapp Group** (Name as NI- ‘A’ station) connecting all officials of NI Deptt. for sharing relevant information in one go quickly.

• Ensure erection of sturdy water proof Gumties well before the requirement as per Gumti Plan with provision of table, chairs, water, telephone, lighting etc. for smooth operation of trains. Sufficient men with crow bar to be deployed at each gumti for assisting in operation of points and fixing of clamps etc.

• Each Deptt (S&T, Optg., Engg. etc.) should give a list of officials deputed & requirement of their **stay/ transport/ meals**. Special imprest lump sum can be arranged by Construction organization to meet such requirement.

12.1.4 **Provision of NI with 30 kmph speed:**

Railway Board vide its letter no. 2020/safety(A&R)/19/07 dated 18.03.2020, has circulated Gazette notification regarding amendment to GR 4.10 permitting 30 KMPH speed of trains during NI period subject to certain new stipulations which should be complied before resorting to NI at 30 kmph. Field Officials should ensure compliance to these instructions before carrying out NI works with 30 kmph speed of train. A copy of Board letter is enclosed as Annexure – 12.04.

12.2 **CRS INSPECTION FOR OPENING OF SECTIONS**

12.2.1 **Preamble**

To exercise effective control over the construction and operation of the first railways in India, which were entrusted to private companies, Consulting Engineers were appointed under the Government of India. Later when the Government undertook the construction of railways, the Consulting Engineers
were designated as Government Inspectors and placed under the Railway Board which was the Safety Controlling Authority for the working and operation of Government and Company managed railways.

To avoid direct subordination of the Railway Inspectorate to the Railway Board, then Chief Inspecting Officer of the British Railways suggested separating the Inspectorate from the control of the Railway Board. Accordingly, the Railway Inspectorate was placed under the administrative control of the Department of "Posts and Air" in May 1941. The erstwhile Railway Inspectorate was redesignated as the Commission of Railway Safety on 1.11.1961.

The Commission of Railway Safety, now working under the administrative control of the Ministry of Civil Aviation of the Government of India, deals with matters pertaining to safety of rail travel and train operation and is charged with certain statutory functions as laid down in the Railways Act (1989), which are of an inspectorial, investigatory & advisory nature. The Commission functions according to certain rules viz. Statutory investigation into accidents rules framed under the Railways Act and executive instructions issued from time to time.

12.2.1.1 Statutory provisions for opening of New line and Doubling

In terms of Section 22 of the Railways Act, 1989 and Rules made under Sections 28, 29 and 198 of the Act, the Commissioner of Railway Safety (CRS) has to carry out his statutory inspection of the new railway line (including doublings), its appurtenances, various sub-grade and accommodation works etc. and submit his report to the Central Government stating whether the railway can be opened without any danger to the public using it. In case the railway cannot be opened without any danger to the public using it, he shall state the grounds thereof as also the requirements, which in his opinion are to be complied with before the sanction is given by the Central Government.

12.2.1.2 Topics Covered

The present chapter covers various aspects of CRS Inspection starting from statutory provisions. Further, preparations for submission of documents to CRS, planning for inspection, preparation for inspection have been discussed. Thereafter, points to be kept in mind during inspection have been noted. In the last, post inspection activities have been discussed.

12.2.1.3 Act, Codes, Manuals and Guidelines

As already stated, section 28, 29 and 198 of the Indian Railways Act, 1989 provides for CRS inspection for opening of new lines. Further reference have also been given in Para 1310 of chapter XIII of Indian Railway P. Way Manual. In accordance with that, Railways Opening for Public Carriage of Passengers) Amendment Rules, 2001 provides for the detailed procedure to be followed. Besides that, all codes/ manuals/ guidelines/ CE circulars issued by RDSO/ Railway Board/ respective Zonal Railways are also applicable and need to be followed.

12.2.2 Planning
Planning for CRS inspection should start well in advance of proposed date of opening. It starts from compilation of drawings and records related to the work followed by preparation of documents to be submitted.

12.2.2.1 Compilation of drawings

Index plan, L-section, Completion plan of all works carried out in connection with the work proposed to be opened are prepared along with completion of each work. A list of all working drawings and completion plans shall be prepared and drawings be arranged in set accordingly.

12.2.2.2 Compilation of documents

All construction time records related to quality shall be compiled which may include the following:

- Earthwork : Soil quality and Compaction record
- Blanketing : Material quality and Compaction record
- RCC : Cube strength record
- PSC : Stressing record
- Steel : Fabrication record
- Major/Imp. Bridges : Technical inspection, Load test, Camber record
- Track : Records for USFD testing of rail, welds. Welding register, Ballast cushion, track parameters, L-section proposed vis-à-vis actual. Layout calculations vis-à-vis actual layout parameters.
- Inspection : Inspection registers for Bridges (Important, major and Minor separately in their specified format), Curve, LWR, Point and crossing, Level crossing, Sand hump registers duly filled in with one inspection. Steel structure register with one inspection.
- SOD : Infringement to SOD and its condonation, Implantation to various structures (Masts, overhead lines, buildings, FOB, platforms etc.)
- Man power : Requirement and matching creation of posts, posting orders for newly created Engineering, Electrical and S&T assets.
- Certificates : Track certificate, bridge certificate

12.2.2.3 Preparation of CRS Documents

The General Manager of a Zonal Railway or the Chief Executive of the non-Government railway shall furnish all the relevant documents to the Commissioner while making reference for inspection under rule 3 from the list of following documents:
(a) Tabulated details;
(b) Index Plan and Section of railway;
(c) Drawings of works;
(d) List of questions and answers;
(e) Certificates;
(f) List of infringements of Maximum and Minimum Dimensions;
(g) Working orders to be enforced at each station; and Administrative note giving the salient features of the project.
(h) Administrative Note Giving the Salient Features of the Project

The document referred to in Sub-Rule

(1) The documents referred to shall indicate the distances from the same fixed point, in kilometres up to two decimal digits and the referred fixed point shall be clearly defined in a Note and on the Plan and Section sheets of the work documents.

(2) The datum adopted shall be Mean Sea Level as fixed by the Survey of India and all heights shall be mentioned with reference to the datum in meters and decimals up to two digits.

(3) Detailed guidelines regarding submission of CRS papers for opening of New Line and Doubling are enclosed as (Annexure – 12.02) for ready reference.

12.2.2.4 Submission of papers

Documents to accompany the application are detailed in Form (Annexure13/1 to IRPWM) and they should be complete in every respect.

The documents shall contain the details as specified below:

1) Tabulated details which shall consist of important characteristics of the railway or a portion of railway to be opened for public carriage of passengers and in particular include –

(a) Curve abstract as specified in Form I
(b) Gradient abstract as specified in Form II
(c) Bridge abstract as specified in Form III
(d) Important bridges - particulars of waterway and construction as specified in Form IV
(e) Ballast and permanent way as specified in Form V
(f) Station and station sites as specified in Form VI
(g) Station accommodation as specified in Form VII
(h) Station machinery as specified in Form VIII
(i) Level crossing abstract as specified in Form IX
(j) Brief particular of tractions installations as specified in Form X
(k) Power supply installation abstract as specified in Form XI
(l) Traction maintenance depot abstract as specified in Form XII
(m) Restricted overhead equipment clearance abstract as specified in Form XIII
(n) Electrical crossing over railway track abstract as specified in Form XIV

(2) Index Plan and Section Sheet shall be prepared as laid down in Para 443 to 451 of Engineering Code. Besides that, following drawings are also required to be submitted.

(a) Completion drawings of bridges, with drawing showing each type of girders used and giving the loading standard for which each is designed, and (if called for by the Commissioner), details of the calculations of their strength
(b) Completion drawing of tunnels, if any
(c) Diagrammatic plans of station yard showing the gradients, the layout of track and Particulars of turnout, block working and of any signals and interlocking installed
(d) Implantation diagrams of OHE masts

(3) List of Questions and Answers shall be prepared in terms of questions enlisted in Form XV

(4) Certificate of works shall comprise of:

(a) Certificate in Form XVI containing the comments on the following matters, namely:
   (i) Maximum and Minimum dimensions
   (ii) Strength of bridges
   (iii) Number of engines on one span
   (iv) Brake and communications
   (v) Accommodation in coach to cater, for different categories of passengers
   (vi) System of working
   (vii) Electric traction equipment
   (viii) Types of rolling stock proposed along with list of restrictions in Indian Railways Policy Circular No.7 Opening of Sections and Sanction of Sectional Speed on Indian Railways Page 14 of 28

(5) List of infringements of maximum and minimum dimensions shall be prepared in Form XVII and shall show the gauge of the Railway and items infringing and shall contain full explanation for
infringement and the reference to the authority under which the infringement is permitted or allowed.

(6) Working orders to be enforced at each station on the Railway to be opened shall be prepared in accordance with the rules provided in Chapter V of The General Rules and shall specify any special condition that are required to be met with.

(7) Where it involves introduction of electric traction on the railway line, the working orders shall include traction working rules.

(8) Where sanction is required for initiation of electric tractions on a line already opened for passenger traffic, the documents specified in items (j), (k), (l), (m) & (n) of Sub-Rule (1), item (d) of Sub-Rule (2) and item (a) (vii) of Sub-Rule (4) of Rule 5 shall be forwarded to the Commissioner. (Ref: Para 7 of Corrigendum issued on 16.02.2005)

(B) The officer should furnish along with his application a Track Certificate where applicable, on Form (Annexure 13/2 to IRPWM) signed by Deputy Chief Engineer (Track) and in his absence by Chief Track Engineer to the effect that the track is suitable for the maximum axle loads stated therein. The certificate shall be countersigned by the Chief Track Engineer/Principal Chief Engineer.

(C) For a major bridge, or when non-standard girders or designs are used, a certificate on Form (Annexure 13/3 to IRPWM) issued by Deputy Chief Engineer (Bridges) to the effect that the bridge or bridges are designed to carry the axle loads proposed to be run, should accompany the application. The Bridge Certificate shall be countersigned by the Chief Bridge Engineer/Principal Chief Engineer.

(D) For purpose of Forms (Annexure 13/2 and 13/3 to IRPWM), the Chief Operating Manager should be consulted in regard to the types of locomotives and rolling stock to be used, their axle loads and speeds. The Rules for Traffic Working obtained from the Operating Department and Particulars of Electric Block-Signaling Work, if any from the Signal & Telecommunication Department should accompany the application.

After all the documents are prepared/collected, these should be compiled in form of booklet along with Safety Certificate and Forwarding letter from General Manager of the Railway. The safety certificate is to be signed by all concerned PHOD and General Manager of the Railway. Finally, the document along with drawings should be submitted to Commissioner of Railway Safety by the concerned Chief Engineer when the section is nearly ready for inspection.

12.2.2.5 Finalization of date of inspection:

First the internal probable date/s of Inspection should be fixed by Chief Engineer after consulting all concerned officers. Thereafter, the Chief Engineer should approach the CRS for fixing for the suitable inspection date.
12.2.2.6 Planning for inspection:

After the date for CRS inspection is fixed, detailed planning shall be done giving due consideration to the following points:

1. Preparedness of section
2. The end from which section is proposed to be inspected
3. Direction of speed trial
4. Road facilities for approaching road/vehicle/stations
5. Stay facilities

12.2.3 Preparation for Inspection:

Preparation for inspection requires extensive work. Some work may be completed before dates of inspection are fixed where as some other can be planned only after the dates are fixed. Detailed Check-Lists for Civil Engineering, Electrical and S&T works and finishing items are enclosed as Annexure – 12.01 for ready reference of field officials. Collection of documents etc. should be completed before dates are fixed to avoid last minute rush.

12.2.3.1 Documents to be collected:

A number of documents are required to be carried during the inspection which includes drawings, construction records, inspection registers and codes and manuals.

12.2.3.1.1 Drawings:

All drawing of works executed should be collected and arranged in folders with index for quick retrieval during the inspection. List of important drawings is given below. Other may also be required based on work.

1. L-sections.
2. LWR Plans
3. GAD and completion plan of Bridges (All major and minor)
4. ESPs of Yards, Halt stations
5. SIPs.
6. L-xings plans/ ESP
9. FOB & PP Shelter.
10. Miscellaneous Plans

12.2.3.1.2 Construction records:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthwork</td>
<td>Soil quality test and Compaction record</td>
</tr>
<tr>
<td>Blanketing</td>
<td>Material quality and Compaction record</td>
</tr>
<tr>
<td>RCC</td>
<td>Cube strength record</td>
</tr>
<tr>
<td>PSC</td>
<td>Stressing record</td>
</tr>
</tbody>
</table>
Steel: Fabrication record
Major/Imp. Bridges: Technical inspection, Load test, Camber record
Track: Ballast cushion, de-stressing, weld testing, Rail testing,

12.2.3.1.3 Inspection Register:

Following inspection registers be prepared for carrying during the inspection:

1. Important, Major & Minor Bridge Register
2. LWR Register.
3. L-xings.
4. Point & Crossing
5. Curve.
6. Steel Bridge Channel Sleeper register
7. Sand Hump Register
8. Material on trial register

12.2.3.1.4 Code Manuals:

All relevant codes and manuals be collected for carrying during the inspection. Correction Slips to all codes/manuals shall be pasted at respective places. Following is the suggested list.

1. Engineering Code
5. LWR Manual
6. Track Manual
7. USFD Manuals
8. Concrete Bridge Code
9. Steel Structure code
10. Pile/well Code
11. Fabrication Standard – IRS-B1
12. RDSO Guidelines on earthwork.
13. Ballast specification
14. GCC
15. CE/Circulars
16. Working Time table  
17. SWR of all stations  
18. LHS/RUB/L-xing guidelines  

12.2.3.2 Inspection/Measuring equipments:  
The calibrated instruments/ kits shall be kept with inspection trolley for inspection/testing of the works. Following shall form part of it:  
1. Gauge cum level  
2. Curve measuring kit  
3. Turnout measuring kit  
4. Level crossing measuring kit  
5. LWR/SEJ measuring kit  
6. Bridge inspection kit  
7. Level equipment with staff  
8. Theodolite/ Total station  
9. Measuring tape  
10. Scale  
11. Soil density measuring kit (sand replacement & core cutter)  
12. USFD equipment with SE/PWay/USFD  
13. Elcometer for measuring paint thickness  
14. Meggar for measuring insulation resistance of Glued Joints  

12.2.3.3 OMS:  
OMS recording is required during trial run. The prior intimation to concerned official shall be given for arranging OMS for trial run. Arrangement shall be made for carrying the equipment and personal from their HQ to site, if required.  

12.2.3.4 Arrangement of trolleys  
About 40 officers and staff use to accompany CRS during the inspection. Minimum 6 Motor trolleys shall be arrange to accommodate the inspection team. It is desirable to keep 1-2 standby trolley also. Detailed seating plan shall be prepared and fixed on each trolley for easy management during the inspection. Generally following arrangement works well:  
1. CRS, CAO/C, DRM : CE/C, DyCE/C, Sr.DEN  
3. Measuring kit + Refreshment + ABE + SE/W &P.Way + Supporting staff  
4. CSTE/C, CEE/C, CE/THOD : Dy.CSTE, Dy.CEE, Div. officers
12.2.3.5 Other arrangement during inspection:

- Inspection steps should be provided on all important and major bridges.
- Besides that, Inspection steps should be prepared on at least all offered minor bridges for easy approach.
- For offered bridges, open foundation of wing wall/abutment should be opened in small length for ready inspection.
- Ballast cushion be opened at every km and on bridges to save time during inspection.
- Route marker for stations may be provided for road vehicles. If night stay is involved, place for stay shall be decided and booked in advance.

12.2.3.6 Improvements/Innovations Booklet:

In every new line/doubling/multiple line section being commissioned, there are some unique initiatives or innovative techniques/methods adopted during construction which needs to be highlighted for appreciation of CRS. A booklet of such improvements/innovations should be given to CRS for advance perusal and appreciation of such developments at site during inspection. A sample improvement booklet for Muzaffarnagar – Deoband section is given as Annexure 12.05 of this chapter 12 for ready reference.

12.2.3.7 Identification of specific duties of officials:

All the inspection related work shall be divided on functional basis and competent officers/staff shall be deputed on the same for smooth conduction of inspection.

12.2.3.8 Identification of assets to be offered for inspection:

Civil Engineering assets to be offered for inspection should be judiciously selected. Usually following norm is followed in selection of number of assets to be offered for inspection.

1. All Important bridges
2. 20% of major and 10% of minor bridge (Minimum 2 of each type per block section)
3. 10% L-xings (Minimum 2 per block section)
4. Blanketing and earth work (including bank profile) on approaches of all offered assets.
5. Opening of ballast cushion on approaches of all offered assets
6. Sleeper spacing and squaring on approaches of all offered assets
7. Welds on approaches of all offered assets
8. 2 T/outs per station
9. 1 LWRs per block section
10. 1 sand hump per station (if provided)
11. 1 curve per block section including sharpest degree curve

12.2.3.9 Minutes to minutes programme:
A detailed minute to minute program shall be prepared for the inspection giving due breaks for tea and lunch time. While preparing the program, inspection time for offered assets shall be duly accounted for. Normally 30 minute per important and major bridge and 15 minute per minor bridge/turnout/curve/LWR is considered reasonable. If too many assets are offered, allowance should be made for assets skipped from inspection while planning lunch and tea break. It is advisable that CE/C should discuss the program with CRS to incorporate his views. Once finalized, the program should be circulated to all concerned for information and necessary action.

12.2.3.10 Resolving/Preparing for foreseeable issues:
There may be local issues which are best known to SE/AEN or Dy.CE, e.g., demand for some facility by local public, issues related to land payment, any likely agitation. These should be deliberated and any likely issue should be brought in the knowledge of higher-ups. The issue may be resolved preferable before inspection or at least planning be made for their solution. If required, assistance of district administration may also be sought. A pre-planned strategy to handle such issues may avoid embracing situation during the inspection.

12.2.3.11 Liaisoning with open line/bridge line
Due intimation will be given to the open line including DRM, Sr.DEN, Sr.DOM, Sr.DSTE, Sr.DEE, SE/PWay/USFD, SE/OMS with their allied staffs for accompanying the inspection. Intimation should also to be given to Dy.CE/Br. Line for deputing his staff for accompany during the CRS Inspection.

12.2.3.12 Liaising with District Administration
An intimation shall be given to concerned DM’s/SSP’s for maintaining Law & Order and safety precautions along the track, L-xings during inspection and High Speed trial run.

12.2.3.13 Miscellaneous
Last but not the least, working lunch arrangement should be planned for
the inspection. In case of long section, this may be planned at any station enroute to save time. In case of short section opening where time is not the constraint, working lunch may be planned in resting facility etc.

12.2.4 During Inspection

12.2.4.1 Marshalling of trolleys:

A due care shall be given for marshalling of trolleys as given in 12.2.3.4 above. The trolleys should be tested on previous day and any deficiencies noted b rectified. All trolleys be kept ready at latest 1 hour in advance of inspection duly fuelled along with properly dressed trolley men having competency certificate. Fast moving trolleys should be place in front. Slow moving may preferable be kept as spare at the end.

12.2.4.2 Start of Inspection:

Inspection is usually started with pooja followed by light refreshment. A handout may be given to senior officers before inspection as ready reckoner. Other officers may be given a copy of minute to minute program.

12.2.4.3 Inspection of Assets:

Inspection will usually be done as per minute to minute programme drawn earlier unless some major anomaly or feature is noted during inspection. Offered assets should be pre-inspected by open line officials with inspection results duly filled in respective proforma. CRS may like to only get results test checked or may order for complete inspection. In any case, pre-inspection is required and it helps.

12.2.4.4 Reply to queries during inspection-

The reply of queries raised by CRS will generally be given by Chief Engineer/Const or by Dy.CE/C (or their counterparts for S&T and Electrical related issues). AEN/XEN should be ready with supporting record related to queries and should produce the same expeditiously whenever asked for. However, questions may be asked from other officers/staff also and in that case the person being asked is supposed to reply. In case of his failure to reply satisfactorily, others may reply with due permission of CRS.

12.2.4.5 Miscellaneous:

12.2.5 Post- Inspection:

12.2.5.1 Issues related to immediate compliance

CRS may ask for immediate compliance of some items either before opening or in very short time after opening. Such work should be planned on priority and carried out expeditiously.

12.2.5.2 Issue of Authorization:

Authorization is issued after the inspection. In case of Doublings where trains are already plying, authorization is issued on the same day after speed trial. In case of new lines, as trains operation on the line are not affected, authorization is issued after some time.

12.2.5.3 Compliance of conditions in authorization:

As soon as authorization is issued from CRS based on his inspection during motor trolley as well as high speed trial, the inspection
12.2.6  **Conclusion:**

Commissioner of Railway Safety is a statutory body responsible for ensuring safety of railway assets and operations. The CRS inspection is therefore of paramount importance and a milestone in itself in commissioning of any railway asset. The present chapter describes the preparations required before, during and after the inspection. A planned preparation is required and helps in conducting the smooth inspection and opening of assets. After commissioning of the section and completion of balance works, the assets should expeditiously be handed over to Open Line. A Procedure Order on Handing/taking Over of New Assets (PCE/NR’s Circular No. 268 R dated 10.04.2015) is enclosed as Annexure – 12.03 for ready reference.

### 12.3  Annexures

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<tbody>
<tr>
<td>(i)</td>
<td>Annexure- 12.01 - Checklist of CRS Inspection</td>
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<tr>
<td>(ii)</td>
<td>Annexure- 12.02- Submission of CRS Papers including Opening of New Line and Doubling</td>
</tr>
<tr>
<td>(iii)</td>
<td>Annexure- 12.03-Procedure Order for Handing/Taking over of New Assets</td>
</tr>
<tr>
<td>(iv)</td>
<td>Annexure - 12.04- Railway Board letter regarding 30 kmph speed of trains during NI working</td>
</tr>
<tr>
<td>(v)</td>
<td>Annexure - 12.05 -Sample Improvement/Innovation Booklet for MOZ-DBD doubling</td>
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</table>
No Policy/ROB/DOP/2015


The Dy. CEE/C/LOK, JUC, S/E Road, TKI, SSB.

Sub: Checklist of CRS Inspection

An effort has been made to prepare a checklist of items to be complied with before arranging CRS inspection in case of New lines, Doublings, Gauge conversion and yards for Engineering, Signalling and Electrical departments. This checklist is only indicative and not exhaustive and may require updation from time to time to ensure smooth CRS inspection without any embarrassment to the organization. Therefore, suggestions from the field units from time to time based on their experience, should be sent to the HQ office for updating this list, as required.

It may be further understood that this checklist does not in any way dilute the provisions of the various Codes, Manuals, Railway Board’s HQ Instructions which are required to be complied with. However, field units may bring to the notice of the HQ, if any of the instruction in this checklist are in deviation to the above.

This issues with the approval of competent authority.


Copy forwarded for information is marked.

1. XEN/C/TKJ
2. AXEN/C/TKJ

(SSE/C/D-III)

Dy. Chief Engineer/C/D-II

Annexure 12.01
<table>
<thead>
<tr>
<th>S.No</th>
<th>Subject</th>
<th>Item</th>
<th>Para No/Code</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Formation</td>
<td>1. Finishing top of subgrade level 125 mm and</td>
<td>PWD</td>
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<td></td>
<td></td>
<td>2. Finish lip of blanket up to 15 mm</td>
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<td>3. As per specifications Cross section, no provision of extra width</td>
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<td></td>
<td>Cross slopes</td>
<td>Cross slopes should be within 1 in 20 to 1 in 30.</td>
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<td></td>
<td>Side slopes</td>
<td>As prescribed in PWD. (normally 1 in 2 for embankment and 1 in 1.5 for cuttings)</td>
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</tr>
<tr>
<td></td>
<td>Quality of Earthwork</td>
<td>1. Records of gradation analysis. Atterberg’s limits OMC and MDD.</td>
<td>PWD</td>
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<tr>
<td></td>
<td></td>
<td>2. Records of placement moisture content and in-situ density. Records of</td>
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<td></td>
<td></td>
<td>Engineering conforming to the accepted limits of gradation, classification, plasticity, etc.</td>
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<td></td>
<td>3. Records of moisture and density control during earthwork execution.</td>
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<td>4. Records of check of thickness, cross-sections, cross-slopes, etc.</td>
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<td>5. Records of at least one test at every change of soil strata subjected to</td>
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<td>minimum of 5000 cu.m to assess suitability of fill material</td>
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<td></td>
<td></td>
<td>and to say down OMC and MDD (Relative Density Band Replacement Method Outer Method).</td>
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<td>6. All records &amp; equipment for checking to be available during CRS Insp.</td>
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<td>7. Rain orders to be issued in advance.</td>
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<td>8. Turfing to be done.</td>
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<tr>
<td></td>
<td>Quality of Blanking</td>
<td>1. Records of gradation analysis. Atterberg’s limits OMC and MDD.</td>
<td>PWD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Records of placement moisture content and in-situ density. Records of</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Engineering conforming to the accepted limits of gradation, classification, plasticity, etc.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3. Records of moisture and density control during blanketing execution.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>4. Records of check of thickness, cross-sections, cross-slopes etc.</td>
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<td>5. Records of test for monitoring at every change of soil strata subject to</td>
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<td>minimum of 5000 cu.m to assess suitability of fill material</td>
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<td></td>
<td>and to say down OMC and MDD (Relative Density Band Replacement Method Outer Method).</td>
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<td></td>
<td>Protection</td>
<td>R.S.M.</td>
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<td></td>
<td>Trolley refuges</td>
<td>120/PPWM</td>
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<tr>
<td></td>
<td>Slide drains, catch water drains</td>
<td>As stipulated in PWD.</td>
<td></td>
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<tr>
<td>Work</td>
<td>All drawings to be available during inspection</td>
<td></td>
<td></td>
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<tr>
<td>Weep holes</td>
<td>As required.</td>
<td></td>
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<tr>
<td>Backfill at bridges</td>
<td>Min. 2 dull to be provided and 1 mlr backfilling material and boulders.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor Bridges</td>
<td>Proforma for Minor bridge inspection as per Annexure 11/10 Para 1103.4 IRBM. Full inspection to be recorded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Painting of HFL and Danger level</td>
<td>1. The highest flood level line should be painted distinctly by a 25mm broad white line along with the year of its occurrence, in figures 100mm high. 2. For bridges up to 60 metres in length, on the downstream side of one abutment. 3. For bridges over 60 metres in length, on each of the abutments on the downstream side or on the downstream side of the piers of the end spans. 4. For built-up abutments, on the piers near the end spans. 5. At important bridges, flood level gauges should be provided on abutments or on piers of the end spans.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clearance of water way</td>
<td>Waterway to be clear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completion plans</td>
<td>To have all the details.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Bridges</td>
<td>Proforma for Major bridge inspection as per Annexure 11/8 Para 1103.4 IRBM. Technical inspection reports duly signed by Dy/Ce/Br line. First inspection to be recorded.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completion of water way</td>
<td>Waterway to be clear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge No. Plaques</td>
<td>1. Plaques containing Bridge numbers and indicating direction of flow should be provided on parapet wall as detailed in Annexure 2/1. 2. All bridge plaques to be in marble.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completion plan</td>
<td>To be available with all details.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge Inscription plaques</td>
<td>Plaques showing particulars of foundations should be fixed over every abutment and pier in accordance with instructions contained in Annexure 11/7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trolley refuges</td>
<td>(i) On bridges with main spans of less than 100 metres - 100 metres. (ii) On bridges with main spans of 100 metres or more - A refuge over each pier. (iii) On ballasted deck Bridges - 60 metres.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. BRIDGES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge name board</td>
<td>Name boards at important bridges should be fixed at either approach at a distance of about 15 metres from the abutment indicating the name of the river and the number and length of spans. 206/IPBM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apron, cut off wall/Toe wall and easing hole</td>
<td>As per approved plan 209/IPBM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitching and inspection steps</td>
<td>As stipulated in IRBM (inspection steps for facilitating inspection for all bridges) 205/IPBM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stressing chart for psc girders</td>
<td>To be available with calculations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ladders on piers</td>
<td>Wherever required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection works, ballast deck level, and path way</td>
<td>As per approved drawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearings</td>
<td>(as per drawing) gap between neoprene bearing and cap to be checked by steel scales 222/IPBM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel girders</td>
<td>1. Records of QAP and all the checks on the raw materials, Structural steel plates, HSFQ Bolts nuts &amp; washers, electrodes as per the QAP. 2. Records for check of Layout of Components &amp; Joints, Jigs template and fixtures. Cutting straightening, edge preparation and milling as per the QAP. 3. Records for check of Quality of Welding. Numbering of welds with Stencils and Proper Maintenance of. Results of DPT n other tests on welds, Dimensional checks, Alignment and leveling of steel girders &amp; Chambers in steel girders 4. Run in run off places to be presented at the time of CRS inspection. 5. Acid check test report to be available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools and Equipment</td>
<td>Tools and Equipment for Bridge Inspection as per Annexure 11/15 Para 1109 of the IRBM (equipment for opening of foundation and toe wall etc should be available during CRS inspection and for 20% bridges it opening should be done in advance) 216/RPWM</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3 TRACK</strong></td>
<td><strong>Ballast cushion</strong></td>
<td>As stipulated in IRPWM (advance opening to be done at 2 sleepers per 1km)</td>
<td>263/IRPWM</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Sleeper density</strong></td>
<td>As stipulated in IRPWM (measurement on 30mtr tape)</td>
<td>4.5.3 IRPWM</td>
<td></td>
</tr>
<tr>
<td><strong>Fish plated joints (availability of 1 m long fish plates)</strong></td>
<td>As stipulated in IRPWM</td>
<td>259/IRPWM</td>
<td></td>
</tr>
<tr>
<td><strong>Fittings of P&amp;C</strong></td>
<td>All in place with proper greasing.</td>
<td>316/IRPWM</td>
<td></td>
</tr>
</tbody>
</table>
| **Track laying standards** | 1) Gauge - 2mm  
2) Expansion gap - +2mm  
3) Spacing of sleepers - + 20mm  
4) Cross level - +3mm  
5) Alignment on straight - +2mm  
6) Alignment on curve - 6mm  
7) Longitudinal level - 50mm | |
| **AT Welding** | 1. Records of Visual examination and Dimensional check as per Para 5.4.2 of the AT Welding Manual and USFD Testing.  
2. AT WELD REGISTER as per (Para5.6.2 Annexure 5) with first inspection recorded.  
3. Each joint shall have a distinctive mark indicating month, year of welding, agency and welder/supervisor identification code number (as appearing on his competency certificate) at non-gauge face side of A.T. weld on head.  
4. Fittings on sleepers in the weld approach are complete.  
5. Reports of testing of periodic test joints to be available during inspection for AT welds and 1mtr straight edge and 10mm straight edge to be available for measurement. | |
<p>| <strong>USFD test</strong> | The USFD Test results should be available with the action plan to remove the IMR Defects. USFD team should be available for check during CRS inspection. | |
| <strong>Joggle fish plating on curves, bridge approaches</strong> | To be ensured as stipulated in IRPWM | 277/IRPWM |
| <strong>Bolt hole chamfering</strong> | To be ensured as stipulated in IRPWM | 251/IRPWM |
| <strong>Initial greasing of ERDs, fish bolts and SEJs</strong> | As per LWR manual |  |
| <strong>Bridge approaches and guard rails</strong> | To be ensured as stipulated in IRPWM (at both ends anchoring to be done by wooden block irrespective of single or double line) | 277.275/IRPWM |</p>
<table>
<thead>
<tr>
<th></th>
<th>LEVEL CROSSING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Check rails</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Length to be checked (road width +2mtrs)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Rail joints should be avoided in check rails and on the running rails, within the level crossings and three meters on either side.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. The level crossing should not fall within the breathing length of L.W.R.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Minimum check rails to be got manufactured and provided.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Clearances of check should be provided and check specifically. It should be within tolerance limit of 51.57mm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speed breakers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. With hot pre-mix bituminous material.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. A speed breaker should be provided on either approach of level crossings located within the Railway land boundary at a distance maximum feasible but not exceeding 20m.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Standard warning signs for speed breakers. Speed breakers to be provided as per Annexure 9/6 Para 918(1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Road Surface between gate posts and approaches</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paver blocks to be provided only after packing of track. At every 3mtrs rail post to be provided from approaches.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gradient and levels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per Annexure 9/1 Para 904</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L-Xing Register</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per Annexure 9/4 Para 915, First Inspection to be recorded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whistle Indicator Board, Stop Board</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Whistle Board as per Annexure 9/5 Para 916(1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Stop board as per Annexure 9/2 Para 905</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gate, Gate Posts, Gate lodge and duty bunks, water arrangement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per Annexure 9/1 Para 904</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gate men equipment's</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per Annexure 9/1 Para 904</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Visibility for unmanned level-Xings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>As stipulated in IRPWM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Detonator posts and marking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. At every manned level crossing there should be distinct indication at 600 meters and 1200 meters on broad gauge, indicator posts should be provided with one dot and three dots at these distances to indicate the number of detonators to be placed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Arrangements for exhibiting the danger signal at a distance of 5 meters during emergency should be made at each level crossing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. GWR with DL</td>
<td></td>
</tr>
<tr>
<td>YARDS</td>
<td>Yard layout</td>
<td>As per approved yard plan, all t/o and other layout calculations to be available</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>---------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>SEIs</td>
<td>As per LWRM</td>
</tr>
<tr>
<td></td>
<td>Center to center distance of track</td>
<td>As stipulated in IRPWM</td>
</tr>
<tr>
<td></td>
<td>Distance block of platform lines</td>
<td>30 ms apart</td>
</tr>
<tr>
<td></td>
<td>Clearance of platform lines</td>
<td>As stipulated in IRPWM</td>
</tr>
<tr>
<td></td>
<td>Height of platforms</td>
<td>High Level Platforms-750MM above Rail Level, 840 mm above Rail Level for suburban stations and stations in cutting.</td>
</tr>
<tr>
<td></td>
<td>Distance of signal posts from center of track</td>
<td>As stipulated in IRPWM</td>
</tr>
<tr>
<td></td>
<td>Infringement to SOD</td>
<td>Should be verified and the list of infringements should be available.</td>
</tr>
<tr>
<td></td>
<td>Yard drainage</td>
<td>Plan of Longitudinal and Horizontal Drains</td>
</tr>
<tr>
<td></td>
<td>Points and Crossings</td>
<td>Actual T/O Length, Switch housing, Alignment, Curvature.</td>
</tr>
<tr>
<td></td>
<td>FOB</td>
<td>1. Uniform Rise (12.5cm) and Tread (30cm) of Steps, Precast steps &amp; House Dwg to be used. Landing position and Length.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Records of QAP and all the checks performed on the raw materials, Structural steel plates, HSFG Bolts nuts n washers, electrodes as per the QAP.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Records of check on the Layout of Components &amp; Joints, Jigs template and fixtures, Cutting straightening, edge preparation and milling as per the QAP.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Records for check on the Quality of Welding, Numbering of welds with Stencils and Proper Maintenance of Results of DPT n other tests on welds, run in run off pieces to be available during CRS Inspection.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Records of all the quality checks undertaken.</td>
</tr>
<tr>
<td>Item</td>
<td>Instructions</td>
<td>Code</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Kilometer post</td>
<td>Stakes to be used for writing</td>
<td>227</td>
</tr>
<tr>
<td>Hectometer post</td>
<td>Stakes to be used for writing</td>
<td>227</td>
</tr>
<tr>
<td>Gradient post</td>
<td>Stakes to be used for writing</td>
<td>227</td>
</tr>
<tr>
<td>Telegraph pole name</td>
<td>All stations to be verified and shaped</td>
<td>227</td>
</tr>
<tr>
<td>Railway Boundary posts</td>
<td>All stations to be verified and shaped</td>
<td>227</td>
</tr>
<tr>
<td>Land plans</td>
<td>Land boundary to be verified as per land plans</td>
<td>227</td>
</tr>
</tbody>
</table>
1. All CE\'s, Certificates and Manuals and codes to be available during the CRS inspection.
2. The details of the actual L-section provided Vis-à-Vis the approved L-section, to be available during the inspection.
3. The details of the actual T/O layout in the yards Vis-à-Vis the Theoretical to be provided should be available during the CRS inspection.
4. ETM/ETM calculations duly vetted by associate finance.
5. Items of IPR (Joint Procedure Order) for handling over of the asset to be prepared thoroughly.
6. Quality records for Earthwork, Blanketing, Ballasting, Concreting, Steel Bridges, Major Bridges, Minor Bridges, Welding to be carried along during the inspection.
7. FOB and Platform shelters Steel Quality inspection records to be available.
8. Identify the items for inspection of CRS-Best 2 Curves, 1 Major Bridge, 2 Minor Bridges, 2 Turnouts.
9. Joint Inspection with Open Line before CRS Application submission or 7 to 10 days before CRS inspection.
10. Good condition trolleys with properly dressed trolleymen having competency certificates to be used during CRS inspection.
11. Minute to Minute Programme for CRS Inspection to be prepared in consultation with Chief Engineer and to be got issued.
12. The inspection kit for inspection of CRS including all the tools required for Inspection of SEs, LW Rs, Welds, Points Xings, Bridges, Level Xings etc to be available on the trolley during the CRS inspection and the same to be personally checked by the Dy/Ce before Inspection.
13. All registers as per attached Annexure to be available with the first entries during the inspection.
15. Details of Gaps with Gaps Gaits.
17. Adequate no. of motor trolley to be arranged.
18. seating arrangement in motor trolley to be decided well in advance and stickers showing designation of officer to be stick on trolley.
19. adequate no. of vehicle to be planned if road movement is involved.
20. Speed trial - it must ensured with consultation of various departments involved that the trial train is able to move at speed 10 % higher than nominated for section. Run through signals must be ensured, and all manned level crossing should be closed for road users during speed trial run.
21. Notice to local people should be given by wide publicity and in consultation with local panchayats bodies, to avoid any mishap during speed trial run.
22. It should be ensure that no material should lie on track or adjacent to track which can cause hindrance to movement of trial train.
23. AEN/con and SSE/peway to be departed in loco cab for controlling movement of train and they should carry walkie talkie for constant communication with observatory car.
1. CRS papers with all enclosures
2. Complete details of depaorts wise manpower (i.e. requirement as per norms, sanctioned and posted by the division and available at site of inspection) along with certification from division and PHOD’s
3. Approval of waterway of bridge and siting of L-xings by DY. Commissioner/DM of state govt.
4. Technical inspection reports of major bridges duly signed by DY.CE/WR. line of open line
5. Deflection test of open web girders bridges
6. Compliance of inspection notes of HO/Ds
7. One set of copies of completion plan of bridge (as per format circulated vide this office letter no. 84-W/7/W.SPL-U-BRIDGE policy/P.T.XI/2012 dt.25.03.2013), Completion plan of yards, LWR plans and SIPs.
8. Details of the gangs with gang beats duly approved by Pr. CE
9. USFD testing of the welds with the certificate that no defective weld has been left in the track.
10. Type of welding adopted at site and the results of testing of test piece may also be furnished.
11. Clean ballast cushion survey along with AEN(open line) of the section may be undertaken at every 250m and tabulated details advising total ballast cushion available and clean ballast cushion available may be furnished duly signed jointly at each page.
12. A comparative list of the passenger amenities to be provided as per Railways Board's yardstick and the amenities provided for each of the stations should be submitted. Special mention should be made about the provisions of FOB,s
13. certificates in respect of the following to be furnished:
   i) data loggers have been provided at all stations on the section.
   ii) Curve register, LWR register, level crossing register, point and crossing register, bridge register etc., have been prepared and inspections carried out and recorded in the registers.
   iii) Destressing of the LWR has been completed along with the fixing of the reference pillars.
   iv) Greasing of all ERC’s in the section has been carried out.
10. Signature of officials with name and date should be clear on all certificates.
No. CRS Inspection

Dy.CEE/C/DRM Office, New Delhi.
Dy.CEE/C/Shivaji Bridge, New Delhi.
Dy.CEE/C/Lucknow.
Dy.CEE/C/Ambala.
SEE/C/NW, SEE/C/BSB.

Dt. 22.03.2016

Sub: Check list for CRS inspection.

A copy of Check-list is enclosed herewith for your information. It may please be noted that the instructions contained in the check-list should be compulsorily complied with before CRS inspection in your section.

Dy.CEE/C to please ensure personally the compliance before CRS inspection.

DA: Check-list (09 pages)

Chief Elect. Engineer (C)

Copy to:

The CAO/C/K.Gate : for kind information please.
<table>
<thead>
<tr>
<th>Station:</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The STWI (Special Traction Working Instruction) were found to be issued along with Appendix ‘G’ of SWR and assurance of the staff regarding the same had been taken.</td>
</tr>
<tr>
<td>2</td>
<td>Electric Traction Working Rule Diagram, Orientation with Signal panel.</td>
</tr>
<tr>
<td>3</td>
<td>Power Block Register, _______ Power Block, Collars _______ Line Block Collars _______</td>
</tr>
<tr>
<td>4</td>
<td>Isolator key Box and register, Safety device (Hand gloves) for isolator operation. List of authorised TRD official who can withdraw key from SM.</td>
</tr>
<tr>
<td>5</td>
<td>Treatment for Electric Shock Chart in trilingual.</td>
</tr>
<tr>
<td>6</td>
<td>First Aid Box ___________ Last replenished on ___________</td>
</tr>
<tr>
<td>7</td>
<td>Fire Extinguishers ——— no, type ——— Last tested on ———</td>
</tr>
<tr>
<td>8</td>
<td>Shri. ___________ SM on duty is in a possession Isolator operation competency certificate dt ——— issued by ___________ Shri. ——— demonstrated the operation of isolators at ___________. Tested the knowledge of power block.</td>
</tr>
<tr>
<td>9</td>
<td>TPC phone working and ringing</td>
</tr>
<tr>
<td>10</td>
<td>Joint Inspection of traction bonds in track circuited area by SSE/TRD &amp; SSE/Sig a register with approved bonding plan at Station.</td>
</tr>
<tr>
<td>11</td>
<td>‘Cross Bond’ at every 100m in station limits</td>
</tr>
</tbody>
</table>

| Platform: |
|---|---|
| 12 | Caution notice boards staff ——— ——— ——— |
| 13 | Caution notice boards public ——— ——— ——— |
| 13 | PF shelter earth <350m, connected to rail by two bonds of earth by two bonds or > 350m separate earth pipe for every 350m with two bonds. Caution boards on entry over roof of PF shelter |
| 14 | Mast on PF with structure bond ‘C’ bond shall be connected |
| 15 | Fencing on the platform connected with bond |
| 16 | Caution Unwired Turnout / Track ahead boards, Electric Engine Stop boards |

| Over Line Structure (FOB/ ROB/FLY OVER etc.) |
|---|---|
| 1 | Clearance from bottom of girder to catenary should be 230 mm or more. |
| 2 | Insulated catenary should be provided under the OLS with minimum 2-3 M on either side from the edge of OLS. Protective screen should be continuous across full span. Nearby OHE structure should be located at least 10 m away from the edge of OLS. |
| 3 | PF/ shed & FOB – Separate Earth Pit, One bond between Earth Pit and Structural Column, another one between Structural Column and Rail. Public Caution Board, 25 KV Danger Board on ascent of FOB and in PF shed. Public Caution Board at station entry and prominent places. FOB – Danger Board 25 KV on protective screen. |

498
### LEVEL CROSSING: Manned

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Description</th>
<th>LC No.</th>
<th>LC No.</th>
<th>LC No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Height of Height gauge from Ground Level (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4 m black band marking on upright.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Danger Board in Trilingual with skull mark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Height of contact wire (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>'C' bond within 5 metre from transverse edge of LC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Distance of OHE mast from transverse edge of LC (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Earthing of fencing, lifting barrier</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Public caution notice boards on uprights.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Staff caution notice boards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Treatment for electric shock chart in trilingual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Gate Working Rules (GWR) should include the precautions to be taken in case of OHE wire cut noticed by the GK.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Availability of insulator in SS wires,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>SS wires, passes through pipes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LEVEL CROSSING: Un-Manned

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Description</th>
<th>LC No.</th>
<th>LC No.</th>
<th>LC No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Height of Height gauge from GL (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4 m black band marking on upright.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Danger Board in Trilingual with skull mark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Height of contact wire (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>'C' bond within 5 metre from transverse edge of LC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Distance of OHE mast from transverse edge of LC (m)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Public caution notice boards on uprights.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Staff caution notice boards</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Switching Station:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caution Board/Danger board for staff as well as for Public - 25 KV AC</td>
<td></td>
</tr>
<tr>
<td>Danger Board.</td>
<td></td>
</tr>
<tr>
<td>Staff Caution Board on the wall of Control Room.</td>
<td></td>
</tr>
<tr>
<td>Earthing Layout drawing (7 sets)</td>
<td></td>
</tr>
<tr>
<td>a) Location Plan</td>
<td></td>
</tr>
<tr>
<td>b) General Arrangement</td>
<td></td>
</tr>
<tr>
<td>c) Structure Layout</td>
<td></td>
</tr>
<tr>
<td>d) Cable run layout</td>
<td></td>
</tr>
<tr>
<td>e) Earthing Layout</td>
<td></td>
</tr>
<tr>
<td>f) Fencing Layout</td>
<td></td>
</tr>
<tr>
<td>Combined earth value w/o traction rail measured (less than 2 ohms)</td>
<td></td>
</tr>
<tr>
<td>Individual earth value (less than 10 ohms)</td>
<td></td>
</tr>
<tr>
<td>Number of earth pits</td>
<td></td>
</tr>
<tr>
<td>No. of earth pipe</td>
<td>separate earth pipe for RC</td>
</tr>
<tr>
<td>Control Room:</td>
<td></td>
</tr>
<tr>
<td>Ring earth with separate earthing - RTU - Resistance less than 10 Ohms.</td>
<td></td>
</tr>
<tr>
<td>Panel &amp; Battery Charger - connected with earth ring by 8 SWG wire.</td>
<td></td>
</tr>
<tr>
<td>Stencilling of earth value</td>
<td>date</td>
</tr>
<tr>
<td>LAs with discharge counters with two earth bonds</td>
<td></td>
</tr>
<tr>
<td>Equipment earth</td>
<td></td>
</tr>
<tr>
<td>Isolator interlocks and flexible earth</td>
<td></td>
</tr>
<tr>
<td>Earth ring to main earthing ring and earth electrode by two bonds. LT</td>
<td></td>
</tr>
<tr>
<td>distribution board, RTU, BC shall be connected to earth ring by two 8</td>
<td></td>
</tr>
<tr>
<td>SWG GI wires.</td>
<td></td>
</tr>
<tr>
<td>Breaker for Main Line BM Inter</td>
<td></td>
</tr>
<tr>
<td>S/L ONE D/L - 4</td>
<td></td>
</tr>
<tr>
<td>Lightning Arrester - S/L 2 D/L - 4 2 Earth</td>
<td></td>
</tr>
<tr>
<td>20 x 6 mm with separate Earth Pit</td>
<td></td>
</tr>
<tr>
<td>Mechanism Box</td>
<td></td>
</tr>
<tr>
<td>1) Local - 2) Remote Switch</td>
<td></td>
</tr>
<tr>
<td>In Vacuum type interrupter- condition of Silica gel to be checked.</td>
<td></td>
</tr>
<tr>
<td>Operator - To operate this switch (safety equipment)</td>
<td></td>
</tr>
<tr>
<td>Flexible copper jumper with operating handle.</td>
<td></td>
</tr>
<tr>
<td>Equipment to be provided with two plates of earth</td>
<td></td>
</tr>
<tr>
<td>MS flats two coats of painting by colour grass green.</td>
<td></td>
</tr>
<tr>
<td>Minimum 10mm thickness crushed rock shall be provided</td>
<td></td>
</tr>
<tr>
<td>Protected area board</td>
<td></td>
</tr>
<tr>
<td>Danger Boards to caution public</td>
<td></td>
</tr>
<tr>
<td>Switching Station Name board</td>
<td>languages</td>
</tr>
<tr>
<td>Safety Equipment:</td>
<td></td>
</tr>
<tr>
<td>First Aid Box</td>
<td>last replenished</td>
</tr>
<tr>
<td>Treatment for electric shock chart</td>
<td></td>
</tr>
<tr>
<td>Fire Buckets (4 nos i.e. 2 sand filled and 2 with water near AT)</td>
<td>no filled with dry sand</td>
</tr>
<tr>
<td>Fire Extinguishers</td>
<td>no, type, last tested</td>
</tr>
</tbody>
</table>
Fire extinguisher to be operated by operator.

17 Penciling Earth by two bonds, Fencing Panel to upright two 8 SWG GI wire.

18 Implantation of fencing———

19 Battery Room:
   - Specific gravity by hydrometer,
   - exhaust fan Must,
   - battery lid – sulphation should not be there,
   - anti acid tiles on floor plus skirting (1 M)
Battery Room light———, exhaust fan———, voltmeter, hydrometer
Battery voltage———

Implantation:
Fencing - 3.5 M (minm.), main gantry - 4.3 m (minm.) AT (auxiliary transformer) is must.
Inner distance between 2 interrupters should not be less than 3 M.

20 Essential caution boards and number plates should be painted with fluorescent paint.

21 Numbering scheme as per approved drawing.

22 Hand glouse

23 Key Box

24 TPC phone, working, ringing

25 Isolator flexible earth

26 EMC socket working

27 Competency certificate for operation of Interrupter and Isolator
Message register and PN book for operation of Interrupters and Isolators
Switching yard 100 mm ballast cushion
Cross feeder (150 Sq. mm copper) for connection with distant track.
Drop Jumper (150 Sq. mm copper) for connection between cross feeder and OHE
Operation of BM locally and remotely in consultation with TPC.

Neutral Section:

PTFE (Poly Tetra Fluro Ethylene) - Manufacturer’s certificate
Length 5.163 m to 8 m
Two Bund with separate earth pit (Must)
Caution Board at 500 M, 250 M, DJ OPEN and DJ close
Condition – Only on tangent track.
   - No gradient
   - Located at least 200 M before stop signal or 400 M after stop signal.
Stagger of OHE should be zero.
<table>
<thead>
<tr>
<th><strong>GIRDER BRIDGE</strong></th>
<th><strong>Loc</strong></th>
<th><strong>Loc</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>In case length is more than 60 M – on both end two flats to be connected with separate earth pit. Bonding between rail and girder and girder and earth pit.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Non Track circuit**: Steel structures shall be connected to traction rail or earth by two bonds; cross bond at 100m.

2. **Track Circuit**: Steel structures shall be connected to traction rail or earth by two bonds; Traction rail with rail bond and connected to an earth at either end of the bridge by two bonds.

---

**Inspection Certificate**:
RITES Inspection Certificate and Manufacturer's Test Certificate with Warranty Certificate.

OHE structure – Mast, Portal, two truck cantilever (TTC) and Small Parts Steel (SPS)

**Conductors – Catenary wire – 65 Sq mm**
- Contact Wire - 107 – 110 Sq. mm
- Jumper Wire – different sizes of 50, 105, 150, 160 Sq. mm
- Dropper wire – 5 mm

**Equipment** -
AT, Interrupter, Circuit Breaker, Isolators, PT (Potential Transformer, LA (Lightening Arrester), CT (Current Transformer) etc.

**Register**:
1. Insulator Testing Register
2. Concrete Cube Test Register
3. Counseling Register
<table>
<thead>
<tr>
<th>1</th>
<th>Area – 90 m x 100 m (varies depending on orientation on TSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td><strong>Earthing</strong> – Should be as per approved earthing lay out based on ACTM guide line. Earth electrode for earth pit should be more than or equal to 3 M. Earth Pit Cover should be with handle. Individual Earth Pit Resistance should be less than 10 ohm. Combined earth resistance should be less than 0.5 ohm. No. of earth pit normally more than 40 (forty). Control Panel Room should be separately earthed with 50 mm x 6 mm flat in merry-go-round on just above the floor level. Further connected with main earthing network. SCADA base Remote Terminal Unit (RTU) separate earthing.</td>
</tr>
<tr>
<td>All equipment - CT, PT, CT, LA, SPI, DPI, AT, BM, Power Transformer etc must be with double earthing. For LA – separate earthing (working of surge counter to be confirmed for ensuring leakage current and number of surge).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cable Trench &amp; Earthing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It should be as per approved drawing based on RDSO. Depth, Width, Depth of Trench should be as per RDSO standard. Execution of cable trench and earthing system should be done as per. Approved Earthing lay out drawing available at site.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transformer -</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Conservator Tank (for visibility of oil level and top up purpose) From top 1/3 rd portion should be vacant.</td>
</tr>
<tr>
<td>(2) Winding temperature should be more than oil temperature from 35-40°C.</td>
</tr>
<tr>
<td>(3) Oil temperature from 35 to 40°C. In case of abnormality in oil and winding temperature indication will appear in Control Panel. Then, if nobody attended, further buzzer will function and in extreme case finally the transformer will trip.</td>
</tr>
<tr>
<td>(4) Auto tap changer (1 to 6 slot @ 1.63 KV range) – operation should be checked.</td>
</tr>
<tr>
<td>(5) Buchw Relay Protection for overheating of oil. At observation Glass always it should be oil filled up.</td>
</tr>
<tr>
<td>(6) In case of any abnormal situation, oil sump should be there for storing drained oil.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TESTING:</th>
</tr>
</thead>
<tbody>
<tr>
<td>In side TSS: Earth Fault Test (providing discharge rod on busbar between LV CB and feeder CV). Indication/ Alarm will appear on Control Panel in respective Relay Board.</td>
</tr>
<tr>
<td>Outside TSS: Earth Fault Test to be done by providing earthing at furthest end of the sector i.e. near SP. Respective feeder CB and relays should be tripped.</td>
</tr>
<tr>
<td><strong>CONTROL PANEL ROOM:</strong></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Rubber Mat at the front of control panel. Schematic Diagram, Working of TPC &amp; DOT phone. Shock Treatment Chart, Fire Extinguishers with refilling date (to be checked physically by operator). Separate earthing for RTU.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>BATTERY ROOM:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor should be with anti acid tiles. Battery (110 V, 200 Ah) – 55 Nos. cell of each 2.1 V. One stand by set should be available. Specific gravity of electrolyte should be checked (1.210 – 1.40 at 27°C).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>BURIED RAIL:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Buried Rail of 13 M length should be buried near feeding post gantry fencing coming from secondary side of transformer. It should be connected with all main line rail by 75x8 mm MS flat. Opposite to TSS/FP all the traction rails should be provided with rail bonds at approximate distances of 300 M, 500 M, 700 M and 1000 M from the TSS/FP.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SAFETY ITEMS:</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Staff Caution Board &amp; Danger Board near main gate, fencing, control room.</td>
<td></td>
</tr>
<tr>
<td>2. TSS Name Board: Fire Bucket on stand (sand &amp; water).</td>
<td></td>
</tr>
<tr>
<td>3. Fire Extinguisher: Rubber Mat, Rubber Hand Gloves, First Aid Box, Shock Treatment Charge</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>POWER LINE CROSSING</strong></th>
<th>Loc</th>
<th>Loc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Anti climb device</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Danger Boards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Tower Earth by two bonds, earth value not less than 10 ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Height actual: ( \text{required} ) Horizontal Clearance LH: ( \text{---} ) R: ( \text{---} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Check List for CRS inspection-Signalling

Name of Station: ..........................

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Items</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Panel Room</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>All indications eg. Point, Signals, TCs etc to be clearly visible on panel.</td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td>Testing of Functioning of SM's Key from panel.</td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td>No Panel Operation when SM's Key removed from panel, but Signal could be put back to ON by pressing signal button and ERN button even when SM's key was removed from the panel.</td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td>Sealing of Emergency route cancellation button</td>
<td></td>
</tr>
<tr>
<td>vi.</td>
<td>Starter Signal taken off and cancelled with 3-Botton (EUUYN) Cancellation. Ensure that Signal cancelled and EUUYN counter increased by one digit.</td>
<td></td>
</tr>
<tr>
<td>vii.</td>
<td>Calling-On signal clearing 60 seconds time delay after occupation of CO Track Circuit. Counter reading increases by one.</td>
<td></td>
</tr>
<tr>
<td>viii.</td>
<td>Slot for LC Gate for opening &amp; closing of gate from panel.</td>
<td></td>
</tr>
<tr>
<td>ix.</td>
<td>Crank handle box locked &amp; sealed.</td>
<td></td>
</tr>
<tr>
<td>x.</td>
<td>Panel Earthing arrangement</td>
<td></td>
</tr>
<tr>
<td>xi.</td>
<td>Block Instrument - Sealing &amp; locking</td>
<td></td>
</tr>
<tr>
<td>xii.</td>
<td>Block Instrument Over Hauling not due.</td>
<td></td>
</tr>
<tr>
<td>xiii.</td>
<td>Block Instrument earthing</td>
<td></td>
</tr>
<tr>
<td>xiv.</td>
<td>Provision of isolation transformers along with Block filter unit in RE area</td>
<td></td>
</tr>
<tr>
<td>xv.</td>
<td>Auto change-over of supplies i.e. AT supply, MSEB supply, DG supply etc.</td>
<td></td>
</tr>
<tr>
<td>xvi.</td>
<td>Telecom Equipment neatly mounted and lettering</td>
<td></td>
</tr>
<tr>
<td>xvii.</td>
<td>Status Monitoring Panel of IPS should be in working order.</td>
<td></td>
</tr>
<tr>
<td>xviii.</td>
<td>Spare Keys of LC gates, CH etc in box.</td>
<td></td>
</tr>
<tr>
<td>xix.</td>
<td>Cable duct properly covered</td>
<td></td>
</tr>
<tr>
<td>xxi.</td>
<td>Flooring in the SM's room after cable laying</td>
<td></td>
</tr>
<tr>
<td>xxii.</td>
<td>Documentation all registers like traffic department, joint testing of pelias &amp; crossing etc.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Relay Room</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>List of details of Relays used</td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td>If Relays used are more than 3 years old, they must be flashed</td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td>Availability of Relay testing / flashing unit</td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td>Relay wiring with proper gauge wires</td>
<td></td>
</tr>
<tr>
<td>v.</td>
<td>AC Immunized relays - QTA2, QSPA1, QNA1 in RE area.</td>
<td></td>
</tr>
<tr>
<td>vi.</td>
<td>CT Rack earthing of cable section</td>
<td></td>
</tr>
<tr>
<td>vii.</td>
<td>Earthing of Data logger and validation</td>
<td></td>
</tr>
<tr>
<td>viii.</td>
<td>No hanging wires, all wires / cables should be through proper supporting arrangement like scaffolding arrangement.</td>
<td></td>
</tr>
<tr>
<td>ix.</td>
<td>Double lock arrangement at door</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>3.</td>
<td>3.</td>
</tr>
<tr>
<td>----</td>
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<td>----</td>
</tr>
<tr>
<td>IPS Room</td>
<td>IPS Room</td>
<td>IPS Room</td>
</tr>
<tr>
<td>i.</td>
<td>Provision of maintenance free earth &amp; lightening discharger.</td>
<td>i.</td>
</tr>
<tr>
<td>ii.</td>
<td>Checking of cells voltages and specific gravity of battery bank</td>
<td>ii.</td>
</tr>
<tr>
<td>iii.</td>
<td>Provision of Rubber pad flooring for maintenance personnel.</td>
<td>iii.</td>
</tr>
<tr>
<td>iv.</td>
<td>Anti static PVC flooring.</td>
<td>iv.</td>
</tr>
<tr>
<td>v.</td>
<td>Incoming / Outgoing cables of proper size.</td>
<td>v.</td>
</tr>
<tr>
<td>vi.</td>
<td>Ceiling fan and exhaust fan should be provided.</td>
<td>vi.</td>
</tr>
<tr>
<td>vii.</td>
<td>Fire extinguisher should be provided.</td>
<td>vii.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.</th>
<th>4.</th>
<th>4.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Room</td>
<td>Battery Room</td>
<td>Battery Room</td>
</tr>
<tr>
<td>i.</td>
<td>Batteries properly numbered and of proper rating</td>
<td>i.</td>
</tr>
<tr>
<td>ii.</td>
<td>Terminal voltage with documents.</td>
<td>ii.</td>
</tr>
<tr>
<td>iii.</td>
<td>Specific gravity with documents.</td>
<td>iii.</td>
</tr>
<tr>
<td>iv.</td>
<td>Provision of Acid proof tiles.</td>
<td>iv.</td>
</tr>
<tr>
<td>v.</td>
<td>Ceiling fan / exhaust fan should be provided.</td>
<td>v.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.</th>
<th>5.</th>
<th>5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out Door</td>
<td>Out Door</td>
<td>Out Door</td>
</tr>
<tr>
<td>i.</td>
<td>Approach/Dead Approach locking in LC gates to be ensured as per SEM II guideline (Chap. 14).</td>
<td>i.</td>
</tr>
<tr>
<td>ii.</td>
<td>Cutting-In Relays for Signal Lamp Circuits with QNA1 Relays.</td>
<td>ii.</td>
</tr>
<tr>
<td>iii.</td>
<td>Earthing of armouring of cables in location boxes, GF lever frame as well as signal posts etc.</td>
<td>iii.</td>
</tr>
<tr>
<td>iv.</td>
<td>Trenching as per approved Cable route plan along the Railway boundary</td>
<td>iv.</td>
</tr>
<tr>
<td>v.</td>
<td>Provision of Cable Route Marker.</td>
<td>v.</td>
</tr>
<tr>
<td>vi.</td>
<td>Neat &amp; clean Foundation of location boxes, Signals, LC gates etc as per approved drawings.</td>
<td>vi.</td>
</tr>
<tr>
<td>vii.</td>
<td>Provision of Crank Handle welded with KLCR key</td>
<td>vii.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6.</th>
<th>6.</th>
<th>6.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of Standard Drawings of</td>
<td>Availability of Standard Drawings of</td>
<td>Availability of Standard Drawings of</td>
</tr>
<tr>
<td>i.</td>
<td>Brick Masonary Channel</td>
<td>i.</td>
</tr>
<tr>
<td>ii.</td>
<td>Cable Trench</td>
<td>ii.</td>
</tr>
<tr>
<td>iii.</td>
<td>Laying of Cable in Rocky Area.</td>
<td>iii.</td>
</tr>
<tr>
<td>iv.</td>
<td>Laying of Signal Cable &amp; Telecom Cable /Power Cable in same trench.</td>
<td>iv.</td>
</tr>
<tr>
<td>v.</td>
<td>Pipe under track crossing.</td>
<td>v.</td>
</tr>
<tr>
<td>vi.</td>
<td>G.I. Pipe on culvert.</td>
<td>vi.</td>
</tr>
<tr>
<td>vii.</td>
<td>Cable Trough (G.I.) for Girder bridges.</td>
<td>vii.</td>
</tr>
<tr>
<td>viii.</td>
<td>Arrangement of Cable Troughing on girder bridge</td>
<td>viii.</td>
</tr>
<tr>
<td>ix.</td>
<td>Cable Marker.</td>
<td>ix.</td>
</tr>
<tr>
<td>x.</td>
<td>Signal foundation.</td>
<td>x.</td>
</tr>
<tr>
<td>xi.</td>
<td>Shunt Signal Foundation.</td>
<td>xi.</td>
</tr>
<tr>
<td>xiv.</td>
<td>Foundation for Junction box.</td>
<td>xiv.</td>
</tr>
<tr>
<td>xv.</td>
<td>Foundation for T.L. Junction box.</td>
<td>xv.</td>
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<td>xvi.</td>
<td>Foundation for Ground Lever Frame.</td>
<td>xvi.</td>
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<td>xvii.</td>
<td>Cable Termination Board with Bakelite Sheet.</td>
<td></td>
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<td>xvi.</td>
<td>Relay Rack Assembly.</td>
<td></td>
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<td>xix.</td>
<td>“P” Marker non illuminated.</td>
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<td>xix.</td>
<td>Earth Electrode (G.I. Pipe).</td>
<td></td>
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<tr>
<td>xii.</td>
<td>C.C. Enclosure Earth Electrode and Handle.</td>
<td></td>
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<tr>
<td>xii.</td>
<td>Foundation for Block section limit board shunt limit board sighting board.</td>
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<td>xxiii.</td>
<td>Simulation Panel.</td>
<td></td>
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<td>xxiv.</td>
<td>Lamp board.</td>
<td></td>
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<tr>
<td>xxv.</td>
<td>Foundation for Type “A” foundation.</td>
<td></td>
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<td>xxvi.</td>
<td>Typical installation of earth for S&amp;T Installations.</td>
<td></td>
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<tr>
<td>xxvii.</td>
<td>Typical bonding and earthing connections for signaling equipments.</td>
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<td>xxviii.</td>
<td>Threaded End for Electric detectors</td>
<td></td>
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<tr>
<td>xxix.</td>
<td>Fixing Arrangement of Electric facing and lock detector independent foundation (B.G.)</td>
<td></td>
</tr>
</tbody>
</table>

7. List of Documents

(A) PLANS
A1. SIP
A2. SWRD
A3. Panel Diagram
A4. Selection table
A5. Track Jumper Plan
A6. Cable Core Plan
A7. Cable Route Plan
A8. ESP
A9. CRS Sanction
A10. CRS Application - Annexure 'A'
A11. Quality Technical Audit conducted by H.Q. Nominated I.A. Grade officers & SAG officers (where applicable)

(B) Pre-commissioning check list issued by RDSO/OEM commissioning certification
B1. IPS
B2. LED signal
B3. Data Logger
B4. Earth Leakage Detector
B5. Maintenance free earth

(C) Testing Documents of Certification
C1. Selection table
C1(i) Duly tested by S&T/Const. SSE/JE & Jointly with S&T open line representative.
C1(ii) Duly tested by S&T/Const. Officers.
C2. Square sheet
C2(i) Duly tested at SSE/JE Construction level.
C2(ii) Duly tested jointly by S&T open line representative.
C3. Cable Meggering
C3(i) Testing done jointly by S&T Const. SSE/JE & open line representative.
C4. Correspondence testing of – Signals, TC, Pt. M/C, CH, LC Gate

507
8. Tool Kit
   i. Digital Multi meter with lead
   ii. Soldering Iron
   iii. Cutting Plier
   iv. Screw driver set complete
   v. Files
   vi. Megger 500 Volt
   vii. Adjustable Wrench
   viii. Double Ended Spanner 30x32
   ix.a. Clamp meter (Motevaz)
   x. Multi meter (Rushabh)
   xi. Steel Scale 30cm
   xii. Point test gauge
   xiii. Screw driver 165 mm
   xiv. Leather Bag
   xv. Measuring Tap 3 mtr.
   xvi. Wire and Short Gauge
   xvii. Dial vernier Caliper
   xviii. Screw Gauge
   xix. Earth Tester
NORTHERN RAILWAY

Headquarters Office,
Kashmere Gate,
Delhi-110000.

No. 13-WW.Spl./Genl
Dated: 30/10/2015

Sub: Submission of CRS papers including opening of new line and doubling.

Instructions on the subject matter issued vide this office letter of even number dated 8.4.2013 are reiterated for strict compliance in the field units.

DA/As above.

(Mohd. Israeel)
Dy Chief Engineer, Const./Genl.II
For Chief Admin Officer/Const.

Copy to:
1. Secy. to CAO/C for kind information of CAO/C.
2. PS to CAO/C-II for kind information of CAO/C-II
3. CEw/Central, NC, NW, East, Spl. & Survey.
5. CEE/CNR/TKJ, NDLS.
Sub: Submission of CRS papers including opening of new line and doubling.

All CRS papers including opening of new line and doubling are required to be routed through G.Branch of HQ.Office, K.Gate to carry out thorough examination of all papers, drawings, plans and annexures before submitting the papers formally to CRS office as per the check list already circulated vide this office letter No.13-WW.Spl./Genl./CRS dt. 29.08.2008. In addition to this a list of documents is also sent herewith which are also required to be submitted along with the items of the check list. Drawings parts of CRS papers like completion plans, yard plans & L-Section etc. are to be dealt and checked by design and drawing cell of HQ. Office and overall coordination is to be done by Dy.CE/C/Genl-II.

DA: As above.

(Mohd. J. I. A)

Dy. CE/C/G-II

Copy to:
1. Secy./CAO/C for kind information of CAO/C.
2. Secy.CAO/C-II for kind information of CAO/C-II.
3. CEs/Central,NC,NW,East,Spl & Survey.
4. CS/EE/C,N, Rly, Baroda House, New Delhi
5. C.E.E./C.,N.R.,TKJ, NDSL
Annexure

Sub: Submission of CRS papers including opening of new line and doubling.

CRS papers including opening of new line/doubling should be routed through ‘G’ Branch of Hq. CRS Office, Kashmir Gate. In case of CRS papers for opening of new line/doubling, the following documents each in triplicate duly completed should be submitted.

1.0 In case of non-electrified routes

a) Brief narrative report
b) Safety certificate (each page to be signed by all concerned officers)
c) Form I to XVIII
d) Check list for certification of earth work
e) Check list of additional 20 points.
f) List of Level crossings
g) List of Yard plans
h) Check list for opening of New line/doubling etc. documents (34 points) along with PSR Annexure
i) Check list of signaling work applications.
j) Date of completion of earth work
k) List of curves
l) List of completion plans of bridges.
m) Test results of concrete.
n) Table showing stone ballast results
go) Index Plan on the scale of 1 in 50000 (one original and three Ferro coloured copies)

2.0 In case of electrified routes, following documents should also be submitted:

a) Safety certificates for electrical works signed by concerned CEE.
b) Certificate of open line officers and knowledge of their staff regarding safety rules for the electrified section countersigned by concerned DRM.
c) Copies of station working rules diagram for 25 KV AC distributed to the various Station Managers/Station Masters.
d) List of implantations of fixed structures where implantation is less than the specified values
e) The approval of energization of OHE issued by Electrical Inspector to Govt. of India.
f) The test report & other certificates for IIG approval for energization at 25 KV.
g) Condensation certificate in case of infringement.

In addition to above, the following documents are also required:

a) The complete details of department wise manpower (i.e. requirement as per norms, sanctioned and posted by the division and available at site of inspection) along with certificates from divisions and PHODS.
b) Approval of waterway of bridges & Siling of L-xings by Dy. Commissioner/DM of State Govt.
c) Technical inspection reports of major bridges duly signed by DYCE/Br Line of open line.
d) Deflection test of open web girder bridges.
e) Compliance of Inspection notes of HODs.
f) One set of copies of completion plan of bridges (as per format circulated vide this office letter No.84-W/7/WW.Sp-I/Bridge Policy/Pl.XII/2012 dt.25.03.2013), completion plan of yards, LWR plans and SIPs.

g) Details of the gangs with gang beats duly approved by the Pr. CE/NR

h) USFD testing of the welds with the certificate that no defective weld has been left in the track.

i) Type of welding adopted at the site and the results of the testing of test pieces may also be furnished.

k) Clean ballast cushion survey along with the AEN (Open line) of the section may be undertaken at every 250 m and tabulated details advising total ballast cushion and clean ballast cushion available may be furnished duly signed jointly on each page.

l) A comparative list of the passenger amenities to be provided as per Railway Board’s yardstick and the amenities provided for each of the stations should be submitted. Special mention should be made about the provision of FOB’s.

m) Certificate in respect of the following should be furnished:-

i) Data loggers have been provided at all stations on the section.

ii) Curve register, LWR register, level crossing register, points & crossing register, bridge register etc. have been prepared and inspections carried out and recorded in the registers.

iii) Desisting of the LWR has been completed alongwith the fixing of the reference pillars.

iv) Greasing of all the ERC’s in the section has been carried out.

n) Signature of officials with name & date should be clear on all certificates.

Dy.CE/C/G-II
उत्तर रेलवे
NORTHERN RAILWAY

PROCEDURE ORDER
Pr. CE's Circular No. 268 R
ON
HANDING/TAKING OVER OF NEW ASSETS

ENGINEERING DEPARTMENT

Date: 10-04-2015

(This supersedes Pr. CE's Circular No. 268 DATED 2.7.2014.)
**Sub: Procedure Order for Quality Assurance In Construction Works (including works being executed by RVNL etc.) and Handling/Taking over of Assets between Construction Unit & Open Line.**

Ref: Board's letters No. i) 85/W6/TS/3 dt. 02.07.91.  
ii) 89/W2/DL/0/7 dt.22-1.91, 20-3-91, 10.5.91 and 13-6-7-1994.  
iii) 2003/W-2/DL/0/1 dt. 10-04-2003,  
iv) 2005/W-1/Genl/H.Over dt. 20.12.05.  
v) Pr.CE’s Circular No.268 dt. 2.7.2014.  
vii) 2012/CE-I/CT/0/16 dt. 20.06.2012.

1.0 Introduction:

Quiet a few instructions have been issued by Railway Board from time to time in regard to handing over of newly created assets such as New lines, Doublings, Gauge conversion etc. by Construction Department to the Open Line for use and their maintenance.

These instructions also provide for inspections at various levels for identifying deficiencies for follow-up & corrective action required, while work is still in progress. Keeping all these instructions in view a complete version in the form of "Procedure Order" is being issued for strict observance in the field. Earlier PCIE Circular No. 268 issued on this subject is being revised hereunder. This revised circular is broadly based on circular prevailing on SER.

2.0 Approval of Plans/Drawings Prior to commencement of Works:

Various plans/drawings of Construction unit will be signed by Open Line Officers of Division and HQ before commencement of the work, as below:

<table>
<thead>
<tr>
<th>SL</th>
<th>Name of Drawing</th>
<th>Initial Approval at Divil level</th>
<th>Final Approval at HQ level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Yard Plans</td>
<td>Concerned BOS &amp; DRM</td>
<td>CPDE &amp; CONCERNED HODs OF OTHER DEPARTMENTS.</td>
</tr>
<tr>
<td></td>
<td>(i)Addition and alterations to existing yards.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii) New line yards</td>
<td>--</td>
<td>Do-</td>
</tr>
<tr>
<td>2.</td>
<td>L-sections (except New Lines)</td>
<td>CTE</td>
<td>CTE</td>
</tr>
<tr>
<td>3.</td>
<td>(i) GAD of all bridges on Open line</td>
<td>SR. DEN/Co-ord</td>
<td>CBE</td>
</tr>
</tbody>
</table>
(ii) GAD of all major bridges where linear waterway is begin reduced or vertical clearance are inadequate & where construction is likely to affect any of the existing bridge on Doubling/Gauge conversion projects.

(iii) GAD of bridges on new lines which affect the existing bridges.

(iv) GAD of all bridges of doubling under RVNL

(v) GAD for ROB/RUB/Flyover

| LWR Plans |  | CBE |
| GAD of New Station Buildings, Addition/Alteration to existing Station & Service buildings | SR. DEN(Co), SR. DCM, SR. DOM, SR. DEE(G), SR. DEE/TRD, SR. DME, SR. DSTE, DRM | CBE & CTPM |
| New Residential Flats/Bungalows/site & detailed lay-out Plans | SR. DEN(Co), SR. DEE(G) & SR. DSTE | CPDE |
| Launching and dismantling schemes |  | CBE |

Note: a) The latest updated yard plans will be handed over by Open Line to Construction Organization for yard arrangement works within 15 days.

b) The L-section submitted by Construction to CTE should be cleared within 15 days.

c) The planning of LHS/ROBs to replace LCs shall be done by Open line on Doubling/Gauge conversion and advised to Construction/RVNL.

d) Any works proposed by Open line in areas where Doubling/3rd line is sanctioned, should be made known to construction for inviting their comments so as to avoid eventuality of demolition at later stage.

e) Construction Organisation to ensure submission of Drawing in proper format and details for launching and dismantling schemes.

f) Bridge drawings should be cleared within 10 days and major bridges within 20 days.

g) Speed potential of existing lines should in any manner not be reduced. by addition of proposed lines.

Quality of work shall be ensured as stipulated in Board's above letter. For ensuring proper quality of works under execution and also to improve the field level co-ordination & interaction between concerned officials of construction and Open Line units, it has been decided that for all works in progress, the inspections should be done as under:

3.1 Mid-Construction Inspections:

During the scheduled inspections in their respective jurisdiction, the ARN/SR.DEN/SAG (Open Line) in-charge should also inspect the ongoing construction works to the relevant extent and deficiencies observed therein should be brought to the notice of their respective counterparts in writing with one copy endorsed to the next higher authority for information.

3.2 Joint Inspections of Works of New Line/Doubling/GC/Yard Remodeling (Prior to CRS's inspection):

a) When the work is nearing completion, one month prior to the date of CRS inspection, Dy. CE/Con shall notify to the concerned Sr. DEN as well as to concerned SAG in-charge (Open Line) in HQ for joint inspection of the section by Division for preparation of list of deficiencies. Soon after that the Sr.DEN and Dy.CE/Con shall inspect the section in detail and prepare a list of deficiencies. These deficiencies shall be attended by Construction before CRS’s inspection.

b) Joint Inspection by the SAG in-charge and CE/Con shall be conducted at least 2 (two) weeks before the CRS’s inspection and list out items of urgent compliance before CRS’s inspection.

c) At the time of joint inspections, the above officials should specifically look for any left out obstructions such as boulders, rail posts and foundations etc. which will create obstructions during deep screening by BCM and accordingly, record the observations in the joint inspection note. In case any obstructions are observed, the same should be cleared by the construction agency on urgency basis. [RB No.2911/Track –III/TK/4 dt. 10th July, 2012]

d) Sample Format of Joint Inspection:

<table>
<thead>
<tr>
<th>SL No.</th>
<th>Location</th>
<th>Deficiency</th>
<th>TDC of compliance by Constn. Deptt.</th>
<th>Any other Remarks</th>
</tr>
</thead>
</table>

3.3 Rectification of deficiencies by Construction, noted down in Jt. Inspections (in pars 3.2 above) before CRS's Inspection:

(i) After every joint inspection, deficiencies & left over works identified shall be given TDC and accord will be promptly attended/ completed by Construction officials within the stipulated time frame.
(ii) Deficiency list framed and rectification done shall be juxtaposed and jointly signed.

(iii) The final left-over works identified at Sr. DEN and Dy. CE(Con) level and further at SAG in-charge and CE(Con) level shall be listed out along with target date of their completion by construction organisation.

It will be imperative on the part of the Construction Organisation to rectify all the deficiencies as pointed out above within the time frame committed and mutually agreed.

4.0 Deployment of Track Machines on New Line/Doubling/OC:

The requirements of track machines and USFD testing shall be sent by construction branch for the full year as per the targets in the month of April and the project specific demands shall be placed one month in advance. Accordingly, machines shall be provided by Open line.


In pursuance of Correction Slip No.8 dt. 25-10-2004 to IRTMM 2000 (Para 5.1.3) following track geometry standards shall be ensured before deployment of track machines on construction projects:

a) Track laying standards in respect of gauge, joints, expansion gaps and spacing of sleepers for the new track as specified in Para-316 of IRTWM shall be followed.

b) The pre-tamping and post tamping operations as specified in chapter-3 of IRTMM-2000 shall be followed.

c) A minimum cushion of 200mm of clean ballast along with adequate ballast on shoulders and cribs shall be ensured before deploying the tamping machines.

d) The new track should be certified fit for 50 KM/PH by SE/JE/P.Way Con before requesting for the deployment of track machines as per Railway Board’s letter number 2006/Track-III/TRK/11 dt. 30.03.2006.

e) Facilities and consumables like provision of HSD oil, reconditioning of tamping tools, stabilising, chowkidars etc. should be arranged by construction organisation before deployment of machine.

f) Construction should provide facilities of 300 m long machine siding and with reentry facility at 30 Km-50 Km interval required for machine maintenance of track after commissioning of section (if such facility is not already available). Such requirements will be furnished by Open line.

4.2 Obligations of Track Machine Organisation:

a) Track machine will have full complements of tools in good fettle.

b) Wherever required, the Operators & M/C staff shall be made available to operate the machines.
c) DOS will be deployed wherever feasible.

d) The machine will be provided only for 2 rounds of packing at the entire section as per the work load assessed. On completion of these two rounds the section shall be made fit to open at a speed not less than 80 KMPH.

4.3 **Sectional Speed:** (B) Letter No. 2003/W-2/DL/0/1 Dt. 10.04.2003

(i) For new lines and doublings, it should be ensured by the Construction organization that track is initially opened to the traffic at a minimum speed of 80 KMPH or maximum sectional speed of existing line, in case of doubling.

(ii) The line should be handed over to Open Line only after its opening at 80 KMPH or maximum sectional speed of existing line, in case of doubling for Passenger Train. The subsequent raising of speed will be done by Open Line.

(iii) However, in case it is decided that Passenger Trains are not to be run for certain reasons, the line will be handed over to Open Line within 3 months of opening to Goods Traffic at 80 KMPH. CTRI's inspection will however be co-ordinated by construction organization, if it takes place within next 1 year of taking over by Open Line (No. 89/W2/DL/0/7 dated 10-04-2003).

5.0 **Maintenance of section, Creation of Posts and Deployment of maintenance staff:**

5.1 **Initial Maintenance contract for newly opened section:**
Maintenance contract for initial period of six months after commissioning of project shall be fixed by Open line in advance of opening of the section in terms of Board's Letter No. 98/W-1/Gen/30-Pt. Dt. 01.11.2011 and letter No.: 2012/CE-1/CT/O/16 dt. 20.06.2012. The maintenance requirements are to be assessed after a joint survey by Sr.DEN and Dy.CE/Con/RVNL officials.

5.2 **Creation of Posts and Deployment of Maintenance Staff:**

a) For creation of posts of maintenance staff, the executing organization will prepare the details of work load in respect of maintenance of new assets e.g. route Km, track km, ETkm, ITkm, waterway, plinth area etc. and get them vetted from the associate finance. The vetted proposal shall be submitted to concerned Division with a copy to CTE at least 10-12 months in advance.

The posts shall be created at divisional level within DRM's power. In case the matching surrender is not available at divisional level, then duly vetted proposal shall be submitted to HQ office (CTE) at least 6 months in advance for processing the creation of the posts.
b) The maintenance staff shall be provided by the concerned Division for newly created assets. Concerned Division shall process for recruitment/transfer of men as required so that the men are in position at the time of commissioning for traffic (BoI's No.2003/W-2/DL/0/1 dt.10.4.2003). In case of likely delay in arrangement of staff, basic staff such as Key Men, Gate and Petrol Men shall be essentially deployed by Open Line well in advance prior to CRS inspection.

c) Vide Board's Letter No. 2011/CEDO/SR/15/O/Vol.I dated 16th Dec, 2013, all requisite arrangement including manpower through departmental staff as well as through outsourcing as per needs for maintenance of all assets including track so as to ensure safe running of trains lies with the zonal railways.

d) Wherever needed, suitable maintenance contracts for P. Way, Works & Bridges where required, shall be awarded by the concerned Division in advance of the opening of the section for passenger train operation, so that maintenance activities may begin with the commissioning of the project. The maintenance contracts shall be for an initial period of one year. Availability of maintenance contracts shall be ensured till posting and availability of requirement of the maintenance staff.

6.0 Handing Over of Equipments/Tools:

With the laying of concrete sleepers, mechanized maintenance has become the only method of maintenance. List of necessary equipment for off-track tampers, cutting/drilling machines, MMUs, small track machines, gang tools etc. shall be prepared jointly as per yardstick given in Indian Railway Small Track Machine Manual-2005 and shall form part of the MOU. Same shall be procured and handed over to Open line before actual handing over of assets. (Board's Letter No. 2003/W-2/DL/0/1 dated 10.04.2003).

- Requirement of track fittings, switches, crossings, special fittings/components etc. as applicable, shall be worked out jointly and will also form part of MOU. Such stores will be handed over to open line prior to actual handing over of the assets to the open line organisation.

7.0 Handing Over of Documents/Drawings:

i) Detailed Project Report
ii) Narrative handing over notes under different heads (Para-E1620)
iii) Memorandum of understanding to complete the left over works signed by Sr.DEN/ DEN and Dy.CE/Con.
and also the following for:-

7.1 New Lines/Doublings/Gauge Conversion:

Registers:

i) Deep Cutting Register.
ii) Tunnel Inspection Register.
iii) The Index Plan Register.
iv) Bridge Inspection Register.
v) Asset Register.
vi) SWR/LWR/CWR plans & Register.
vii) Welding Register.
viii) Section Register.
ix) Curve Register.
x) Elevators & Crossing Register.
x1) Rail/Weld failure Register.
xii) Level Crossing Register.
xiii) USPD Register.
xiv) Land boundary registers. (807(b) (c) (d) (e) (f) of IRWM)
xv) Standard measurement book for Service buildings/Staff Quarters etc., (227(a) of IRWM).
xvi) Infringement Register with details of condonation to the
     infringements.
xvii) Bad bank Register.
xviii) Rivet(Loose) inspection Register/camber Register.

7.2 Plans / Drawings:

i) The Index plan & “L” section in tracing paper, duly approved.
ii) The certified land plans, land acquisition documents and
    compensation paid, Mutations etc. where land acquisition involved
iii) P. Way diagram.
iv) The original completion drawing of all the bridges including road-
    over bridges, road under bridges and pipe line crossings,
    buildings, stations yard plans Level Crossings etc.
v) Colony layout plans.
vi) The water supply arrangement details and the plans for water
    supply distributory system.
vii) The details of water purification plant.
viii) List of sections having ballast deficiency.
ix) History of major breaches/Cutting slips etc.
x) List of RATs with details/history/plans.
x1) Special feature like excessive tilting of wells of major bridges,
    unusual phenomenon encountered while construction of new line,
    etc.
xii) CRS's sanctions.
xiii) Compliance of CRS's observations at the time of opening.
xiv) List of Bridges (Para-E1621).
xv) List of Buildings (Para-E1622).
xvi) List of Level crossings (Para-E1623).
xvii) List of Bench marks (Para-E1624).
xviii) List of completion drawings (Para E-1625).
7.3 New Buildings/ROB/RUB/FOB/Pipe Line Crossings/other structures:
   i) Approved site plan.
   ii) Approved GAD.
   iii) Approved structural drawings.
   iv) Agreement's copy (In case of ROB/RUB/Pipe line crossings).

7.4 Documents to be handed to other Deps.: The documents to be handed over to the departments like S&T, Electrical and other departments are also required to be prepared and handed over to the respective departments by the Construction organization as per the system laid down by respective PHODs.

8.0 Handing Over/Taking Over of Assets and Signing of MOU:

8.1 On completion of CRS's inspection, an MOU shall be drawn between Open Line and Construction/RVNL for completion of deficiencies/lef over works by Construction/RVNL within 6 months duly indicating TDC against each item [BD's letter No. 98/W-1/Gen/0/30-Pt. Dt.01.11.2011]. A copy of the MOU shall be sent to PCE and CAO. The MOU shall be based on the inspections reports of Sr.DEN and Dy.CE/CE/Con., SAG/OL & CE/Con. And CRS.

8.2 The work completed by Construction organization should be taken over by Open Line after CRS's inspection at the earliest. For any delay beyond one month, the details/report be submitted by the concerned SAG office of Construction Department to CTE under intimation to PCE and CAO/Con. (2005/W-1/GNL/H Over dated 20.12.2005).

8.3 Past MOUs, if any, entered between Construction and Open Line be also commented upon for the progress made on items mentioned therein.

9.0 Data Entry of new section in Track Management System (TMS):

It is the responsibility of executing agency that complete Master Data as per TMS proforma is filled up correctly, checked & signed by its supervisors & officers and handed over in hard copy to open line.
Correctness of data should also be verified & entered in TMS by open line before taking over new section/line.

10.0 Conclusion:
In nutshell, the handing over of new section should be done in a systematic manner. Good quality of work is to be ensured, sanctions of staff for maintenance to be in place, selected staff to be posted in position, the prescribed Register opened, completion/land plans finalized and the required facilities as per sanctioned Estimates provided to facilitate efficient operation of the section without having to arrange for further facilities/staff etc., subsequently. Standard of works as per various codes and manuals and good construction practices to be followed. There should be regular dialogue between Dy.CE and Sr.DEN concerned of Open line and also between concerned Construction and Open Line HODs throughout the construction process in respect of issues brought out in this JPO.

No. 219-W/24/O/Pl. IV/TP

Date: 10.04.2015

Copy to:
1) Secy. To GM for kind information of GM.
2) CAO/Const., Northern Railway, K. Gate, New Delhi.
3) All PHODs, N. Railway.
4) All HODs, Engg. Branch.
5) Sr. DEN/C's/N.Rly., DLJ, FZR, LKO, MB & UMB
No. 2020/Safety (A & R)/19/07  New Delhi, dated 18.03.2020

The General Managers
All Indian Railways,
Konkan Railway Corp., Navi Mumbai,
Railway Electrification, Allahabad,
Metro Railway Kolkata.

Sub:  Notification of Indian Railways (Open Lines) General Rules 4.10-Increasing speed of trains to 30 KMPH during NI working.

Gazette Notification of amendment of Indian Railways (Open Lines) General Rules 4.10-Increasing speed of trains to 30 KMPH during NI working has been notified by Govt. of India Press and published under G.S.R. 168 (E) dated 12.03.2020. Copy of the notification in Hindi and English, is enclosed herewith for information.

While approving the amendment to G.R. 4.10 following precautionary conditions were stipulated and approved by Board and CCRS:

i) Speed can be raised up to 30 Kmph with clamp padlocking of points by using suitable clamps.

ii) No separate temporary panel is needed and only free home signal shall be given.

iii) Integrity of point shall be checked by Operating Staff and normal detection of facing points shall be proved in the concerned signal by suitable circuit wiring.

iv) Physical verification of track shall be done by ASM physically.

v) Necessary safety directions should be incorporated in temporary working instructions for non-interlocking at 30 Kmph under approved special instruction with suitable infrastructural support as deemed necessary.

Zonal Railways are requested to issue necessary instructions as brought out above and take appropriate precaution.

DA:  As above.

-Sd-
(K.P. Yadav)
Executive Director/Safety-II
Railway Board
NORTHERN RAILWAY
CONSTRUCTION ORGANIZATION

IMPROVEMENTS CARRIED OUT

IN

TRACK & WORKS

MUZAFFARNAGAR - TAPRI
DOUBLING PROJECT
(51.53 Kms)

MUZAFFARNAGAR - DEOBAND
(23.532 Km)
Commissioning:MAR-2020
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<tr>
<td>IN CIVIL/P.WAY WORKS IN MOZ-DBD SECTION</td>
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<td>P.Way Works:</td>
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<td>CIVIL WORKS:</td>
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<td>PLATFORM WORK</td>
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<td>BRIDGE WORK (MAJOR BRIDGE)</td>
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<td>ALL OTHER WORKS</td>
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1.1 Cast in-situ Glued Joint: Enhanced Safety and Economy

Insertion of Glued Joint in Railway track for track circuiting requires cut In Rails and two AT Welding. AT Welding in track is potential area due to weak link and area of concern in view of possible fractures and reliability of running system. Cast in-situ Glued joint method eliminates two weld joint from each location and hence results in Enhanced Safety as well as Economy. Further traditional method consists of hassles and costs of various transportations of Rails, Inventory, Handling and re-handling, chain supply management and involved man power in all such activities. Case study of use of cast in-situ glued joints in doubling project of section Meerut-Daurala presented here to sum up significant benefits. Applicable references have also been listed for ready reference.

1.0 Introduction:

Normally, the Glued joints are fabricated in shop floor and transported to the site and inserted by introducing two AT welds. The fabrication of Glued joint by providing single cut in existing Rail or Panel and provision of glued joint without requirement of AT weld has numerous advantages. The detailed methodology of Cast in situ glued joint has been given in CE circular (1) by Northern Railway in 2008 in supersession of earlier one of 2007.

The requirements of material, Equipment and specification including precautions and repair to existing Glued joints have been covered in this document in details.

2.0 Cast in-situ requirement:

In addition to other methodology, important changes for in-situ fabrications are briefed below.

a) In case of fabrication in running track, minimum traffic block of 2 hours shall be taken and track protected with banner flag and detonators. Rail should be made free of fitting over a length of 2.00m on either side.

b) The fabrication operation should be finished within 45-60 minutes so that minimum 60 minutes setting time is achieved.

c) About 20 min after initial tightening, all the bolts shall be re-tightened with the torque of 105 kg-M.

d) Traffic may be passed at restricted speed of 30Kmph for about two hours after which the speed restriction shall be relaxed to normal.
e) In Works where rail renewal is also involved or spare rails are available, fabrication of glued joint should be done on cess and a rail panel of required length made on cess without need of a traffic block.

3.0 Inspection requirements:
   a) Every fabricated/assembled joint shall be checked for vertical and lateral alignment within 1m long straight edge. The tolerance permitted shall be as under:
      (i) **Vertical Alignment:** Variation at the joint shall be within +1mm and -0mm measured at the end of 1m straight edge placed at the top of rail head.
      (ii) **Lateral Alignment:** Variation at the joint shall not be more than +0.5mm measured at the end of 1m straight edge placed along the gauge face.
   b) All the other tests shall be carried out only if the joints are dimensionally satisfactory.
   c) Each joint shall be subjected to insulation resistance test in dry condition. A meggering voltage of 100 volts D.C shall be applied across the joint, the value of the insulation resistance shall not be less than 25 mega ohms.

4.0 RDSO Approved Firms:
   There are 37 firms approved by RDSO for fabrication of Glued Joints and details are available in RDSO document No: QC-M-7.1-1 Ver.13.0 page-52 to 54.

5.0 Various Savings in cast in-situ G. Joints:
The following are the possible savings if cast in-situ Glued joint method is preferred to the extent, as per site conditions.
   a) Two AT Welding including block
   b) Testing of AT Welding and associated man/machine
   c) Re-Welding in case of USFD failure of weld
   d) Transportation of prefabricated Glued Joints (Depot to site)
   e) Transportation of Rails for prefabrication of Glued Joints
   f) Transportation of Prefabricated Glued Joints (Factory to Depot)
   g) Inventory and Chain Supply Cost
   h) Handling, re-handling of Glued Joint at each stage
   i) Man power saving in all above processes

6.0 Proforma for Record Keeping:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Dt of Fabrication</th>
<th>Exact location</th>
<th>Name of Artisan</th>
<th>Name of Supervisor</th>
<th>Whethe r on cess /Traffic Block</th>
<th>Inspectio n by</th>
<th>Dimensional Check (OK or NOT OK)</th>
<th>Insulation Resistance (in Mega Ohm)</th>
</tr>
</thead>
</table>

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7.0 Pull Out Test:

On a lot of each 50 joints or part thereof one test piece glued joint shall be fabricated by agency at site on cess with similar material and quality control measures and with same set of equipments. For G3(L) type joint load applied shall be 150 T for 52 Kg and 170 T for 60 Kg.

a) The pull out test shall be conducted by suitably gripping the two rail pieces of the joint and subjecting the joint to axial tension.

One method of the conducting the test is to hold on end of the glued joint with the help of the fish plates as fixed end. The other end of the glued joint is held to a moving frame with the help of a wedge inserted in slot cut in the glued joint through the moving frame brackets. The other method of conducting the test is to hold the glued joint with the help of fish plates at both the ends of the testing frame. One end of the testing frame remains fixed and the other is moved with the help of two hydraulic jacks operated simultaneously.

8.0 Plans and number of cast in situ Glued joints at different yards: So far in KAT-MOZ

Track circuit plan are attached and the total no of AT welds saved given in table below:

<table>
<thead>
<tr>
<th>Station</th>
<th>No. of Glued Joint</th>
<th>AT Weld Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOZ</td>
<td>142</td>
<td>284</td>
</tr>
<tr>
<td>BMHR</td>
<td>132</td>
<td>264</td>
</tr>
<tr>
<td>RNA</td>
<td>98</td>
<td>196</td>
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<tr>
<td>G. TOTAL</td>
<td>372</td>
<td>744</td>
</tr>
</tbody>
</table>

9.0 Conclusion:

The method of cast in-situ glued joints is far superior in comparison to traditional pre-fabricated glued joint insertion on account of not only economy, but also enhanced safety due to elimination of AT welds which are weak links in track. Further, traditional pre-fabricated glued joint method involves various indirect costs like multi stage transportation, inventory, handling and processes costs in comparison to in-situ glued joint method.

References:
1. CE Circular No. 259/R-1 (P-Way) on "In site Fabrication of Glued Joints".
Welding of T/outs except 6 nos fish plated joints in tongue rail and crossing for smoother riding

Turn outs in Railway tracks consists of many joints in view of various track components. The running quality as well as wear & tear and maintenance efforts get effected due to additional joints in this area.

Though the number of joints cannot be eliminated but the same have been welded except 6 numbers, which are essential to be connected by fish plates at heel of switches and around crossings.

This improvement of welding of all joints in turnout position except 6 nos will enhance riding quality, maintenance effort and help retain the geometry of track due to less vibrations in comparison to ordinary fish plated joints.

DETAILS OF WELDING IN TURNOUT ZONE

(1) Weld saved Marked in Green by using panels and making in-situ glued joint.

(2) All joints in turn outs are welded (W) except 6 nos Fishplated (F/P), which will reduce maintenance requirements.
### Opening of S&T rods/stretcher bars in T/outs for tamping

Machine temping in turnout portions are important as special machine (UNIMAT) is used for the same. S&T rods/stretcher bars create infringement to the temping tools and generally left for manual packing resulting in mismatch in track geometry. This mismatch in packing results into requirement for frequent attention/packing by calling UNIMAT machine and consequently requiring additional blocks, machine, man power.

In KAT-MOZ doubling section, opening of S&T rods/stretcher bars done. It will help in uniform packing & geometry and will reduce frequency of attention of turn outs by open line unit.

### Re-grading of road surface on approaches to make required grade i.e.

1 in 40/1 in 30
<table>
<thead>
<tr>
<th>Replacement of all non standard height gauges</th>
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<tr>
<td><img src="image" alt="Replacement of all non standard height gauges" /></td>
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</tbody>
</table>

<table>
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<tr>
<th>Provision of machine cut check rails in all level crossings</th>
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</thead>
<tbody>
<tr>
<td><img src="image" alt="Provision of machine cut check rails in all level crossings" /></td>
</tr>
</tbody>
</table>
Provision of precast panels in platform walls

VDC flooring in alternate panels to prevent diagonal thermal cracks

CC pavers in the area where utilities like pipe line, electrical, S&T cables passes to allow maintenance
Sacrificial shuttering in FOBs

Protection screen on FOB in full length

AT BMHR STATION

ATRNA STATION
<table>
<thead>
<tr>
<th>Fixing of temporary channel support in nosing angles to ensure step's dimensions (150mm size &amp; 300m tread).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run on/Run off pieces of SAW welding in all girders of FOB</td>
</tr>
<tr>
<td>Turfing with Sarkanda on bridge embankment for stability.</td>
</tr>
</tbody>
</table>
Sacrificial shuttering used at major bridge 189 for better durability

Elimination of curve in MOZ yard

Earlier approved Drawing
After removal of Curve
Rebuilding Plan of ROB at LC-54 in Rly Portion
(New Pier out side of Railway Land)
Planning and work of new station building in progress at MOZ

Planned possibility of conversion of line no 5 from goods to passenger, in case goods facilities shifts out of MOZ in future
Elimination of LC 52 planned by LHS after efforts of two yrs with state authorities in getting feasibility

Saving of all existing OHE portals in BMHR Yard by planning loop line away.
OHE PORTAL SAVING AT BAMANHERI YARD
Advance planning of Goods facilities at BMHR with 5th line as well as future expansion of UP loop. BMHR has location advantage being on peripheral road of MOZ.

Station buildings planned with stilts at BMHR and RNA.
Phase plan of DBD yard to eliminate curves in approaches in future yard remodeling

Already Appd ESP of 4 Lines

Proposed R-1 ESP of 5 Lines

Yard Planning to save OHE Poles at MOZ Yard
Master plan of DBD yard planned with 5 line facilities as it will be Junction station after DBD-RK new line.
Innovative Concept of Design of ROB with Bow shaped girder with curved bottom to accommodate summit curve & HSFG Bolts

1 - Summit Curve
2 - Horizontal “RLY” Portion
3 - Summit Curve
4 - Summit Curve in RLY Portion
5 + 6 - Shortened Approaches
   (Shortened Viaduct or Fill: “Savings”)

(Prevalent System in Blue Color, Proposed in Red)
CHAPTER -13  
SIGNALLING WORKS

13.1 Checklist for ESP & Signalling Documents

13.1.1 Checklist for Engineering Scale Plan

Engineering scale plan is the starting point for signalling work. Development of SIP, Signal Interlocking plan depends on error free ESP. In order to expedite development of SIP, PCSTE/NR had issued a checklist as under:

Following items need to be incorporated in ESP before sending to S&T deptt.
For approval:

1. North point should be shown and should be correct.

2. Gradients up to 2.5 km on either side of facing points must be shown and should be in sequence (particularly where panel interlocking is to be provided).

3. Gradients in ‘Station Section’ should not exceed 1 in 400, if it does, safety sidings are necessary. If gradient in neighbourhood of yard is more than 1 in 80 falling towards station, catch siding is necessary. Slip siding is necessary for gradients more than 1 in 100 falling away from station.

4. Existing lay-out should be correct and should reconcile with the existing signalling plans. Correct reference of previous NRHQE plan should be mentioned if a new plan is made.

5. All lines should be designated for identification and reference.

6. The CSR of a reception line should be 700m (Min) from starter to F.M. at the rear end.

7. The clear available length of all lines should be given indicating whether it is from F.M., or F.M. to trap or point.

8. Signals must not be shown on these plans.

9. Platforms should be provided on lines on which it is intended to receive passenger trains.

10. The classification, number type of gates unmanned/manned and number of gateman should be written for all gates within 2.5 km of facing points (particularly for panel interlocked station).

11. The angle of crossing of turnout should be noted, Passenger trains are permitted over 1 in 8 & ½ only if switches are curved.

12. If signalling post, signal foundation or any signalling gear is to be provided between two tracks then distance between centre of adjacent tracks must be increased by the width of such signalling installation as per advance correction slip no. 19 of Schedule of Dimension 2004. Thus in ESP
clearance between centre of tracks of adjacent tracks must be checked in view to ensure no infringement by signalling post/foundation with SOD.

13. Location of Cabins
   a) The cabins should not be in front of a trap or snag or dead end.
   b) Cabins should be so located that all points and signals are within working range as far as possible.
   c) Where two cabins are provided, they should be so located that the cabin men ensure complete arrival of trains.
   d) The cabins and Station Master’s office should not be on the same side of the track, so that a train can be inspected from both sides when running through. Cabins should preferably be on the side where the home signal is required to be.
   e) In case of central cabins, they should be located close to the S.M’s office.

14. All running lines must be isolated from sidings (i.e. non running lines). Derailing side of trap should be shown correctly.

15. All passenger running lines must be isolated from goods running lines.

16. Traffic yard should be isolated from the private siding, if any.

17. At junction station where trains run through on the main line at speed exceeding 30-50 km per hour, the main line should be isolated from all other lines including the branch line.

18. It is desirable that sidings take off from the loop line and not from the main line as far as possible.

19. Where alterations are made to existing layout, it may be ensured that points and signals remain within the working range as far as possible.

20. If panel interlocking/electronic interlocking is to be provided, reference of standard plan for generator room, Panel room etc. to be given.

21. There should not be any change of gradient within 30m of points because difficulty in installation of gears to operate the points.

22. Chainage of the outer most facing points on both sides of the yard to be mentioned.
    a) Gate lodges to be shown near the level crossings.
    b) Whether extension of cabin is required or not, if required give with leverage.
    c) UP & DOWN directions in the yard must be shown.
    d) Correct reference of previous ESP to be mentioned in the notes.
23. All dimensions/scale/chainage etc. should be in meters only and not in feet, inches or O/H alignment poles.

24. Kilometre of central line of station should be given as per time table in force.

25. The dismantled work should be shown in green clearly.

26. Adequate provision for PRC/Wooden sleepers invariably be made for track circuiting new portions or on account of shifted position of signals.

27. ‘To’ & ‘From’ stations/junction stations on either side may be correctly marked along with arrows ‘From’ on left hand side & ‘To’ on the right hand side of the ESP.

28. No. of levers in the cabins must be indicated.

29. Revision plan like R-1 etc. must also be approved by concerned Divisional Officers.

30. Preferably the gradient should not be continuously steeper than 1 in 260 between distant & home in single distant territory & between inner distant & home signal in double distant territory; otherwise Block overlap would be increased from 180.00 mtrs to 300.00 mtrs.

31. Correct opening of points are shown.

32. Length of overlaps / dead end to be of 120 mtrs for MACLS and 180 mtrs for LQ for signal overlap.

(Ref: Letter no.56-Sig/0/16 dt 08.12.05 issued by office of CSTE/NR)

13.1.2 Preparation of Signalling Documents

1. As per existing policy (Railway board letter no. 2003/SIG/G/5 date 28.04.2016, Annex-13.01) all future stations up to 500 routes are to be interlocked with Electronic interlocking. Further relay interlocking estimates may be revised for provision of EI without causing material modification as per Railway board letter No. 2008/SIG/SGF/4E1/Geni dated 05.07.2011, Annexure-13.01.

2. Railway board has issued standard scheme for preparation of SIP vide its letter no. 2018/Sig/36-SD/1 date 26.11.2019 (Annex-13.02) and has instructed to prepare all future SIP, Selection table and VDU diagram as per railway board scheme. The complete document/scheme for standard drawing is available at railnet website http://10.195.2.19/iriweb/wiki/LearningResources. Vide the same letter Railway board has also issued standard circuit for EI for stations up to 100 routes and has instructed to implement the same for future EI up to 100 routes. The standard circuit (i.e. logic and interface) is available at railnet website http://10.100.2.19/signal/policy/uniform circuit diagram.htm.

3. All stations on A and B routes be provided with double distant signal as per Railway board letter no. 2017/SIG/WP/Double Dist. Date 22.08.2017 (Annex-13.03) and as per sanctioned work for other routes.

4. Up to 100 routes dual VDU must be provided for operation and indication of signalling gears.
5. Major alteration in existing PI/RRI must be avoided and if unavoidable then approval of PCSTE will be required. (Railway Board letter no. 2012/SIG/SF/2(Policy) dt. 09.4.2012, para 1.6 of annexure (Annex-13.04).

13.2 Utility Shifting Involving S&T during Doubling Works in Construction

- Track layout plan must be studied in consultation with Engineering Department for understanding the route map of the proposed line.
- Cable laying Drawings of the existing cables (S&T) of running circuits should be taken from open line.
- Joint Survey (Supervisor or JS officer level) (S&T/OL, S&T/C &Engg. /Const.) on foot should be carried out to verify the cable route plans physically and finding out the patches which are in infringement of the route map. Thereafter, vulnerable assets like location boxes, patches/stretch of cables should be identified with engineering & preventive action of shifting should be taken through agency already fixed and liasoning with S&T Open line. Preference will be given to main line linking.
- There may be a stretch where the cable may be sufficiently deep not getting affected by the movement of JCB. Such cases do not involve shifting of cables.
- Alternative place to lay/shift cables/location boxes to be demarcated by the agency under guidance of S&T/C & S&T/OL.
- Availability of adequate space is very crucial and hence, must be clearly identified beforehand.

13.3 Planning / Preparation of NI Works

13.3.1 Essentials of Planning for NI works

i. NI working should be carefully planned, listing out activities required to be completed during the allowed period and should be checked for adequacy at the minimum level of JA Grade officer consulting the Divisional Operating & Signal officers at every stage. In case of stations having more than 100 routes, the planning and checking of requirements should be done at a higher level.

ii. Most of the works should be completed in advance, leaving the bare minimum works for completion during pre-NI periods with final changing over, testing/commissioning to be completed during NI period.

iii. The preparatory works should be closely monitored and reviewed jointly by Construction organization with Open Line officers and outdoor works should be re-confirmed and re-tested before taking up NI.

iv. The NI period should be minimum to ensure operational safety with minimum detention of trains.

v. For major yard, PNI work will be indicated clearly in method statement to be submitted to CRS in CRS application and PNI works will be started only after receiving CRS sanction for same.
vi. A detailed day to day program for NI and BNI should be prepared and signed by Dy.CE, Dy.CSTE, Dy.CEE and concerned divisional officers. The format of day to day should be as under.

<table>
<thead>
<tr>
<th>Day</th>
<th>Civil Engg. Works</th>
<th>S&amp;T Works</th>
<th>TRD Works</th>
<th>Block Requirement</th>
<th>Repercussion on movement</th>
<th>OPT G</th>
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</table>

vii. Following points must be mentioned in day to day program

1. NI work will be started after completion of all BNI work and after joint inspection of XEN, AESTE/C.

2. (Left Blank).

3. Independent teams of black smiths & Gang man for crossover shall be deputed for timely completion of work related with points and proper packing shall be done after spacing of sleepers for timely completion of P-way work as S&T work will be taken in hand afterward & has to be completed on same day.

4. Proper Lighting arrangement in goomties, all points. point zones with Generator back up shall be made available by DYCEE/C.

5. During NI, train without engine will not be stabled in yard as there will be no isolation during this period.

6. Temporary goomties will be erected by Engg. Deptt. of construction organization. Lighting in these goomties will be done by Elec. Deptt. of construction organization. Communication in these goomties will be done by S&T Deptt. of construction organization.

7. NI program does not include minor blocks for welding, insertion of Glued joints and point machines adjustments etc. which shall be taken as per site requirement.

8. 20kmph caution may be introduced in the Yard 10 days before NI for insertion of glued joint, PRC sleepers of turn out and SEJ and 2 hrs traffic block for insertion of CMS crossing for each 4 no. T/out in main line.

9. Packing of points shall be done by UNIMAT machine before or during NI period.

10. CSM, UNIMAT & DGS will be required for tamping of newly laid track & t/o'uts.

11. Infringement of OHE mast may be removed 30 days before introduction of NI
12. RE Tower wagon with wiring train must be allowed on new tracks and points before start of BNI & NI works on OHE so that it can be made fit for traffic whenever NI complete.

13. Reception of trains will be governed by free Home Signal & dispatch will be made on free starter and advanced starter interlocked with block instrument working.

14. During NI period, no interlocking will be effective except advance starter signal which will be interlocked with block instrument. Hence, before lowering reception/departure signal (Home/starter), manual route setting and locking must be ensured by concerned ASM on duty after ensuring proper route setting, clamping & pad locking of points in required position, ensuring LC gate closed.

15. All signals will be free from all type of interlocking control of track circuit, level crossing gate, point indication etc.

16. All points in the yard shall be operated locally by crank handle or tie bar if point machine is not fitted.

viii. It must be ensured that method statement of CRS application includes details of signalled movement in yard over undetected point during BNI and insertion of such points be done only after obtaining CRS sanction. For signalled movement over undetected point speed restriction of 15 KMPH is imposed. In Temporary-working-instruction, it should be clearly mentioned that the operating staff should ensure correct the setting and locking of the non-interlocked point for movement over it.

13.3.2 Checklist for Planning and Preparation of Works:


i. Ensure that detailed planning of all the activities to be done keeping in view of the available NI working period and/or traffic blocks planned and available.

ii. Ensure that issues related to each and every portion of the indoor and outdoor signalling& Telecom works, Yard Modifications, Electrical & OHE, P-Way and Engineering works listed out and tied up for execution in time.

iii. Ensure all plans and system design documents related to below mentioned items are carefully prepared and got approved.

a. Engineering Scale Plan (ESP).

b. Signalling Interlocking Plan (SIP).

c. Route Section Plan (RSP).

d. Selection Table or Route Control Chart (RCC).

e. Track Circuit Bonding Plan.

f. Station Working Rule Diagram (SWRD).
g. Interface Circuit and Logic Circuit Diagram.

h. Key Plan (MiniEngg.. Plan in A4/A3 size).

i. Contact booking/allotment and contact Analysis should be made available to assess the repeater relays.

j. VDU/Panel Diagram.

k. SIP shall be prepared fresh after three alterations.

l. Cable Route Plan.

m. Cable Core Chart.

iv. In case of existing interlocked installations, completion drawing should be physically verified before starting fresh wiring for incorporating the alterations. Fresh wiring should be done using wires of different colour to distinguish it from existing wiring. At least 2 level checking should be done before a wire is tagged and terminated.

v. Wiring alterations in existing PI/RRI installations should generally not be allowed in case alteration involved in existing relay wiring is large. The permission to carry out a sanctioned work by wiring alteration in existing PI/RRI shall be granted after due deliberation at the level of PCSTE only.

vi. NI period for alteration in existing installation should be sought based on number of jumper wires involved and testing of panel as per selection table.

vii. Calling on Signals below Starters Signals should be allowed to take off with zero time delay. Calling On below Home Signals should be provided with time delay of 60 seconds.

viii. All Signalling reliability improvement measures issued by HQ, Board & RDSO should be complied while executing new RRI/PI works to avoid alterations at a later stage.

ix. For better appreciation of SIP of major yards, Route Table in the following format should be sent to Traffic branch listing out all routes required for safe train operations as per the proposed SIP:

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Signal No.</th>
<th>Route up to Signal No.</th>
<th>Remarks (Regarding Short Shunt, Overlap/isolation Points locked, Sectional Route Release, Parallel movements and Restrictions, if any).</th>
</tr>
</thead>
</table>

13.3.3.1 Disposal of CRS Observations

All observation of CRS should be discussed with CTPM/other concerned officers and an agreed version of comments duly approved by PCSTE & PCOM (where required) should be sent to CRS to avoid dispute at a later date especially with regard to short shunt, overlap release, isolation, simultaneous movements etc.

13.3.3.2 Quality Audit Inspection

Quality audit inspection should be conducted for all EI/PI/RRI work and all addition/alteration Signalling work & other major Signalling works involving changes in Signalling Circuits in the proforma issued by HQ vide letters no. 433-Sig/Quality Audit Insp./Pt-III dated 16.03.2017, 11.12.2017, 07.08.2019 & 06.09.2019 (Annex-13.05).

13.3.3.3 Technical System Application Approval

Technical System Application Approval should be obtained for EI works as instructed vide Railway Board Letter No 2012/Sig/ATSS dated 02.09.2015 (Annex-13.06).

13.3.4 Checklist for Execution of Field Works

i. As the work progresses, 60 days before proposed NI, regular weekly reviews at SAG level should be done for final planning of all the activities during BNI, NI and Post-NI period. During these reviews, progress of these activities should be closely monitored and all hurdles should be resolved in close coordination with concerned departments and agencies.

ii. Ensure commencement of NI for all RRI/EI/PI works at major station/junction stations only after approval of competent authority.

iii. Phased commissioning should be adopted, where feasible, to reduce NI period.

iv. Ensure completion of all major activities/works, which can be completed prior to NI, are completed in all respects before NI.

v. Compliance of observations of joint JAG and joint SAG inspection are ensured before starting the NI work.

vi. Assistance of OEM, RDSO & Zonal Design Team etc to be taken to resolve any design related issues.

13.3.4.1 Points

i. Care should be taken while laying switch rails. LH tongue rail should be provided with LH turn out and similarly for RH side.
ii. Ensure all the points to be inserted are pre-assembled on a staging outside and point machine fixing arrangements and ground connections are pre-tested and kept ready for final adjustment. Ensure proper housing of tongue rails in assembled turnouts by Engineering officials at site.

iii. Interlocking of Siding point should be done with care, keeping in view restriction imposed if any on CSL.

iv. Point must be inspected as per SEM para no. 12.40 and annexure 5 of chapter 12 before insertion in track & also after insertion in track and any short coming must be corrected prior to interlocking the point.

v. Ensure housing of 5 sleeper in fan shaped turnout and 13 sleeper in thick web turn out.

13.3.4.2 Schedule of Dimensions(SOD)

i. Ensure checking of all infringements at the time of installation of the equipment, Signal Posts with Units, Point machines and their ground connection, Location boxes etc and again rechecking before the NI commences.

ii. Infringement of signalling gears to SOD must be checked as per clearance mentioned in advance correction slip no. 16 of Schedule of Dimension 2004.

iii. If signalling post, signal foundation or any signalling gear is to be provided between two tracks then distance between centres of adjacent tracks must be increased by the width of such signalling installation as per advance correction slip no. 19 of Schedule of Dimension 2004.

iv. Prior sanction of Railway Board through the Commissioner/Chief Commissioner of Railway Safety be taken if there is unavoidable infringement to SOD by signalling gear in execution of the work.

13.3.4.3 Relay Wiring & Testing

i. Ensure, testing of new functions and outside gears in advance in case of alteration/modification to existing Signalling/Interlocking alteration work. Also verification of existing wiring, contact analysis etc. should be done deploying additional trained staff.

ii. Ensure rechecking of Old wiring / cabling / fitting of points / track circuit and signals etc. lying unused for more than 3 months, jointly by concerned construction & maintenance supervisors and officers before taking up NI. For old wiring, wiring is re-checked from base point to tag block and tag block to tag block before NI. Control Panel should be checked and verified as per SIP before starting wiring.

iii. Ensure Physical check of wiring to check dry soldering, loose connection, short circuit on terminals/tag blocks, clip not plugged etc before plugging relays and extending power supply.
iv. Relays stored for more than three years should be separately tested from Testing Jig for checking their working and contact resistance. Testing jig should be provided in maintenance Room/Relay Room (at least one installation in three stations).

v. Quality of wiring work should of high standard. Temperature controlled soldering iron should be used. Dropping of solder material on the terminal / wire should be prevented.

13.3.4.4 Track Circuiting

i. Ensure thorough checking of condition of ballast, track and sleepers for their suitability for signalling. GFN liners and rubber pads for all PSC sleepers in track circuited zones should be ensured. Wherever, new concrete sleepers are required to be inserted, they should be electrically re-tested even though they are tested earlier in the sleeper plant.

ii. Track circuit bonding should be done with double bonds. J clips for Glued Joints portion should be ensured.

iii. Track feed charger 'off' indication should be provided in ASM/Maintenance room and also connected with datalogger.

iv. PPTC fuses are to be provided at track circuits along with all other external circuits.

v. In addition to above, ensure compliance of all the instructions stipulated in SEM Part II, Chap 17.

13.3.4.5 Power Supply

i. Power supply arrangement should be properly designed to cater for the additional load, on account of modification in existing signalling. Dual power supply arrangement should be provided for RRI work at major station / Junction station. Adequate power supply for outdoor circuit should be made available to ensure proper functioning of farthest point under load.


iii. In addition to above, ensure compliance of all the instructions stipulated in SEM Part II, Chap 16.

13.3.4.6 Maintenance, Staff Deployment, Training, Spares etc.

i. Maintenance panel should be fully wired and made functional along with RRI for quick rectification of fault. Data logger wiring and validation should be done in advance before Pre-NI. In case of EI maintenance terminal should be provided.

ii. Maintenance staff of the station should be fully associated during the course of RRI/EI work. Additional staff as required for maintenance should be got sanctioned and deployed.
iii. Spare Modules: 10% of each sub-system / module should be made available before commencing NI. Required T&P items, vehicles and other measuring instruments should be made available by construction before NI.

iv. Training in advanced modern signaling being installed at the station should be ensured for all S&T staff posted for maintenance before NI.

13.3.4.7 Telecom Facilities & Communication Arrangements

i. All Telecom facilities in new RRI/EI building must be commissioned along with NI.

ii. Communication amongst staff working on Panel and Relay Room/Equipment Room should be through hands free talk back system and VHF/Walkie-Talkies sets. Communication with staff deployed at Goomties/Relay Huts, Temporary shelters and in the field should be only through VHF with standby point to point Magneto Telephones. Sufficient VHF batteries and battery chargers shall be available.

13.3.4.8 Cable Testing

i. All cables should be tested jointly with supervisor of maintenance organization.

13.3.5 Pre NI/NI Works

13.3.5.1 General

i. Before permitting NI at major yard/junction, a foot by foot inspection of entire yard at least by JS/SS officers of all concerned departments should be done along with SS of the station.

ii. Security arrangement and lighting arrangements should be ensured during Pre-NI/NI.

iii. Transportation, Boarding and lodging facilities should be made available for all staff & officers deployed for NI work. Special imprest should be got sanctioned for the same.

13.3.5.2 Deployment of Staff and Distribution of Works

i. Separate teams in round the clock shifts should be formed for Panel, Relay Room, Equipment Room, Data Logger Room, Relay Huts, Locations and a set of field gears. Activities assigned to each team should be clearly documented and a copy given to all concerned for immediate reference by them.

ii. Distribution of work should be done to different teams by name giving them documents for various activities/works on S&T equipment expected to be done by them. Officers deputed for NI work should come with their full support team of supervisors, technicians and helpers to form effective working team. They should not leave the work site without permission of CSTE/C or Officer in-charge. Team of Officers/Supervisors/Technicians &
Helpers deployed from other Divisions and Railways should report at least 3 days before NI and should remain available at least 5 days after NI.

iii. Dy.CSTE in-charge of field work should take control of remaining work and have continuous touch with Relay Room, Equipment Room, each of the site locations, relay huts etc. through VHF communication, and occasionally inspect the outdoor locations.

iv. S&T officer in-charge of design along with his group should be available at site during the period for assisting in testing and commissioning and issuing of design corrections/modifications, if required.

v. Adequate Engineering, Operating, Electrical and Signalling teams should be available 3 days before the NI working and for a period of at least 5 days after the NI is completed.

13.3.5.3 Preparation for CRS Inspection

CRS inspection will be carried out for all New line/Doubling/Gauge Conversion works.

List of Documents and Testing Report to be kept at station during CRS Inspection

13.3.5.3.1 Documents

1. CRS sanction and compliance of stipulations (if any)
2. ESP, SIP, SWRD, Selection Table, Panel Diagram, Track Bonding Diagram, Cable core plan, Cable route plan
3. Pre-Commissioning Checklist of IPS, Data Logger, LED Signal, ELD, BPAC/SSDAC/HASSDAC/AFTC, UFSBI, EI or any other equipment as applicable.

13.3.5.3.2 Testing Reports

1. Selection Table Test with test check of JAG
2. FAT & SAT for EI
3. Bell Testing of Wiring diagram
4. Quality audit inspection of JAG level with open line and its compliance
5. Joint inspection at SAG level with open line and its compliance
6. Corresponding Test of functions
7. Cable meggering jointly with Open Line
8. Relay desposition chart
9. Signals on Right hand side and condonation from COM.
10. Joint validation of Data logger.

13.3.5.3.3 MISC. items
1. Housing of points should be up to 5 sleepers for normal switches and 13 sleepers for thick web switches. Keep list of all the points with their housing.

2. Gap between leading stretcher bar and bottom of rail should not be more than 2 mm. Measured value should be available for all the points.

3. Small relay hut (3.5m x 3.5m) must be constructed wherever no. of Location Boxes is more than 4 at one place.

4. Cross-over wise time taken for initiation of command and setting of point must be less than 10 sec. Detail of this must be available for 20\% points for both Normal & Reverse direction along with timing report from data logger.

5. Bus bar voltage and voltage at HR relay for all the main signals must be recorded and available.

6. Voltage at HPR/DPR for the farthest signal must be available.

7. At least 2 points, 2 track circuits, 2 signals, 2 crank handle, 1 LC gate (where available), 1 Axle counter (where available) must be checked jointly and parameter record of same, duly signed by open line and construction staff must be available.

8. Test jig for testing of relays must be available and record for testing of all the relays which are more than 3 years old must be available.

9. Tool-kit, containing all the tools required for various measurements during CRS inspection, should be available.

13.3.5.4 Training of Operating Staff

Training of ASMs is extremely important. They should be available during simulation and functional test. Before handing over the panel to traffic, special emphasis should be given for button identification for various Signalled Routes, Crank handle release, LC Gate locking/ release, Emergency Operations for route cancellation, emergency sub route release, emergency point operations, Calling On etc. ASMs posted at Panel should have Panel Competency Certificate issued by Zonal Training School. ASM should have earlier worked on the panel and be familiar with buttons, various routes etc.

13.3.5.5 Testing of Function

i. In outdoor, special attention is to be paid for greasing and oiling of points where new point machine/new turn out is provided or new cable is provided in existing point machine.

ii. Proper adjustments of various parameters of Point including packing of Points, track, signal, ECR etc shall be done for their correct functioning.

iii. Old slot/Block/BPAC working etc shall be kept fully tested for proper change over.

iv. Glued Joint & Track bonding to be got checked & verified jointly with Engg.& TRD department respectively.
v. Corresponding test of each function is to be done, before NI between cable terminations from Relay Room to location box and from panel to function during NI.

vi. Full testing of correspondence of all functions, wire count test, square sheet test for conflicting signals, simulation and functional test (100%) shall be done and records are maintained.

vii. Details of Interlocking Logic/Circuits tests and certification required to be completed for each and every station before commissioning is issued vide HQ letter no 256 Sig/O/SG/Pt-XVI dated 03.04.2018 (Policy No 07/2018), Annex-13.08.

13.3.5.6 Plans and Documents

i. Copy of wiring/circuit diagram should be available at each Gears / Locations / Relay Huts / Goomties.

ii. Copies of Mini SIP /SWRD should be made available for display at important locations like Relay Room, Panel Room, Equipment Room, Maintenance Panel Room, Relay Huts and also handed over to each officer deployed at site.

iii. Supervisors and officials deployed for execution of the work and for train operations should be made to read the documents and instructions to understand the procedure and sequence of NI working and sign the assurance register.

13.3.5.7 Deployment of Contract Staff

i. Technical representatives of the contractor shall be available during Pre-NI and NI period for immediately attending to faults / prompt removal of released material etc.

ii. Deployment of contractor staff as per requirement should be ensured during work. Technicians and Engineers of contractors and/or manufacturers should be available 3 days before the start of NI and should continue for a period of at least 5 days after the NI is completed.

iii. Requirement of supervisors, workmen and labourers is to be conveyed to contractor well in advance by Dy.CSTE in-charge of field work.

13.3.6 Checklist for Train Operations and Control during NI

DOS

i. All preparatory works and arrangements pertaining to Signal, Permanent Way, Traction Distribution and Electric General and Telecommunication should be pre-tested and kept ready for NI working. PA system should be provided for NI working.

ii. Ensure availability of Free Home and Starter Signals for use of the traffic staff during NI working. For Block working, existing system of block working should be provided for each block section. Point to point telecommunication facilities as required for NI shall be provided, tested and kept in working order.
iii. Ensure rehearsal of Special duty traffic staff for setting, clamping and padlocking of points for different routes during NI.

iv. Insist deployment of ASMs who are trained/conversant in use of crank handle for operating the point machines and for prompt delivery of paper authority to the driver in case of signal failure.

v. Ensure setting of Points in the normal position and clamped and padlocked for straight Up/Down movements.

vi. Ensure effective control of train operations during NI working by deploying the required number of traffic staff and an officer for monitoring their working. Prompt receipt and dispatch of trains be ensured during NI. An operating officer (DOM/Sr.DOM/G) should be available at site during NI period to monitor and control operations. If required, goods trains/less important passenger trains may be regulated / terminated for major stations.

vii. Ensure preparedness for handling train operations immediately after completion of NI work.

**DON'TS**

i. Requirement of NI for alteration work in existing installation should not be compared with that of new work. Adding one cross over on main line may involve large scale changes in circuit.

ii. Avoid Single/Double Slip points where space is available for a fan shaped turn out.

iii. Don’t permit Point fittings in infringement of SOD.

iv. Do not commence NI unless wiring of the interlocking logic is complete and at least one stage of signal lowering is checked from control panel.

v. No shortcut should be adopted to run trains under any circumstances.

vi. Do not carry out crossings and precedence of trains at stations, where NI is being undertaken during duration of NI. No shunting should normally be done.

### 13.4 CHECK LIST FOR CRS APPLICATION (REF: SEM PART I, CHAP 9)

**Opening Documents Pertaining to S&T Submitted to CRS :**

a. Tabulated details Form no. VIII of Rules for opening of a Railway.

b. Drawings of works, plans of station yards showing gradients, the layout of tracks and signals and interlocking including locking and selection tables.

c. List of Question and answers.

d. Station Working Rules (assisting the operating branch in their preparation).

e. Certificate for introducing or extending electric traction.
13.5 Requirements for Making Signalling System Compatible to RE Standard
25KV AC (Ref: SEM Part II, Chapter - 22)

13.5.1 Check List for Re-Fitness

13.5.1.1 Relay Interlocking

a) All external relay shall be AC immunized relay.
b) External circuits shall work in Double Cutting.
c) The relay which releases an interlocking shall be slow to pick up. Time delay may be of the order of 0.6 to 0.8 sec.
d) Polarized Relay shall not be used in any external circuit.

13.5.1.2 Repeating Relays

The distance between the signal control relays and the signal must not exceed 180m in single line section and 220m in double line section. In case distance exceeds then as mentioned above repeating relay shall be used.

13.5.1.3 Splitting of Power Supply

Ensure separate batteries for external and internal circuits.

13.5.1.4 Cable Core Plan

Cable core plan shall be made taking into consideration of double cutting & repeating relays requirement as above with 20-30% spare as admissible.

13.5.1.5 Point Machine Wiring

(a) Ensure use of AC immunized relays for point detection and point repeater circuit.
(b) Ensure AC-immunization of all point machines. The permissible parallelism varies as per type of point machine and AC immunity level tolerance of the point machine.

13.5.1.6 Track Circuit suitable for RE

The length of DC single rail track circuit in AC electrified area with AC immunized 9 ohms shell type relay shall not exceed 450m where wooden sleepers are used and 350m where concrete sleepers are used. The length of track circuit can be extended up to 450m when QTA2 plug in relay is used. This can be further enhanced using QBAT relay as practiced in S.R.

(a) To protect the equipment from the effect of AC rail voltage a choke coil of approved type shall be provided in series with the feed resistance.
(b) Immunized DC track relay shall be provided.

13.5.1.7 Provision of Earthing Arrangement

(a) The lever frame & other metallic frame of the cabin shall be connected together to a separate earthing.
(b) Ensure earthing at every location box where cable terminates.
(c) Block circuits working on earth return through the respective block filters shall be earthed separately.
(d) Surge arresters provided in Block shall be earthed separately.
(e) In case of signals within 2m from the electrified track, the protection screen shall be provided and connected to earth.

13.5.1.8 Rodding & Wire Insulation

(a) Insulated rodding joints shall be provided as per approved drawing.
(b) Earth rodding wire shall be provided with an insulator in the lead out as close to the cabin as possible.
(c) If the distance between the insulators at either end is more than 300m, additional insulators shall be provided on each rodding so that the distance between two consecutive insulators on the same rodding is not more than 300m.

13.5.1.9 Block circuits

(a) Barring Block Instrument circuit no earth return circuit shall be used on AC electrified Territory. Block Instrument, however, shall be suitably protected by using Block Filters of approved design.
(b) Separate battery or DC-DC converter shall be used for each Block Instrument. This battery shall feed only Block Instrument and not to any other circuit.

13.6 Cable Laying Standards

- The cable laid parallel to the track shall normally be buried at a depth of 1.0m from ground level. While those laid across the track must be 1.0m below the rail flanges. However, in case of rocky soil, the depth may be reduced suitably. When it concerns the laying of tail cables which serve the track apparatus etc the depth should not be less than 0.50m. In theft prone areas the cables may be laid at a depth of 1.2m with anchoring at every 10m.
- The width of manually made cable trenches should commensurate with number of cables. The minimum width shall be kept as 0.30m. In the rocky ground, the cable should be laid on a layer of sand or sifted earth of 0.05m thickness previously deposited at the bottom of the trench. In both the above cases, the cable should be covered with a layer of sand or sifted earth of 0.10m thickness and thereafter a protective cover of trough or a layer of bricks should be placed.
- When a cable has to cross the track, is should be ensured that
  i) The cable crosses the track at right angles;
  ii) The cable does not cross the track under points and crossings and
  iii) The cable is laid in concrete/GI/CI/PVC pipes, suitable ducts or in any other approved manner while crossing the track.
- When cables have to cross a metallic bridge, they should be placed inside a metallic trough which may be filled, as an anti-theft measure, with sealing compound. The cable should be supported across the
bridge in a manner which would involve minimum vibrations to the cable and which will facilitate maintenance work. Adequate cable length to the extent of 2 to 3m shall be made available at the approaches of bridge.

- Cable markers wherever provided should be placed at suitable interval and at diversion points.
- While laying the cables in accordance with the above instructions, the following instructions should be adhered to for the safety of the track.
  
  i) Outside the station limits, the cable should generally be laid at not less than 5.5m from the centre of the nearest track.
  
  ii) Within the station limits, the trenches shall preferably be dug at a distance of not less than 3m from the centre of the track, width of the trench being outside the 3m distance.
  
  iii) At each end of the main cable an extra loop length of 6 to 8m should be kept.
- Cables need to be laid close to the Railway boundary on one side of the Railway track to the extent possible to avoid any interference with the future works.
- In addition to above, instructions issued vide SEM Part II, Chap 15; RB’s letter no. 2003/Tele/RCIL/1 Pt IX dt 24.6.13 and HQ letter no 256-Sig/O/SG/Pt-XV dated 22.08.2016 (Policy Circular No 02/16, Annex – 13.09) must be complied.

13.7 Electric Point Machine

(Ref: SEM Part II, Chap 19, Para 19.28 to 19.38)

13.7.1 Introduction

There are 3 types of Point Machines:

a) IRS TYPE

The IRS type of electric Point Machine (Rotary Type) is manufactured as per IRS specification S-24/2000 and RDSO Drg.No-S10.800. These machines can be used for single point, single switch, double slips and trap points, for all types of switch fittings and weight of rails. The point machine is rated for nominal operating voltage of 110 VDC. IRS type point machine can impart a maximum of 143 mm.

b) CLAMP TYPE

The Sectional capacity is adversely affected by the speed restriction at points. Hence it became essential to review the existing design of Electric point machine by incorporating with clamp lock type of machine in full compliment. The unique feature of thick web switch is the crossing angle has been broadened so much that the train negotiating is at higher speeds as not put to any danger of any sort. This is necessitated a switch opening of 160 mm as against of 115 mm of ordinary cross over. The web of the switches was also made thicker to make than them strong enough to withstand load of train at high speeds. A CLAMP LOCK that clamps together the closed switch against the stock rail achieves the locking of the switch. For the working of clamp lock, the throw bar of points machine is provided with a total of 220 mm stroke that is 60 mm for the unlocking, 100 mm for the throwing of points and 60 mm for the locking of closed switch. The Clamp
type of electric Point Machine (Rotary Type) is manufactured as per IRS specification S-24/2000 and RDSO Dr.No.S11000.

c) SIEMENS TYPE

The Siemens type of electric Point Machine is manufactured as per IRS specification S-24/2000 and RDSO Dr.No.S10.800. These machines can be used for single point, single switch, double slips and trap points, for all types of switch fittings and weight of rails. The point machine is rated for nominal operating voltage of 110 VDC. IRS type point machine can impart a maximum of 143 mm. This machine is used where super imposed detection is required. Siemens type of electric Point Machine can operate from 60 VDC and Successive operation of two ends of a cross over point can be employed.

13.7.2 Salient Features

(a) Each point switch is independently locked with rotary type locking arrangement. The lock notches are different for Normal & Reverse position of a switch and hence Normal lock notch cannot be used for Reverse position and vice versa.

(b) IRS point is a High thrust type of Electric point machine rotary type.

(c) No need for any adjustment in friction clutch at site and does not require electrical snubbing for smooth stoppage of motor as the friction clutch is an integral part of the main gear disk and rotates only less than one revolution.

(d) Detection and controlling contacts are of heavy duty and self-wiping type (vertical wiping). Hence loose packing effect on the point indication is minimized.

(e) The possibility of both slides (lock & detection) moving together due to rust/friction in case of one slide connecting rod breaks is prevented by the provision of brass strips between them.

(f) Conversion of rotary motion into linear motion is achieved by rack and pinion arrangement.

(g) The detection contacts are allowed to close only on completion of locking of the switches. Similarly, the contacts are made to open before unlocking of point begins.

NOTE: For further detail, refer to IRISET Signalling Notes

13.8 Data Logger

1. Data loggers are mandatory for all new relay interlocking (PI/RRI), EI installations and it is also recommended to provide in all existing PIs / RRIs.

2. It is to be ensured and certified Synchronization of the EI clock and data logger clock.

3. All relays and alarms to be extended to DL.

4. Validation of DL jointly with open line officer is to be ensured.

5. Remote monitoring of stations with the help of Networking to be ensured.

NOTE: For detailed information refer IRISET Signalling Notes and for detail check list, refer RDSO Letter No.: STS/E/DATA LOGGER dated: 29-10-2010.
13.9 **Electronic Interlocking**

- EI is a computer based electronic interlocking system, used for controlling points, signals, level crossing gates etc, through a centralized control panel or through VDU, like existing relay based/mechanical interlocking systems. (Microprocessor or Micro controllers are used in EI's).

- As per railway board letter no 2003/SIG/G/5 dated 28.04.2016, only Electronic interlocking is to be provided for all new works having up to 500 routes.

- As per Northern Railway letter dual VDU is to be provided at stations having upto 100 routes for train operation.

- There are two RDSO specifications available for Electronic Interlocking
  a) RDSO/SPN/192/2019 ver 2.0
  b) RDSO/SPN/203/2011 ver 1.0 (Only applicable for Big yards)

- As per NR HQ letter no 109-Sig/387/EI/Pt.VI dated 08.10.2018, applicability of RDSO specification for Yards with more than 200 routes will be decided by PCSTE office on case to case basis.

- Following policy circulars/Guidelines/Advisory notes has been issued from Railway board, RDSO & NR Head Quarter. Compliance of these must be ensured.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Subject</th>
<th>Letter/Circular No.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical system application approval of advanced technology Signal system (New installation) (Annex-13.06)</td>
<td>RB letter no 2012/Sig/ATSS</td>
<td>02.09.2015</td>
</tr>
<tr>
<td>3.</td>
<td>Use of hot stand by architecture for Electronic interlocking</td>
<td>RDSO Ref no STS/E/TAN/3004 Ver 1.0</td>
<td>13.06.2012</td>
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<td>4.</td>
<td>Use of Embedded PC for Electronic Interlocking (EI)</td>
<td>RDSO Ref no STS/E/TAN/3007 Ver 1.0</td>
<td>02.11.2012</td>
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<td>5.</td>
<td>Centralized and Distributed Architecture of Electronic Interlocking</td>
<td>RDSO Ref no STS/E/TAN/3008 Ver 1.0</td>
<td>31.03.2013</td>
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<td>6.</td>
<td>Modification/Alteration in Electronic Interlocking (Manufactured by M/s ASTS)</td>
<td>RDSO Ref no STS/E/TAN/3009 Ver 1.0</td>
<td>09.06.2014</td>
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13.10 INTEGRATED POWER SUPPLY (IPS)

Ref: (RDSO/SPN/165/2012, Version 3)

13.10.1 General requirements

The SMPS based Integrated Power Supply (IPS) system is meant to give continuous supply to both AC & DC signalling circuits for wayside and medium size signalling installations without AFTC (upto 15kVA signalling load) in RE &Non-RE areas.

The SMPS based IPS system consists of the following:

1. SMPS based Float cum Boost Charger (FRBC) Panel
   This panel consists of FRBC (float rectifier cum boost charger) module, Distribution/ Supervisory control / Alarm (DSA) unit and metering section.

2. AC Distribution Panel
   This cabinet consists of Inverters, Ferro-Resonant based Automatic Voltage Regulator (AVR), Transformers and metering section.

3. DC Distribution Panel
   This panel consists of all DC-DC converters and common Digital voltmeter for measurement.

4. Status Monitoring Panel for ASM s Room
This panel consists of status indications and critical alarms of IPS to be provided in ASM’s room. The monitoring panel shall be of wall mounting type. OEM shall supply 12 core, 1.5 sq.mm signalling cable as per IS:S 63/2007 for connecting IPS to Status Monitoring Panel in Station Master’s room (distance to be given by Railways at the time of indenting).

5. **Battery Bank**

IPS system is suitable for charging 110V battery bank of Low Maintenance cells as per IRS:S 88/2004 or VRLA Maintenance free cells as per IRS:S 93/96(A). Battery bank is part of this specification and the same shall be supplied and commissioned along with IPS. Manufacturers shall give an undertaking regarding use of battery grade acid as per IS 266:1993 and de-mineralised/distilled water as per IS 1069:1993 for initial charging.

i) Battery racks (MS) for VRLA batteries / wooden rack for low maintenance batteries, along with its accessories duly approved by purchaser, shall also be supplied with battery bank.

ii) The battery is to be installed in a separate room. Low Maintenance batteries are to be charged at the site by OEM for which power supply shall be arranged by Railways. A test certificate of initial charging/capacity testing shall be submitted by OEM to Railways.

iii) OEM shall supply copper cable of suitable dia. as per IS: 694 and grade 1100V for connecting IPS to Battery bank (distance to be given by Railways at the time of indenting) as given below

   a. For 120AH battery 10Sq.mm
   b. For 200AH battery 16 Sq.mm
   c. For 300AH battery 25 sq.mm

iv) An exhaust fan of 12 size (minimum) shall be supplied for the IPS room by the OEM. The exhaust fan shall run with commercial AC supply. Railways shall ensure installation & commissioning of the exhaust fan.

### 13.10.2 Typical Configurations

Typical configuration of IPS for wayside & medium size PI /EI station upto 4/6 lines. Details of the configurations are given below

<table>
<thead>
<tr>
<th>S. N.</th>
<th>IPS configuration</th>
<th>Drawing no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upto4 line wayside station without AFTC in Non RE area</td>
<td>SDO/IPS/PI-4L/NRE/001</td>
</tr>
<tr>
<td>2</td>
<td>Upto4 line wayside station without AFTC in RE area</td>
<td>SDO/IPS/PI-4L/RE 002</td>
</tr>
<tr>
<td>3</td>
<td>For 4-6 line wayside station without AFTC in Non RE area</td>
<td>SDO/IPS/PI-6L/NRE 003</td>
</tr>
<tr>
<td>4</td>
<td>For 4-6 line wayside station without AFTC in RE area</td>
<td>SDO/IPS/PI-6L/RE 004</td>
</tr>
<tr>
<td></td>
<td>Annexures:</td>
<td></td>
</tr>
<tr>
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<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Annexure - 13.01- Policy of type of interlocking to be adopted at stations provided with centralized operations of points and signals</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Annexure- 13.02- Standardization of Signaling drawings</td>
<td></td>
</tr>
<tr>
<td>(iii)</td>
<td>Annexure- 13.03- Provision of Second Distant signal on ‘B’ Route</td>
<td></td>
</tr>
<tr>
<td>(iv)</td>
<td>Annexure - 13.04 -Commissioning of EI/PI/RRI</td>
<td></td>
</tr>
<tr>
<td>(v)</td>
<td>Annexure -13.05 -Revised Proforma for conducting Quality Audit Inspection of S&amp;T works being executed by Division, Project, Construction, RE and other organizations</td>
<td></td>
</tr>
<tr>
<td>(vi)</td>
<td>Annexure -13.06 -Technical System Application Approval of Advanced Technology Signaling Systems</td>
<td></td>
</tr>
<tr>
<td>(vii)</td>
<td>Annexure- 13.07- Power Supply arrangement for Distributed Electronic Interlocking</td>
<td></td>
</tr>
<tr>
<td>(viii)</td>
<td>Annexure- 13.08- Standardization of Safety and integrity checks for Interlocking Logic/Circuits</td>
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<td>(ix)</td>
<td>Annexure- 13.09 - Guidelines for Signaling Cables laying on Northern Railway</td>
<td></td>
</tr>
<tr>
<td>(x)</td>
<td>Annexure- 13.10- Technical System Application Approval (TSAA) of Electronic Interlocking</td>
<td></td>
</tr>
<tr>
<td>(xi)</td>
<td>Annexure- 13.11- Provision of dual VDU in place of 1 VDU + 1 Panel at Stations with Electronic Interlocking</td>
<td></td>
</tr>
</tbody>
</table>
Annexure 13.01

GOVERNMENT OF INDIA (भारत सरकार)
MINISTRY OF RAILWAY (रेल मंत्रालय)
RAILWAY BOARD (रेलवे बोर्ड)

No. 2003/SIG/G/5 Date: 28.04.2006
General Manager (S&T),
All Indian Railways,
General Manager (S&T) Const.,
All Indian Railways,
Director General (Signal), RDSO.

Sub: Policy on type of interlocking to be adopted at stations provided with centralized operation of points and signals.

In supersession to the policy directive issued by Railway Board vide Board’s letter dt 14.09.2006 referred above, following policy directives are now issued for type of Interlocking to be adopted at stations provided with Centralized operation of Points and signals:

<table>
<thead>
<tr>
<th>SN</th>
<th>Type of Station</th>
<th>Avg. no. of routes</th>
<th>Type of Interlocking to be provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a. ‘C’ class station,</td>
<td></td>
<td>Electronic Interlocking</td>
</tr>
<tr>
<td></td>
<td>b. Mid-section Interlocked LC gates</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. IB/S/IBH,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d. Stations on Double Line section without loop and with one emergency X-over or/and siding,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Stations on Single Line section with one loop</td>
<td>Upto 10</td>
<td>Electronic Interlocking</td>
</tr>
<tr>
<td></td>
<td>f. Automatic Block Signalling with/without Mid-section Interlocked LC gate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Way-stations &amp; small Junction stations</td>
<td>10 to 50 routes</td>
<td>Electronic Interlocking linked to Signal Control Centre if required.</td>
</tr>
<tr>
<td>3</td>
<td>Big stations and Major Junction stations</td>
<td>50 to 500 routes</td>
<td>Electronic Interlocking with Distributed Architecture and/or Object Controllers</td>
</tr>
<tr>
<td>4</td>
<td>Very Large stations/Junction stations</td>
<td>More than 500 routes</td>
<td>Route Relay Interlocking with metal to metal type relays OR Electronic Interlocking with Distributed Architecture and Object Controllers</td>
</tr>
</tbody>
</table>
2 The works shall be planned in such a way by Railways that same EI Technology/Equipment gets installed on a section in a contiguous manner aiming at one type of equipment under one jurisdiction (say SI)” at least. This is more achievable in New Line works, Doubling, Gauge Conversion and Railway Electrification works where works are awarded for a considerably longer section.

3 Officers and staff responsible for Installation, Commissioning and Maintenance of EI shall be competent enough and shall be trained to make them fully conversant with EI. Regular EI training courses shall be organized by Railways and IRISET. Latest updates and developments related to EI and TAs issued from time to time shall be documented and circulated by RDSO which shall be passed on to the field staff & Officers by Railways.

4 Railways shall plan for Annual Repair Contracts (ARC) for EIs so that defective components/cards/sub-modules/modules can be got repaired through OEM after expiry of warranty. Railways shall also plan for sufficient inventory of spares for EI through revenue budget.

5 OEMs shall develop specific training module for “making changes in Application data and logics to suit yard modifications done at a later stage”. RDSO shall make it mandatory for OEM while enlisting them as Approved Vendors for EI to impart training on making changes in Application data and logics to field staff.

All the Zones should have a dedicated team, competent to make modifications in the application data and logic.

6 The revised policy as above will be applicable for new works as well as for those PI works which are already sanctioned but tender has not been invited/awarded yet. The detailed estimates already sanctioned for such PI works shall be revised as per Railway Board’s policy letter no. 2008/SIG/SGF/4/EI/Genl db3 05.07.2011.

This issues with the approval of Board.

(P.K.Goyal)
Director/Project (S&T)
Railway Board
GOVERNMENT OF INDIA (भारत सरकार)
MINISTRY OF RAILWAYS (रेल मंत्रालय)
RAILWAY BOARD (रेलवे बोर्ड)

No. 2008/SG/SGF/4/El/Genl New Delhi, Dt 05.07.2011

The Chief Signal & Telecom Engineers,
All Indian Railways.

Subject: Policy on type of interlocking to be adopted at stations provided with centralized operation of points & signals – Revision of estimate from Relay Electrical Interlocking (PI) to Electronic Interlocking (EI).

Ref: CSTE/SER’s letter no. S&T/Con/Tech/POL/7/12 dt 05.05.2011

CSTE/SER vide above referred letter sought guidelines regarding the revision of estimates from Relay Electrical Interlocking (PI) to Electronic Interlocking (EI) without resorting to material modification.

The proposal has been examined in the Board’s office and it is clarified that so long as the standard of interlocking remains unchanged while the revising the estimates from Relay Electrical Interlocking (PI) to Electronic Interlocking (EI), it cannot be construed as a material modification in terms of Para 1110(i) of Engineering Code.

Accordingly, it is advised that the estimate from relay electrical interlocking to electronic interlocking can be revised without resorting to material modification and get sanctioned as per delegation of powers.

(Rajmal Khatri)
Director (Signal)

No. 2008/SG/SGF/4/El/Genl New Delhi, Dt 05.07.2011

Copy forwarded for information to-
1. PA&CAOs, All Indian Railways.
2. Dy. Controller and Auditor General of India (Railways), Room No.224, Rail Bhawan, New Delhi.

Copy to:
1. ED(F) and FC(X)-I Br. of Railway Board.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(Railway Board)

No. 2018/Sig/36-SD/1
New Delhi, dated 26.11.2019

PCSTEs
Zonal Railways
Metro Railway, Kolkata
& CORE/ALD

Sub:- Standardization of Signalling Drawings

Ref:-
1. CSTE/Planning’s Conference dt. 30.10.18- Mumbai/WR (Minutes 2018/Sig/36-SD/1 dated 14.11.19)
2. PCSTEs Conference dt. 27.04.2019- Maligaon/NFR (Minutes 2018/Sig/25-Conf/2 dt. 04.06.2019)
3. RDSO’s letter No.STS/E/Signaling Principles Vol-I/64 dt.18.10.19

1. Two under mentioned committees were nominated during CSTE/Planning’s Conference in October, 2018 at Mumbai, WR over standardization of signalling circuits:

1.1 Standardization of Typical Circuits (Minutes item no 38 of Ref 1)

a) Shri S. Khandelwal
CSTE/ECR,
presently ED/T/RDSO
- Convener
b) Shri V.K. Pandey
Dy.CSTE(P&G)/NR
- Member
c) Shri Siddhu Yadav
Dy.CSTE/P&D/PNR
- Member
d) Shri M M Warie
JT.Dir/Sig-III/RDSO
- Secretary

The Committee has discussed the draft report during PCSTEs’ conference in April, 2019 at Maligaon, NF/Railway (Ref 2) and further with EI OMs in July, 2019. The Committee has since submitted its report on ‘Standardization of Typical Circuits’ for Electronic Interlocking upto 100 routes to Railway Board.(Ref 3). The report is available at RDSO website http://10.100.2.19/signal/policy/uniform_circuit_diagram.htm.

1.2 Standardization of Signalling Drawings (Minutes item IV of Ref 1)

a) Shri P Venkata Ramana
Dean/IRISET
- Convener
b) Shri K V Reddy
CSTE/P&G/SCR
- Secretary
c) Shri K N Kherotia CSEWR - Member
d) Shri Benu Haldar Dy. CSTE/P&D/SER - Member
e) Shri K Kameshwar Rao DSTE/Const/Dig./SR - Member

The committee has discussed the report during PCSTEs' conference in April, 2019 at Maligaon, NFRailway (Ref 2) and further conducted a workshop in June, 2019 at IRISET with Zonal Railways. The committee has since finalized the report and it is available at IRISET website http://10.195.2.19/riweb/wiki/LearningResources.

2. Zonal Railways are directed to implement the standardization schemes of the above two reports. It is also directed that at least one station may be completed by 31.03.2020 and submit feedback.

\[\text{Signature}\]

(Arjun Singh Tomar)

निर्देश (निर्देश)

Copy to — DIRECTOR/IRISET and EP/Slg/Co-ord/RDSO — for circulating the reports to Zonal Railways.
GOVERNMENT OF INDIA भारत सरकार
MINISTRY OF RAILWAYS रेल मंत्रालय
(RAILWAY BOARD) (रेल बोर्ड)
रेल मंत्रालय, नई दिल्ली - 110001
Rail Bhawan, New Delhi-110001

No.2017/SIG/WP/Double Dist. Date 22.08.2017

General Managers,
All Indian Railways

Sub: Provision of Second Distant Signal on 'B' Route.

In order to overcome capacity constraints, Indian Railways has undertaken a massive augmentation of existing infrastructure on the saturated routes. As a part of this exercise, several works of doubling/tripling are being done on various sections on 'B' Routes of different Zonal Railways.

2. In order to achieve full benefits of the ongoing infrastructure augmentation, it is necessary that maximum potential of higher speed is achieved on 'B' Routes similar to 'A' Routes.

3. Keeping these objectives in view, Board have decided that all works of doubling/tripling being undertaken on 'B' Route on various Zonal Railways shall be carried out with the provision of Second Distant Signal.

4. The work for provision of Second Distant Signal shall be done as a part of the existing estimate with suitable revision.

(R. Kashinath)
Additional Member (Signal)

(Ajit Pandit)
Additional Member (Works)
Government of India  
Ministry of Railways  
Railway Board  
New Delhi, dt. 30.12.2016

The CSTE  
All Indian Railways  
ED/Signal/Coord  
RDSO  
Lucknow

The CSTE  
CORE  
Allahabad  
ED/Signal  
RVNL  
Bhikaji Cama Place  
New Delhi

Sub: Commissioning of EI/Pi/RRI  

Detailed instructions/guidelines were circulated vide letter No. 2012/Sig/SF/2 (Policy) dt.9.4.2012 with the approval of Board (Mt., MT & ME) to ensure adequate precautions, full preparedness for commissioning of Pi/EI/RRI.

In recent past it has come to notice that Non interlocked working is being taken without full preparedness resulting in the bursting of Non interlocked period and large number of failures post commissioning. This issue was also discussed during CSTE’s Conference held on 27th November, 2016. A copy of the guidelines issued under reference is enclosed for ready reference.

To ensure good quality work and full preparedness, agency executing the work shall submit following documents to CSTE of the Zone for approval before undertaking Non-interlocking or commissioning of interlocked station. These documents compiled in a folder will be titled as “Safety and quality book for Station XYZ”.

(i) Work ready for interlocking certification for CSTE’s approval. Appendix 1 & 2 as mentioned in the Railway Board’s letter No. 2012/Sig/SF/2(Policy) dt. 9.4.2012.
(ii) Cable Route Plan and Cable Core Chart.
(iii) Cable Depth Record in A4 size, Cable Meggering Record.
(iv) Track Circuit Bonding Plan.
(v) Signal Sighting Committee Report.
(vi) Pre-commissioning Checklist for EI, IPS, Axle Counters, SPAC, Data Logger Universal Fail Safe Block Interface, etc.
(vii) Earth reading of the various earth provided; Earthing arrangement diagram.
(vii) Testing record of Selection Table/Table of Control, FAT & SAT.

(viii) Reading/parameters of Point Machine, Signals — including distance from Centre Line of Track, Track Circuit reading.

(ix) Copy of CRS sanction/authorization letter.

(x) Inspection: Certificates of RDSO for EI, UF/SBI, IPS, Ade Counters Data Loggers, Relays, Battery Chargers, cables, ELD's, etc.

(xii) Works to be done during pre-NI & NI

Encl.: Railway Board Letter no. 2012/Sig/SF/2(Policy) dt. 09.4.12

[Signature]

ED/Signals
Government of India (राष्ट्रीय शासन)
Ministry of Railways (रेल मंत्रीपत्रक)
Railway Board (रेलवे बोर्ड)

No. 20/12/34/PSA (Policy)

New Delhi, Dt: 08.04.2012

General Managers,
All Indian Railways,

Sub: Non-Interlocked (NI) working – Commissioning of RRs at Major Junction stations.

1. In order to meet the changing and challenging needs of safe train operation, to create additional capacity and to ensure higher level of safety, Zonal Railways have undertaken large scale works for upgradation of signalling and remodelling of yards. For this, non-interlocked (NI) working and/or major blocks are being taken to commission new signalling systems. It has been observed that recently on some of the Zonal Railways, unwarranted restrictions were imposed during the course of NI working and the work was not carried out in a co-ordinated manner which led to avoidable signal failures after completion of non-interlocked working affecting train operations. The following instructions are, therefore, reiterated for implementation on Zonal Railways:

(i) For major RRI work and yard remodelling, CSTE (Open Line) shall be the overall in-charge for pre-NI and NI works and he shall work in close co-ordination with COM. It must be ensured that the project does not get delayed and the targets for construction organization be assigned the required priority and yard remodelling work shall be closely monitored by CSTE(O/L), CSTE(Con.) shall work under the guidance of CSTE(OL).

(ii) Most of the works should be completed in advance, leaving the bare minimum work for completion during pre-NI periods with final changing over, testing/commissioning to be completed during NI period.

(iii) The preparatory works should be closely monitored and reviewed jointly by Construction organization with Open Line officers and outdoor works should be re-confirmed and re-tested before taking up NI.

(iv) The NI period should be the barest minimum to ensure operational safety with minimum detentions to trains.

(v) Adequate deployment of trained staff, supervisors and officers must be ensured for completing these works. Additional resources should be arranged as standby including obtaining assistance from adjoining division/divisions, wherever required, to meet any contingency.
(vi) Planning and execution of major RPL works should be reviewed at the level of General Manager.

2. It is reiterated that Railways should prepare plan for executing such works carefully and execute NI taking adequate precautions ensuring full preparedness for handling train operations immediately after completion of NI work. Broad guidelines in this regard are enclosed. These guidelines/instructions are not comprehensive as Zonal Railways shall have to prepare specific action plan for each location.

This issues with the approval of Board (ML, MT & ME).

Encl : As above.

Copy to:

(i) CSTEs, POEs & COMs All Indian Railways
(ii) AM(C&I), AM(T), Adv(Bridge) & Adv(Safety)
N.O.O.

(i) PPS to ML for kind information of ML
(ii) Sr. PPS to ME for kind information of ME
(iii) PPS to MT for kind information of MT.
1. Planning and Preparation of Works:

1.1 Detailed planning of all the activities should be done keeping in view of basic requirement of short NI working and/or traffic blocks. All issues related to each and every portion of the Indoor and Outdoor Signalling & Telecomm works, Yard Modifications, Electrical & OHE, P Way and Engineering works should be listed out and tied up for execution in time.

1.2 All plans and system design documents like Engineering Scale Plan (ESP), Signal Interlocking Plan (SIP), Route Section Plan (RSP), Selection Table or Route Control Chart (RCC), Track Circuit Bonding Plan, Station Working Rule Diagram (SWRD), indoor & outdoor Wiring Diagram and Key Plan (Mini Engg Plan in A4/A3 sizes) should be carefully prepared and got approved along with the tentative wiring diagram. Contact booking / allotment and Contact Analysis should be made available to assess the repeater relays. SIP shall be prepared fresh after three alterations.

1.3 For better appreciation of SIP, Route Table in the following format should be sent to Traffic branch listing out all routes required for safe train operations as per the proposed SIP:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Signal No.</th>
<th>Route No.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Regarding Short Shunt, Overlap, Isolation Points locked, Sectional Route Release, Parallel movements and Restrictions, If any).</td>
</tr>
</tbody>
</table>

CRS Observations:

1.4 All observations of CRS should be discussed with CTPM and an agreed version of comments duly approved by CSTE & COM should be sent to CRS to avoid dispute at a later date specially with regard to short shunt, overlap release, isolation, simultaneous movements etc.

1.5 In case of existing interlocked installations, completion drawing should be physically verified before starting fresh wiring for incorporating the alterations. Fresh wiring should be done using wires of different colour to distinguish it from existing wiring. At least 2 level checking should be done before a wire is tagged and terminated.

1.6 Wiring alterations in existing PVRRI installations should generally not be allowed in case alteration involved in existing relay wiring is large. The permission to carry out a sanctioned work by wiring alteration in existing PVRRI shall be granted after due deliberation at the level of CSTE only.

1.7 Requirement of NI for alteration work in existing installation should not be compared with that of new work. Adding one cross over on main line may involve large scale changes in circuit.

1.8 NI period for alteration in existing installation should be sought based on number of jumper wires involved and testing of panel as per selection table.
1.9 Calling On signal below Starter Signals should be allowed to take off with 220
time delay. Calling On below Home Signals should be provided with time delay
of 60 Seconds.

1.10 Compatibility of EGR with LED signal shall be ensured as per extinct
Instructions.

1.11 All Signalling reliability Improvement measures issued by Board & RDSO should
be complied while executing new R/R/E/I/P works to avoid alterations at a later
stage.

II. Execution of Field Works:

General

2.1 As the work progresses, 60 days before proposed NI, regular weekly reviews at
SAG level should be done for final planning of all the activities during Pre-NI, NI
and Post-NI periods. During these reviews, progress of these activities should
be closely monitored and all hurdles should be resolved in close coordination
with concerned departments and agencies.

2.2 NI for all R/R works at major station / Junction stations shall commence only
after approval of CSTE, COM and GM.

2.3 Phased commissioning should be adopted to reduce NI period.

2.4 Executing unit should give certificates for compliance of instructions as per
Format enclosed as Appendix-I & II and should be submitted through Divisional
Officers before permitting NI by CSTE & COM.

2.5 10 days before NI, all major activities/works, which can be completed prior to NI,
should be completed in all respects.

2.6 Assistance of OEM, RDSO & Zonal Design Team etc to be taken to resolve any
design related issues.

Points:

2.7 Care should be taken while laying switch rails. LH tongue rail should be
provided with LH turn out and similarly for RH side.

2.8 All the points to be inserted should be pre-assembled on a staging outside
point machine. Fitting arrangements and ground connections should be
tested and kept ready for final adjustment. Proper housing of tongue tails
should be ensured in assembled turnout by Engineering officials at site.

2.9 Single / Double Slip points should be avoided where space is available for
shaped turn out.

2.10 Interlocking of Siding Point should be done with care, keeping in view
imposed if any on CSL.

Schedule of Dimensions (SOD):

2.11 All Infringements should be checked at the time of installation of Vee Signal Posts with Units, Point machine and their ground connect
boxes etc and then rechecked before the NI commences.

2.12 Point fittings should not infringe SOD. Infringing fittings should be
rectified.

2.13 For all new works, NI should not be commenced unless
Interlocking-Logics to complete and at-least one stage of
checked from control panel. In case of alteration/modification to existing
Signalling/electricals, testing of new functions and outside gear should be
done in advance. In alteration work, verification of existing wiring, contact
analysis etc should be done deploying additional trained staff.

2.12 Old wiring /cabling / fitting of points / track circuiting and signals etc, lying
unused for more than 3 months, should be rechecked jointly by concerned
construction & maintenance supervisors and officers before taking up NI. For
old wiring, wiring is rechecked from base point to tag block and tag block to tag
block before NI. Control Panel should be checked and verified as per SIP before
starting wiring.

2.13 Physical check of wiring shall be done to check dry soldering, loose connection,
short circuit on terminals/tag blocks, clips not plugged etc before plugging relays
and extending power supply.

2.14 Relays stored for more than 6 months should be separately tested from Testing
Jig for checking their working and contact resistance. Testing Jig should be
provided in Maintenance Panel Room.

2.15 Quality of wiring work should be of high standard. Temperature controlled
soldering iron should be used. Dropping of solder material on the terminals/wire
should be prevented.

2.16 Condition of ballast, track, sleepers should be thoroughly checked for their
suitability for signalling. GSF liners and rubber pads for all PSC sleepers in
track circuited zones should be ensured.

2.17 Track circuit bonding should be done with double bonds. J clips for Gased Joints
portion should be ensured.

2.18 Power supply arrangement should be properly designed to cater for the
additional load on account of modification in existing signalling. Dual power
supply arrangement should be provided for RRl work at major station / junction
station. Adequate power supply for outdoor circuit should be made available to
ensure proper functioning of farthest point under load.

2.19 Maintenance-Staff Deployment, Training, Spares etc:

2.19 Maintenance Panel should be fully wired and made functional along with RRl for
quick rectification of fault. Data logger wiring and validation should be done in
advance before Pre-RRI.

2.20 Maintenance staff of the station should be fully associated during the course of
RRl work. Additional staff as required for maintenance should be got sanctioned
and deployed.

2.21 Spares Modules: 10% of each sub-system / module should be made available
before commencing NI. Required -T&E items, vehicles and other measuring
Instruments should be made available by construction before NI. Wherever, new
concrete sleepers are required to be inserted, they should be electrically re-
tested even though they are tested earlier in the sleeper plant.

2.22 Training in advanced modern Signalling being installed at the station should be
obtained for all S&T staff posted for maintenance before NI.
2.23 Ni working should be carefully planned, listing out activities required to be completed during the allowed period and should be checked for adequacy at the minimum level of a Grade officer consulting the Divisional Operating & Signal officers at every stage. In case of stations having more than 100 routes, the planning and checking of requirements should be done at a higher level.

Telecom facilities & Communication Arrangements:

2.24 All Telecom facilities in new RRI building must be commissioned before Ni.

2.25 CUG public, mobile, communication should not be used. Communication amongst Staff working on Panel and Relay Room/Equipment Room should be through hands-free talk-back system and VHF/Walkie Talkie sets. Communication with Staff deployed at Goods / Relay Huts, temporary shelters and in the field should be only through VHF with standby point to joint Magneto Telephones. Sufficient VHF batteries and battery chargers shall be available.

2.26 Telecom Officer of the Railway should be deputed at station, responsible for collection of regular updates from field and relaying them to Divisional / Zonal Railway / Board officials. He should also look after the Telecom Arrangement.

Cable Testing:

2.27 All cables should be tested jointly with supervisor of maintenance organization.

III Pre Ni / Ni works:

- General:
  3.1 Before permitting Ni at major yard / junction station, a foot by foot inspection of entire yard at least by J6/68 officers of all concerned departments should be done along with SG of the station.

- Security and lighting arrangements should be ensured during Pre N/NI.

- Transportation, Boarding and lodging facilities should be made available to the staff & officers deployed for Ni work. Special Inquest should be got sanction for the same.

Deployment of staff and Distribution of Works:

- Separate teams in round the clock shifts should be formed for Panel Room, Equipment Room, Data Logger room, Relay Huts, Locations and field gears. Activities assigned to each team should be clearly documented and a copy given to all concerned for immediate reference by them.

- Distribution of works should be done to different teams by name and documents for various activities / works on S&T equipment expected by them. Officers deputed for Ni work should come with their teams of supervisors, technologists and helpers to form effective working. Should not leave the work site without permission of CSTE. Team of Officers / Supervisors / Technologists & Helpers of other Divisions and Railways should report at least 3 days before Ni starts and remain available at least 5 days after Ni.

- Dy CSTE in charge of field work should take control immediately on Control Panel staying in continuous touch with Relay room, etc.
each of the site locations, relay hubs etc through VHF communication, and occasionally inspect the outdoor locations.

3.7 SAT officer in-charge of design along with his group should be available at site during the period for assisting in testing and commissioning and issuing of design corrections/modifications, if required.

3.8 For RRI work, SAG officers should be available at major / In station.

3.9 Adequate Engineering, Operating, Electrical and Signalling teams should be available 3 days before the NI working and for a period of at least 5 days after the NI is completed.

3.10 SAG / Officer in-charge should review the NI work every six hours and give directions and send update to Divisional / Zonal Railway / Board officials through nominated telecom officers.

Training of Operating Staff:

3.11 Training of ASMs is extremely important. They should be available during simulation and functional test. Before handing over the panel to traffic, special emphasis should be given for button identification for various Signalled Routes, Crank handle release, LC Gala locking / release; Emergency Operations for route cancellation, emergency sub route release, emergency point operations; Calling On etc. ASMs posted at Panel should have Panel Competency Certificate issued by Zonal Training School. ASM should have earlier worked on the Panel and be familiar with buttons, various routes etc.

Testing of Functions:

3.12 In Outdoor, special attention is to be paid for greasing and oiling of points where new point machine / new turn out is provided or new cable is provided in existing point machines.

3.13 Proper adjustments of various parameters of Point including packing of Points, track, signals, ECR etc shall be done for their correct functioning.

3.14 Old Slot / Block / SPAC working etc shall be kept fully tested for proper change over.

3.15 Track bonding to be got checked & verified jointly with Engg & TRD department.

3.16 Corresponding test of each function is to be done, before NI between cable terminations from Relay Room to Location Box and from Panel to function during NI.

3.17 Full testing of correspondence of all functions, wire count test, square sheet test for conflicting signals, simulation and functional test (100%) shall be done and records are maintained.

Plane & Documents:

3.18 Copy of wiring / circuit diagram should be available at each Gears / Locations / Relay Huts / Goomlases.

3.19 Copies of Mini SIP / SWRD should be made available for display at important locations like Relay Room, Panel room, Equipment Room, Maintenance Panel Room, Relay Huts and also handed over to each officer deployed at site.
3.20 Supervisors and officials deployed for execution of the work and for train operations should be made to read the documents and instructions to understand the procedure and sequence of NI working and sign the assurance register.

Deployment of Contractor Staff:

3.21 Technical representatives of the contractor shall be available and visible during Pre-NI and NI period for immediately attending to faults / prompt removal of released material etc.

3.22 Deployment of Contractor Staff as per requirement should be ensured during work. Technicians and Engineers of Contractors and Manufacturers should be available 2 days before the start of NI and should continue for a period of at least 5 days after the NI is completed.

IV. For Train Operations and Control during NI:

4.1 No short cut should be adopted for nil trains under any circumstances.

4.2 All preparatory works and arrangements pertaining to Signal, Permanent Way, Track Distribution and Electrical General and Telecommunication should be pre-tested and kept ready for NI working. PA system should be provided for NI working.

4.3 Free Home and Starter Signals should be made available for use of the train staff during NI working. For Block working, existing system of block working should be provided for each block section. Point-to-Point telecommunication facilities as required for NI shall be provided, tested and kept in operating order.

4.4 Rehearsal of special duty traffic staff for setting, clearing and relocking of points for different routes during NI.

4.5 ASM who are trained in use of traffic handle for operating the point machines and for prompt delivery of signals authority to the driver in case of signal failure should be deployed.

4.6 At stations where NI is being undertaken crossings and precedence of lines should be avoided during duration of NI. No shunting should normally be allowed. Points should be set in the normal position and clamped and positioners should be straight up / down movement.

4.7 Traffic operations during NI working should be effectively controlled by keeping the required number of traffic staff and an officer for monitoring the traffic. Prompt receipt and dispatch of trains be ensured during NI. An operational DOM/R/DOM/GO should be available at all stations during NI period to regulate control operations. If required, goods trains / less important passenger trains may be regulated / terminated for major stations.

4.8 SWR should be issued fresh every five-year or after issue of the slips.

V. Post NI Maintenance & Monitoring:
5.1 Nominated Maintenance Teams should be stationed at every 10-12 points, Relay Huts and other locations having S&T equipment.

5.2 Trouble shooting flow chart should be provided in Relay room, Panel Room, Maintenance Panel room, relay huts etc. for quick diagnosis of failures.

5.3 Released materials should be shifted promptly from station after NI working period is completed and the system handed over for operations.

5.4 Proper record of various events shall be kept in separate register and this shall continue till the installation gets fully stabilized.

5.5 Field lighting of the yard during night hours shall continue for 3 days after NI is over.

5.6 At major station / Junction station, Operating Staff deployed for NI working should continue even after commissioning of Panel till it get stabilized and certified by Sr. DSTE & Sr. DOM of the Division.

5.7 Completion Drawing should be carefully prepared with the required level of checking and finalized. One copy be kept available at station.

Rajesh Khairwal
Director (S&T)
NORTHERN RAILWAY

Headquarters Office,
Baroda House,
New Delhi.

Dated: 16.03.2017

No.433-Sig/Quality Audit Insp./PL-III

Sr.DSTEa
Northern Railway,
DRM Office,
LKO, MB, DLJ, UMB & FZR

CSTE/Project,
CSTE/Construction,
CSTE/P/HQ,
CSTE/P/West,
Baroda House,
New Delhi.

Sub: Revised Proforma for conducting Quality Audit Inspection of S&T works
being executed by Division, Project, Construction, RE and other
Organizations.

Ref: This Office letter of even no. dated 13.06.12, 18.03.16 & 12.04.2016.

In continuation of this office letters of even no. dated 13.06.12, 18.03.16 &
12.04.2016, please find enclosed the revised/modified proforma for conducting Quality
Audit Inspection.

All other instructions of letters under reference will remain unchanged.

DA: As above.

(Asapp)

(V.B. Mathur)

Dy.CSTE/Signal/HQ

for GM/S&T

Copy to:

i) CSTE/CORE, 1, Nawab Yusuf Road, Civil Lines,Allahabad-211001 for
information and necessary action please.

ii) CSE, CCE & CSTE/P&g

iii) Dy.CSTE/P&D.

iv) All Dy. CSTE of Project & Construction unit.
QUALITY AUDIT INSPECTION CONDUCTED ON ----------- IN CONNECTION WITH  
PU/BRI/41 WORK AT ----------- STATION

<table>
<thead>
<tr>
<th>S.N.</th>
<th>ITEM</th>
<th>Observations by Executing Official</th>
<th>Remarks by Audit Official</th>
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<tr>
<td>a)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>IFS</td>
<td></td>
<td></td>
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<tr>
<td>ii</td>
<td>LED Signal</td>
<td></td>
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<td>iii</td>
<td>Data Logger</td>
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<td>iv</td>
<td>SSDAC/BPAC</td>
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<td>V</td>
<td>Earth Leakage Detector</td>
<td></td>
<td></td>
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<tr>
<td>b)</td>
<td>Earth and SPD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>IPS provided with B&amp;C class SPD connected to earth with earth resistance less than 1 ohm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii</td>
<td>Earth of resistance less than 1 ohm for Electronic equipments with equipotential bonding as per RDSO guidelines.</td>
<td></td>
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</tr>
<tr>
<td>iii</td>
<td>Separate earth for block instruments.</td>
<td></td>
<td></td>
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<tr>
<td>iv</td>
<td>Earthing of Signals and Location boxes.</td>
<td></td>
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<tr>
<td>v</td>
<td>Earthing/soldering of Cable armors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi</td>
<td>Appropriate Gauge Earth wire (Green Color) provided between Earth Pit to MEBB, MEBB to SEBB and SCBB to Equipment as per RDSO guidelines.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vii</td>
<td>Nuts/Bolts/Washers used for connection to MEBB/SEBB/Equipment should be of rust free material.</td>
<td></td>
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</tr>
<tr>
<td>viii</td>
<td>Standard size Copper strip to be provided as MEBB and SEBB/Perimetric Bus Bar as per RDSO guidelines.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Signal</td>
<td></td>
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</tr>
<tr>
<td>i</td>
<td>Joint Signal Sighting of new signals has been done.</td>
<td></td>
<td></td>
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<tr>
<td>ii</td>
<td>Retroreflective Number plates provided</td>
<td></td>
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<tr>
<td>iii</td>
<td>LED Signal provided (Main, Route, Shunt, C- On, A/AG Marker etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv</td>
<td>Implantation of Signal given</td>
<td></td>
<td></td>
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<tr>
<td>v</td>
<td>All openings of Signal unit provided with suitable gaskets and cable/wire entrances are sealed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi</td>
<td>U Locks provided on all Signal Units</td>
<td></td>
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<tr>
<td>vii</td>
<td>Other Observations, if any</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>IPS &amp; Power Supply Arrangement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Input Supply Arrangement (AT, Local, DG and Solar supply)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td>Status monitoring Panel provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is it visible to ASM from his sitting position?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii</td>
<td>Load Sharing SMR provided in N+1 configuration.</td>
<td></td>
<td></td>
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</tbody>
</table>

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<p>| | |</p>
<table>
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<tr>
<td><strong>iv</strong></td>
<td>DC-DC converters for Relay Internal provided in N+2 configuration.</td>
</tr>
<tr>
<td><strong>v</strong></td>
<td>N+1 configuration provided for other circuits in DC - DC converters</td>
</tr>
<tr>
<td><strong>vi</strong></td>
<td>Auto transferring of load of signals from Inverter-1 to Inverter-2. Inverter-2 to CVT, CVT to Inverter-1 is functional.</td>
</tr>
<tr>
<td><strong>vii</strong></td>
<td>Nearest wall to IPS cabinet distance of minimum 1 mts from sides &amp; rear and minimum 2 mtrs in front is available.</td>
</tr>
<tr>
<td><strong>viii</strong></td>
<td>Cold Standby as per RDSO Specifications.</td>
</tr>
<tr>
<td><strong>ix</strong></td>
<td>Spares and T&amp;P as per RDSO specifications</td>
</tr>
<tr>
<td><strong>x</strong></td>
<td>Spare wires available between Main supply distribution board to CT rack for Internal, External &amp; Point supply duly terminated at both the end.</td>
</tr>
<tr>
<td><strong>xi</strong></td>
<td>Spare cables between Change Over Panel to IPS SPD box duly terminated at both ends with changeover arrangement.</td>
</tr>
<tr>
<td><strong>xii</strong></td>
<td>Availability of Ring supply arrangements for:</td>
</tr>
<tr>
<td>a.</td>
<td>24V DC supply</td>
</tr>
<tr>
<td>b.</td>
<td>60V DC supply (where applicable)</td>
</tr>
<tr>
<td>c.</td>
<td>110V AC supply</td>
</tr>
<tr>
<td>d.</td>
<td>Along with Zone wise/Line wise bifurcation of 24V/60V DC external supply.</td>
</tr>
<tr>
<td><strong>xiii</strong></td>
<td>Separate 24V DC/110V AC in ring arrangement for LC gates located in station yard</td>
</tr>
<tr>
<td><strong>xiv</strong></td>
<td>Separate cables with path/trench diversity for extension of 230V AC(or 110 V AC) to LC Gate located outside station section but within 2 km of station</td>
</tr>
<tr>
<td><strong>xv</strong></td>
<td>For Cut-in-Arrangement in Block section- Supply from two sources with changeover arrangement</td>
</tr>
<tr>
<td><strong>xvi</strong></td>
<td>Other Observations, if any</td>
</tr>
<tr>
<td><strong>e)</strong></td>
<td>IPS Battery</td>
</tr>
<tr>
<td>i.</td>
<td>Type (LMLA/VRLA), capacity and make of batteries.</td>
</tr>
<tr>
<td>ii.</td>
<td>Physical condition of battery</td>
</tr>
<tr>
<td>iii.</td>
<td>Charging: No of cycles, Back up time etc</td>
</tr>
<tr>
<td>iv.</td>
<td>Date of Installation Written on each battery</td>
</tr>
<tr>
<td><strong>f)</strong></td>
<td>Track Circuit</td>
</tr>
<tr>
<td>i.</td>
<td>Double bonding provided</td>
</tr>
<tr>
<td>ii.</td>
<td>Plug-in type Track Relay provided</td>
</tr>
<tr>
<td>iii.</td>
<td>Whether sufficient battery provided?</td>
</tr>
<tr>
<td>iv.</td>
<td>Whether choke provided?</td>
</tr>
<tr>
<td>S. No.</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>V</td>
<td>Fixing of TUB at rail level (Top surface of which shall not go beyond 1 feet above rail level)</td>
</tr>
<tr>
<td>VI</td>
<td>Whether all type traction bonds i.e. structure, transverse, cress and continuity bonds are provided?</td>
</tr>
<tr>
<td>VII</td>
<td>Whether GFN liners and rubber pads available?</td>
</tr>
<tr>
<td>VIII</td>
<td>Whether I-type pandrol clip provided on gudge joints?</td>
</tr>
<tr>
<td>IX</td>
<td>Batteries for TC provided in separate location boxes</td>
</tr>
<tr>
<td>X</td>
<td>3 Batteries provided for each TC. A. Charging, B. Voltage C. Date of Installation written on Cells D. All battery connection done using Proper Jugs</td>
</tr>
<tr>
<td>XI</td>
<td>Track Feed Charger and Battery wired in V Connection to ensure both are not disconnected simultaneously</td>
</tr>
<tr>
<td>XII</td>
<td>Positive and negative rail are wired as per TC Bonding plan</td>
</tr>
<tr>
<td>XIII</td>
<td>Series wiring of point zone as per NR practice/guideline</td>
</tr>
<tr>
<td>XIV</td>
<td>Jumper cable is tied on wooden sleepers using iron clamps/hooks or on PSC sleepers jumper cable tied by using clamps as per NR policy no. 2/16</td>
</tr>
<tr>
<td>XV</td>
<td>Provision of Dual detection to be checked in conjunction with SIP &amp; as per HQ letter no. 256/Sec/05/06/Pt.XIV dt. 01.02.2017 for:</td>
</tr>
<tr>
<td>I</td>
<td>Track Circuits, which are prone to failure during monsoon season</td>
</tr>
<tr>
<td>II</td>
<td>Track Circuits, which are prone to failure on account of their location being on a curve and/or in iron or area or any other area, where the Track circuit fail due to shorting of the insulated gudge joints or leakage of current through the sleepers to ballast</td>
</tr>
<tr>
<td>III</td>
<td>On bridges provided with steel channel sleepers</td>
</tr>
<tr>
<td>8)</td>
<td>Relay Room</td>
</tr>
<tr>
<td>I</td>
<td>Proper wire for wiring of relays (16/0.20)</td>
</tr>
<tr>
<td>II</td>
<td>Metal to Carbon Relays of after Feb-2008 only to be provided in A, B &amp; C route</td>
</tr>
<tr>
<td>III</td>
<td>For Metal to Carbon Relays, no of contacts in a circuit should be limited to 45</td>
</tr>
<tr>
<td>IV</td>
<td>Whether approved relay connectors provided?</td>
</tr>
<tr>
<td>V</td>
<td>Relay based Flasher provided</td>
</tr>
<tr>
<td>VI</td>
<td>Whether HR/ASR indication board provided in relay room?</td>
</tr>
<tr>
<td>VII</td>
<td>Bunching, dressing &amp; lacing of wiring completed</td>
</tr>
<tr>
<td>VIII</td>
<td>Insulation of relay rack done</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
<th>Diagnostic Panel provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Inter relay rack distance 1 meter and wall to wall relay distance 1.5 m available.</td>
</tr>
<tr>
<td>XI</td>
<td>Parallel loading of contacts of all important relays.</td>
</tr>
</tbody>
</table>

b) Fuses

| i | NDT, HRC fuse of app. Type |
| ii | Fuse blow off indication |

| iii | Provision of PPTC fuse as per HQ letter no. 109-Sig/380 dt. 31.01.2017 for outdoor circuits of TPR, NKPR/RKPR etc as referred/specify in above mentioned instruction. |

i) Control Panel

| i | Domino type panel |
| ii | Button stuck up alarm provided |
| iii | Working of Veeder Counters |

j) Data Logger

| i | Whether configuration/design/wiring is as per diagram approved by HQ? |
| ii | Contacts of all Relays, IPS, ELD, Track feed battery charger taken in Data logger |
| iii | Monitoring of Relay Room Opening |
| iv | Validation and Networking |
| v | Data Acquisition equipment inside relay room. |
| vi | Maintenance Interface outside Relay room but secured |
| vii | Uninterrupted power supply by AT + UPS stabilizer in RE or through IPS in Non RE. |
| viii | Connectivity with C&MU |

k) Cable as per NR policy circular no. 2/16

<p>| i | 20% spare conductor in each Main cable. Thereafter 10% spare conductor in tail cables. |
| ii | Duplicated power cable arrangement for installations with more than 100 routes. |
| iii | Signalling cable from Home to Home Signal laid in RCC duct. |
| iv | Signalling cable in Automatic Signalling territory, between Advance Starter of one station and Home Signal of other station laid in RCC duct. |
| V | Signalling cable during Track Crossing laid in DWC-HPDE pipe |
| vi | Signalling cable during Road Crossing laid in GI pipe |
| vii | Cable laying on Bridges/Culverts as per NR policy circular no. 2/16 |
| viii | Spare conductors shall be provided on the outermost layer. |</p>
<table>
<thead>
<tr>
<th></th>
<th>ix</th>
<th>Two numbers of minimum 12 Core dedicated spine cables from home signal to home signal laid and terminated in all locations for cable failure and cable testing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td>Provision of Cable huts, where ever too many location boxes (5-10) are expected to come, in lieu of location boxes for security, proper protection and ease of maintenance.</td>
</tr>
<tr>
<td>xi</td>
<td></td>
<td>Provision of line wise/function wise Signalling cable.</td>
</tr>
<tr>
<td>xii</td>
<td></td>
<td>All cable entry points in cabin, relay room, battery room, SM's room, location boxes, location huts, junction boxes, etc. must be closed with suitable masonry works, sand covering and plastering to prevent entry of rain, etc.</td>
</tr>
<tr>
<td>xiii</td>
<td></td>
<td>RCC slab provided on the cable pit of cabin and relay room station.</td>
</tr>
<tr>
<td>xiv</td>
<td></td>
<td>Provision of ELD.</td>
</tr>
<tr>
<td>l</td>
<td></td>
<td><strong>Block working</strong></td>
</tr>
<tr>
<td>i</td>
<td></td>
<td>Condition of Guard Cable [Insulation resistance, DC loss, etc.]</td>
</tr>
<tr>
<td>ii</td>
<td></td>
<td>Power supply arrangement through battery charger suitable for Aisle Counter working or through IFS.</td>
</tr>
<tr>
<td>a</td>
<td></td>
<td>On Auto section, where train density is more than 20 trains each way.</td>
</tr>
<tr>
<td>b</td>
<td></td>
<td>For Aisle Counters used for IIS and BPS.</td>
</tr>
<tr>
<td>m</td>
<td></td>
<td><strong>Testing and Measurements</strong></td>
</tr>
<tr>
<td>i</td>
<td></td>
<td>Cable Meggering and pairing.</td>
</tr>
<tr>
<td>ii</td>
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<td>Wire count test.</td>
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<td>Bell test.</td>
</tr>
<tr>
<td>iv</td>
<td></td>
<td>Break test.</td>
</tr>
<tr>
<td>v</td>
<td></td>
<td>FAT certificate (in case of E)</td>
</tr>
<tr>
<td>vi</td>
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<td>Selection table Test.</td>
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<tr>
<td>vii</td>
<td></td>
<td>Square sheet.</td>
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<td>n</td>
<td></td>
<td><strong>Observation regarding work in yard</strong></td>
</tr>
<tr>
<td>i</td>
<td></td>
<td>Location Boxes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Earthing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Painting inside and outside</td>
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<tr>
<td></td>
<td></td>
<td>- Numbering and labeling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sand filling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Proper fixing of relays, terminals,</td>
</tr>
<tr>
<td>ii</td>
<td>Point machines</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Cable entry in J8 is not rubbing with J8 edges or any other sharp edges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Oiling and greasing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ground connections are free from obstructions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- J8 is properly fixed and earthed. All Cable armors are earthed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Connection to Point Machine is laid in pipe</td>
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<tr>
<td></td>
<td>- Wires are properly laid inside machine and terminated</td>
<td></td>
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<tr>
<td></td>
<td>- Ward plate as per CH is provided</td>
<td></td>
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<tr>
<td></td>
<td>Other Observations</td>
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<td>iii</td>
<td>Shading point</td>
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<td></td>
<td>- Condition of Transmission</td>
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<td></td>
<td>- Proper stroke is available at both ends</td>
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<tr>
<td></td>
<td>Other observations</td>
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</tr>
<tr>
<td>iv</td>
<td>Laying gate</td>
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</tr>
<tr>
<td></td>
<td>- Checklist filled in case of ELB</td>
<td></td>
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<tr>
<td></td>
<td>- Condition of Rodding / Wire transmission in case of MLB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Working of Rased Signals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Working of Hooter</td>
<td></td>
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<tr>
<td></td>
<td>- Gate Signal- Approach locking, Warning available (wherever applicable)</td>
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<tr>
<td></td>
<td>- CH for emergency operation provided as per GWR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- All indications and operations provided as per SWR/GWR</td>
<td></td>
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<td>Other Observations</td>
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<tr>
<td>v</td>
<td>Crank handle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- LCR fixed and wired properly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Magneto Phone provided in CH location boxes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- CH with proper ward/key provided</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Padlock for SM provided</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Numbering labeling of cable termination done</td>
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</tr>
<tr>
<td></td>
<td>Other observations</td>
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</tr>
<tr>
<td>o)</td>
<td>DG Set</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Remote Operation</td>
<td></td>
</tr>
<tr>
<td>ii</td>
<td>Change over switch between commercial supply / AT &amp; DG sets provided?</td>
<td></td>
</tr>
<tr>
<td>iii</td>
<td>Earthing</td>
<td></td>
</tr>
<tr>
<td>p)</td>
<td>Electric Lifting Barrier</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Reliable power supply is available for operation of electric lifting barrier.</td>
<td></td>
</tr>
<tr>
<td>ii</td>
<td>Clearance between the road surface and the boom is 0.8 to 1 mtr.</td>
<td></td>
</tr>
<tr>
<td>iii</td>
<td>Time of operation less than 12 seconds at rated voltage.</td>
<td></td>
</tr>
<tr>
<td>iv</td>
<td>Positive boom locking is effective.</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Boom painted alternately with 300mm bands of black and yellow colour and additionally provided with luminous stripes.</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>600mm Red disc provided at the centre of boom, with red reflector buttons/luminous stripes facing road traffic. Disc marked with “STOP” sign of 50mm width in white luminous paint/stripes.</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>LED type boom light provided at the centre of the boom.</td>
<td></td>
</tr>
<tr>
<td>viii</td>
<td>Sliding boom</td>
<td></td>
</tr>
<tr>
<td>ix</td>
<td>Road signal with hooter for road users</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>q)</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Approved Cable Route Plan updated/modified, as per actual cabling done, indicating distance of cable, cable crossing locations with respect to fixed structures</td>
</tr>
<tr>
<td>ii</td>
<td>Cable core plan- Certified by Executive Engineer as per site</td>
</tr>
<tr>
<td>iii</td>
<td>Track jumper plan- Certified by Executive Engineer after testing- As built</td>
</tr>
<tr>
<td>iv</td>
<td>HQ approved circuit diagrams, ST, PD, SIF, Application Logic, Interface drawings- duly certified by Executive Engineer after testing.</td>
</tr>
<tr>
<td>V</td>
<td>Infringement of Signaling assets/equipments i.e. Signals, Location boxes, Pt m/e etc. w.r.t to BG SOD 2004</td>
</tr>
<tr>
<td>vi</td>
<td>Provision of Automatic Fire Detection and Alarm system/Automatic Fire Suppression System along with Automatic Fire Detection and Alarm system as per Rly Bd’s letter no.2015/Sig/A/Fire/Pt dt. 08.11.2016</td>
</tr>
<tr>
<td>vii</td>
<td>Provision of Air Conditioning for Signalling installations as per Rly Bd’s letter no.2015/Sig/A/AC/Conditioning dt. 07.12.2015</td>
</tr>
</tbody>
</table>
### ELECTRONIC INTERLOCKING

**a) Power Supply arrangement:**

1. The 110 volt DC supply from IPS room to EI rack provided with duplicated cable of suitable gauge to ensure that voltage drop in cable is not more that 1.0 volt from IPS.

2. The DC-DC converters provided for EI segregated for ‘A’ & ‘B’ systems along with segregation of cabling and termination for power supply up to DC-DC converters, for all the converters & shall be in N+1 configuration.

3. The DC-DC converter shall be installed near to EI rack or in the EI rack itself to avoid the line drop. The line drop shall not be more than 0.5volt.

4. For better reliability each OC, CIU have separate DC-DC converter preferably near the CIU, OC rack & shall be in N+1 configuration. The 110 V supply shall be taken from IPS battery bank to CIU, OC and PPM rack in redundant manner with separate core of wires.

5. Where Panel Processor module is installed in SM room, the 110 volt DC power supply provided from EI or from IPS room with duplicated cable arrangement. The Panel Processor module have separate DC-DC converter in N+1 configuration.

6. 24 V or 110 V DC supply for fan fed with separate external (IPS) supply, isolated from EI supply and provided with fuse.

**b) Communication arrangement:**

1. The panel processor preferably housed inside CCIP and connected with EI on OFC cable in redundant manner in separate duct pipe to avoid failure due to cutting of OFC.

2. EI to VOU, CPU to CPU (in case of distributed system), CIU to Object Controller (in case of distributed system) & EI to Panel Processor Module connectivity planned with OFC cable to avoid damage due to surge and
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>iii</td>
<td>The communication line between the CPU, CPU to PPM, CPU to DC and VDU provided in the ring system (Redundant manner) to avoid failure due to loss of communication. The OFC and other network provided with NMS.</td>
</tr>
<tr>
<td>c)</td>
<td>Earthing arrangement: For all FI's except Kyosan make KSBMC E1</td>
</tr>
<tr>
<td>i</td>
<td>Earthing provided as per RDSO’s TAN, STS/I/TAN/30056/Ver.1.0 of 02.11.2012</td>
</tr>
<tr>
<td>ii</td>
<td>Class A protection provided on top of the building.</td>
</tr>
<tr>
<td>iii</td>
<td>Copper tape (Bonding ring conductor) as per drawing mounted on insulated standoff is provided to cover the maximum area in the Relay room, Power room &amp; Equipment room and the connection to equipment shall be made at the nearest point.</td>
</tr>
<tr>
<td>iv</td>
<td>As far as possible, Railways shall make attempt to provide earthing in such a way that it can cover most part of the building. This is to ensure that earth resistance shall be less than 1ohm at the equipment.</td>
</tr>
<tr>
<td>v</td>
<td>The interlinking of all Relay racks, as well as EI racks shall be ensured.</td>
</tr>
<tr>
<td>vi</td>
<td>All the cable trough and ladder shall be earthed properly.</td>
</tr>
<tr>
<td>d)</td>
<td>Synchronisation with Data Logger:</td>
</tr>
<tr>
<td>i</td>
<td>Synchronization of the EI clock and data logger clock through CMU in network condition verified and certified at minimum Assistant Officers' level.</td>
</tr>
<tr>
<td>ii</td>
<td>The analog monitoring of output of DC-DC converter of EI wired into data logger for monitoring the healthiness of converter.</td>
</tr>
<tr>
<td>e)</td>
<td>Wiring Practice:</td>
</tr>
<tr>
<td>i</td>
<td>The input, output, data and power supply cable shall be routed indifferent cable troughs separated with a gap of minimum 6 to 8 inches.</td>
</tr>
<tr>
<td>ii</td>
<td>The input and output cables (RDSO approved) of EI twisted to minimize EMI &amp; EMC effect.</td>
</tr>
<tr>
<td>iii</td>
<td>The fuse terminals fixed with proper fuse rating marking, fuse number and should be of indicative type.</td>
</tr>
</tbody>
</table>
iv The lightening and surge protection devices installed as per concerned EI installation document.

v Wire ends properly crimped with correct size of lugs & there are no loose connections at the terminals end. Ensured and verified at site min. by Assistant Officers level.

f) Miscellaneous:

i The Pre-commissioning checklist (as issued by RDSO for OEM) checked at site at minimum Assistant Officers level jointly with the executing OEM or as per the guidelines on the matter.

ii ODM Certificate of installation available.

iii The input and output details and logic scrutinised and verified at min. JAG level Officer before commissioning.

iv FAT verified by Railway official and sample verification done by min. level JAG officer during SAT.

v Specification of embedded VDU as per RDSO’s TAN No. STS/E/TAN/3007 Ver. 1.0 dated 02.11.2012.

g) Training:

i Training of staff for Maintenance in
   - OEM Premises,
   - On-Site training,
   - Trouble shooting

ii Availability of trouble shooting instructions.

Note:

1. In order to comply the instructions issued by Railway Board vide their letter no. 2012/Sig/SF/2 (Policy) dated: 30.12.2016, field units are also required to submit following informations/documents (or copy of documents) along with their request for nomination of Officer to conduct quality audit of proposed stations:
   
   
ii. Cable Route Plan and Cable Core Chart.
   
iii. Cable Depth Record in A4 size, Cable Meggering Record.
   
iv. Track Circuit Bonding Plan.
   
   
vi. Pre-Commissioning Checklist for EL IPS, Axle Counters, BPAC, Data Logger, Universal Fail Safe Block Interface, etc.
vii. Earth reading of the various earth provided; Earthing arrangement diagram.
viii. Testing record of Selection Table/Table of Control, FAT & SAT.
ix. Reading/parameters of Point Machine, Signals—including distance from centre Line of Track, Track Circuit readings.
x. Copy of CRS sanction/authorization letter.
xi. Inspection Certificates of RDSO for BI, UFSL, IPS, Axle Counters, Data Loggers, Relays, Battery Chargers, Cables, ELDs etc.

xii. Works to be done during pre-Ni&Ni.

2. All other documents and test reports as required by Quality Audit Perforima are to be produced before the officer nominated for QA at the time inspection.

Recommendations -

(Signature)  
Name & Designation of Audit Officer
No.433-Sig/Quality Audit Inspection/Pl.-V

Sr.DSTE:
Northern Railway,
DRM Office,
LKO, MB, DLI, UMB & FZR,

CSTE/Constd.,
CSTE/Project,
CSTE/P/West,
CSTE/P/HQ,
Baroda House, New Delhi.

Dated: 11.12.2017

Sub: Addendum to the “Revised Proforma for conducting Quality Audit Inspection of S&T works”

Ref: This office letter no.433-Sig/Quality Audit Inspection/Pl.-V dated 13.06.12, 18.03.16, 12.04.16 & 16.03.17.

In continuation of this office letter no. 433-Sig/Quality Audit Inspection/Pl.-V dated 13.06.12, 18.03.16, 12.04.16 & 16.03.17, please find enclosed a proforma for submission of completion drawings which need to be filed up during Quality Audit Inspection along with other items of proforma issued vide this office letter no. 433-Sig/Quality Audit Inspection/Pl.-V dated 16.03.17.

All other instructions of letters under reference will remain unchanged

(V.B. Mathur)
Dy.CSTE/Sig/HQ
For GM/S&T

Copy to:
1. CSTE/CORE, 1, Nawab Yusuf Road, civil Lines, Allahabad-211001 for information and necessary action please.
2. CCE/BH & CSTE/Pig/BH for information please.
3. Dy.CSTE/P&D for information.
Annexure 13.06

GOVERNMENT OF INDIA (भारत सरकार)
MINISTRY OF RAILWAY (रेल मंत्रालय)
RAILWAY BOARD (रेल निदेशन)

No. 2012/Sig/ATSS
Date: 02.09.2015

CSTE
All Indian Railways

CSTE/Construction
All Indian Railways

ED(Coordination)/Signal/ RDSO


Ref: (i) Railway Board’s letter no. 2012/Sig/ATSS dtd. 03.05.2012,
(ii) RDSO’s letter no. STS/E/General/Cross Approval dt 09.12.2014,
(iii) RDSO’s letter no. STS/E/General/Cross Approval/Vol.II
dtd 14.08.2015.

The practice of obtaining Technical System Application Approval (TSAA) from RDSO before any Electronic Interlocking (EI) or Automatic Block Signalling (ABS) System is commissioned by Railways has been reviewed, as requested by RDSO. Keeping in view the fact that adequate experience has now been gained by Railway in commissioning of EIs and ABS, it has been decided that:

"Railways are not required to obtain Technical System Application Approval (TSAA) from RDSO for commissioning of Automatic Block Signalling or Electronic Interlocking installation up to 100 routes. However, for Electronic Interlocking installation with more than 100 routes, the practice of obtaining TSAA from RDSO prior to commissioning will continue."

Please acknowledge receipt of the letter.

(P.K. Goyal)
Director/Project (S&T)
Railway Board

Copy to: Director, IRISET
NORTHERN RAILWAY

No: 109-Sig/387/F3/PLVI

Sr. DSTE’s
DM Office,
Northern Railway,
LKO, MB, DLI, UMB & FZR.

Sub: Power Supply arrangement for Distributed Electronic Interlocking.

Power supply is an important part of Electronic Interlocking. Existing power supply arrangement for Electronic Interlocking systems defeat the purpose of keeping the distributed Electronic Interlocking. For proper benefit of the distributed Electronic Interlocking systems following power supply arrangement should be adopted for future Distributed Electronic Interlocking installation.

a) Relay huts more than 2 km from Station, separate AT with IPS should be provided in relay huts. IPS at other places, where AT in relay hut may be available should also be provided for feeding of Object Controller (OC) and Signalling gears.

b) For other stations with distributed Electronic Interlocking, the scheme of supply arrangement will be as under:
   i. Power supply arrangement for OC in the relay huts should be as per TAN no. STS/E/TAN/3012 Ver 1.0 dated 28.08.2014 (enclosed as Annexure – I).
   ii. For Signalling gears the power supply arrangement will be as per Annexure – II, enclosed.
   iii. Suitable protection and changeover arrangement for protection of battery and main IPS should be adopted.
   iv. Suitable arrangement for indication of Power Supply in relay hut with alarm system should be made available at the station along with monitoring through Data Logger.

This is issued with approval of competent authority.

(Hari Prasad)

Dy. CSTE/Signal/HQ
for General Manager/S&T

Copy to:
1) CSTE/Construction for information & necessary action please.
2) CSTE/Pro/ East, West & HQ for information & necessary action please.
3) CPM/RE/UMB for information & necessary action please.
4) MD/RVNL/NDSL for information & necessary action please.
1. Scope
These guidelines are issued after analysing the TSAA (technical system application Approval) of Electronic Interlocking installation documents at RDSO during last 3½ years for carrying out installation of Electronic Interlocking in Indian Railway. These guidelines shall be followed by the Railways to ensure speedy clearance of TSAA from RDSO and will help in further improving the reliability of EI installation.

2. Suggestion:
2.1 Power Supply arrangement:
a) The 110 volt DC supply from IPS room to EI rack shall be provided with duplicated cable with suitable gauge so as to ensure that voltage drop in cable shall not be more that 1.0 volt from integrated power supply (IPS).

Reason: Duplicated cable is provided from IPS to EI to have redundancy of power supply connection to equipment and to prevent failure due to rat cut or any other damage.

Cable voltage drop is restricted to 1 volt to avoid overloading of cable & also ensure correct AWG, quality wires.

b) The DC-DC converters provided for Electronic Interlocking system shall be segregated for ‘A’ & ’B’ systems along with segregation of cabling and termination for power supply up to DC-DC converters, for all the converters & shall be in N+1 configuration. It is advised that reliable DC-DC converters as advised by OEMs shall be considered for better reliability. (Tentative Power Supply Sketches are attached as Annexure – A1, A2 & A3).

Reason: This is provided for the better supply arrangement with redundancy for main/standby EI system to get high availability and reliability so that in case of failure of one set of DC-DC converter whole EI equipment will not shut down.

c) The DC-DC converter shall be installed near to EI rack or in the EI rack itself to avoid the line drop. The line drop shall not be more than 0.5 volt.

Reason: To avoid high drop in line voltage, so that full operating voltage is available to the system.

d) The location of DC-DC converter shall be made in such a way that the 110V DC power supplies wires do not run and cut across other cables in the Electronic Interlocking room and this cable shall be treated as dirty cable and segregated from other clean wiring.
**Reason:** To avoid induced surges from the incoming power supply of 110 VDC, in other indoor wiring, cables of 110 VDC shall be taken in completely segregated way in the Electronic Equipment Room.

e) Where ever Panel Processor module is installed in the SM room, the 110 volt DC power supply shall be provided from EI or from IPS room with duplicated cable arrangement. The Panel Processor module shall have separate DC-DC converter in N+1 configuration.

**Reason:** It is seen normally that 12V/24V power supply is directly taken from IPS room to Station Master’s room which are normally more than 25 meters away. This lead to lot of voltage drop in cables as well as in heating of the cable. The N+1 configuration of DC-DC converters provide extra redundancy to panel processor.

f) 24 V or 110 V DC supply for fan shall be fed with separate external (from IPS) supply, which should be completely isolated from Electronic interlocking supply and same shall be provided with fuse.

**Reason:** This is to avoid effect of inductive loading of DC-DC supply of main EI equipment which normally results in resetting of the system and also avoids failure of DC-DC converters in case the fan became short-circuit.

2.2 Communication arrangement:

a) The panel processor shall be preferably housed inside the control cum indication panel (CCIP) and shall be connected with EI on OFC cable in redundant manner in separate duct pipe to avoid failure due to cutting of optical fibre cable.

**Reason:** By accommodating Panel Processor inside the CCIP, space in the station master room can be saved and it also avoid the placing S2 rack for PPM. Communication connection shall be made with OFC to avoid failure due to lightening & increase reliability of system.

b) It is advised that the EI to VDU, CPU to CPU (in case of distributed system), EI to Object Controller (in case of distributed system) & EI to Panel Processor Module connectivity shall be planned with OFC cable to avoid damage due to surge and lightening. The optical modem shall be of industrial grade with operating temperature range of 0 to 70°C.

c) The communication line between the CPU’s, CPU to PPM, CPU to OC and VDU shall be provided in the ring system (Redundant manner) to avoid failure due to loss of communication. The OFC and other network shall be provided with NMS (network Management System).

**Reason:** To avoid the failure of system due to loss of communication due to single cut, maintain high reliability & availability of system.
2.3 Earthing arrangement: (For all EI’s except Kyosan make KSBMC EI)

It is advised that the Earthing drawing circulated vide RDSO’s TANSTS/E/TAN/3006 dated 02.11.2012 shall be followed for protection from lightening. The following shall also be ensured by authorized Railway Officials before commissioning:

a) Class A protection shall be ensured on top of the building.

b) Copper tape (Bonding ring conductor) as per drawing mounted on insulated stand-off is provided to cover the maximum area in the Relay room, Power room & Equipment room and the connection to equipment shall be made at the nearest point.

c) As far as possible, Railways shall make attempt to provide earthing in such a way that it can cover most part of the building. This is to ensure that earth resistance shall be less than 1ohm at the equipment.

d) The buried earth conductor shown as copper can be of GI type to avoid theft.

e) The interlinking of all Relay racks, as well as EI racks shall be ensured.

f) All the cable trough and ladder shall be earthed properly.

g) Provision of the relevant Surge Protection Device (SPD) for the power supplies used for Electronic Interlocking systems shall be ensured. During many cases, it was noticed that the proper earth connections in the SPDs was missing which renders SPD as functionless, hence, the same shall also be ensured.

h) It shall be ensured that front and back doors of all cabinets using copper braid with shortest path to earth bus bar in equipment room.

**Reason:** A good earthing arrangement provides better protection of electronic system against lightening and surges. The above drawing has been made considering for provision of good earthing system for Electronic Interlocking.

2.4 Data Logger Installation:

a) The Data logger shall be commissioned prior to the commissioning of EI system with all the external relay contacts wired into data logger.

b) Synchronization of the EI clock and data logger clock through CMU in network condition must be verified and certified at minimum Assistant officers’ level.

c) The analog monitoring of output of DC-DC converter of EI shall be wired into data-logger for monitoring the healthiness of converter.

**Reason:** For proper health monitoring of DC-DC converter for preventive and predictive maintenance.
2.5 Wiring Practice:

a) The input, output, data and power supply cable shall be routed indifferent cable
troughs separated with a gap of minimum 6 to 8 inches.

Reason: This is one of the most important items to be taken care of in EI
installations. The EI output cables as well as power supply and other dirty cables
generated lot of electromagnetic interferences, which if passed to input cable of EI
results in repeated resetting and failure of EI system.

b) The input and output cables (RDSO approved) of EI shall be twisted to minimize
EMI & EMC effect.

c) The fuse terminals are to be fixed with proper fuse rating marking, fuse number
and should be of indicative type.

d) The lightning and surge protection devices shall be installed as per concerned
Electronic Interlocking installation document.

e) It is observed at many installations that wire ends are not properly crimped with
correct size of lugs & loose connections are found at the terminals end. It is to be
ensured and verified thoroughly at site minimum by Assistant officers’ level.

f) Separation of 110V DC and other external power supply from the internal
12V/24V/50V DC power supply in the relay room by placing them in separate
trough/ladder.

Reason: The 110V DC/external power supply wires run in outdoor field also and thus
are highly susceptible for induction of surges, and if 12V/24V/50V DC input power
supply has been placed in the same trough, this will have transmission of surges
from external supply wires to the input power supplies resulting in damage to the
equipments.

g) Voltage monitoring cables to the data logger shall also be placed in a different
trough which does not have any internal power supplies.

Reason: It must be understood that external power supplies particularly 220V AC
monitoring wires are highly susceptible to the lightning surges as this is a
completely non-protected circuit, hence, all voltage monitoring circuits of data
logger shall be considered as dirty and should not be placed with internal power
supply or other cables of Electronic Interlocking.

2.6 Miscellaneous:

a) In terms of Railway Board’s letter no. 2012/Sig/ASTS dated 03.05.2012, the
application for technical system approval shall be forwarded through CSTOE/Open
line after due scrutiny and verification by Open line.

b) As per Railway Board’s letter no. 2010/Sig/SGF/EI (Arsalco) dated 26.12.2012, in
order to avoid failures due to reset, commissioning shall be planned with hot
standby system only.
c) The input and output details and logic shall be scrutinised and verified at minimum level of JAG officer before commissioning and certificate for the same shall be submitted to RDSO.

d) The Factory Acceptance Test (FAT) shall be verified by Railway official (Open line/Construction) and Sample verification shall be done by minimum JAG officer during SAT (Site Acceptance Test).

e) It is advised, for better reliability the guideline specification of embedded VDU as given in “Technical Advisory Note No STS/E/TAN/3007 Ver. 1.0” Date 2.11.2012 may please be seen for guidance.

f) It is observed that document submitted to RDSO for Technical system application approval are not verified & signed by authorised Railway officer (open line/construction). They are either signed by RVNL official or only by the firm official who are commissioning the Electronic interlocking installation, same shall not be accepted.

g) The pre-commissioning checklist for concerned EI shall be thoroughly checked at the site at the minimum Assistant officers’ level jointly with the executing OEM.

h) The quality and integrity of the installation remains complete responsibility of the OEM. The firm must provide an OEM certificate regarding this before commissioning of any installation, any deficiency pointed out later, shall be done free of cost by OEM, this shall be confirmed by OEM before commissioning.

End: As above

(Alok Katiyar)
Director/Signal-III
for Director General/Signal

For any issues related to this TAN (Technical Advisory Note) please contact Director/Signal-III at RDSO, Lucknow (Rly phone- 032-42653, DOT-0522-2465734, Email: dstg3rds@gmail.com)
Power Distribution Scheme (110V DC Supply) - Electronic Interlocking System

Note: The number of DC-DC converter shown above are tentative and actual number of DC-DC converter should be calculated based upon maximum load current at site depending upon the Electronic Interlocking configuration.
EI Power Distribution (110V DC Supply) Medha EI System Scheme

Note: The number of DC-DC converter shown above are tentative and actual number of DC-DC converter should be calculated based upon maximum load current at site depending upon the Electronic Interlocking configuration.

I.P.S. ROOM (POWER SUPPLY ROOM)

CENTRAL CABIN (EI ROOM)

SM ROOM

OC END CABIN A

OC END CABIN B

110V DC Short path

110V DC Long Path

230V AC Supply

IPS

OC

110V DC

US CABLE

Internal Power

(For EI Relays)

External Power

(For Fans)

Channel A DC Power

Channel B DC Power

Channel A DC Power (BI)

Channel B DC Power (BI)

Channel A DC Power

Channel B DC Power

Internal Power

External Power

Annexure -A-2 of TAN No STS/E/TAN/3012 Ver 2.0
Configuration of Electronic Interlocking in Distributed Installation
POWER SUPPLY SCHEME FOR DISTRIBUTED ELECTRONIC INTERLOCKING
(Annexure - II of HQ letter no. No:109-Sig/387/El/Pt.VI Dated: 28.08.2019
NR Policy No. 06/2019)

El Central Cabin

SMR PANEL

230V AC from Auto Change Over

Battery Bank

AC DISTRIBUTION PANEL

110 V DC

(2X25 Sq mm) 110VDC (Long Path)
(2X25 Sq mm) 110VDC (Short Path)

(2X25 Sq mm) 110VDC (Long Path)
(2X25 Sq mm) 110VDC (Short Path)

El End Cabin

DC DISTRIBUTION PANEL

To El (110V DC)
Internal 24V
External 24V
Axle Counter 24V

for Point M/c

for Signal Lighting

for Track circuit & LC Gate

Internal 24V
External 24V
Block Inlet Supply

(2X25 Sq mm) Spare Power Cable
(30/19X1.5 Sq mm) Spare Signalling Cable
Policy No: 07/2018

Headquarters Office,
Baroda House,
New Delhi.

Dated: 03.04.2018

CSTE/CORE,
Railway
Electrification
1-Kawab Yusuf
Road
Allahabad.

CSTE/P/West
Northern Railway
Baroda House
New Delhi.

Sub: Standardization of Safety and Integrity checks for Interlocking Logic/Circuits.

It has come to notice that only selection table test is being carried out during FAT/SAT. There are number of tests which are also important and should be done along with selection table test. Testing methods/procedures are also at variance across divisions/units. In view of this, details of tests required to be carried out for Interlocking Logic/Circuits are needed to be standardized for uniformity of testing across divisions/units.

In regards to this, following Interlocking Logic/Circuits tests and certifications are to completed for each and every station before commissioning:-
1. **Type of Tests**

<table>
<thead>
<tr>
<th>SN</th>
<th>Test Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Negative test</td>
<td>Status of every function mentioned in STLT will be changed i.e. track, point, L/X gate, slot, crack handle etc. controlling the signal and observe the change in the status of the signal.</td>
</tr>
<tr>
<td>2</td>
<td>One signal one train test</td>
<td>After signal is cleared, first control track circuit is dropped and picked up. Signal shall change to red and remain in danger even after first control track circuit is picked up again.</td>
</tr>
<tr>
<td>3</td>
<td>Route release test for light engine movement</td>
<td>After clearing the signal, tracks are dropped to simulate light engine movement. Route release relays operation as specified in STLT at each stage is checked.</td>
</tr>
<tr>
<td>4</td>
<td>Route release test for long train movement</td>
<td>After clearing the signal, tracks are dropped to simulate long train movement. Route release relays operation as specified in STLT at each stage is checked.</td>
</tr>
<tr>
<td>5</td>
<td>Route holding test</td>
<td>All route releasing conditions are fulfilled except the picking up of route holding track and route locking is observed.</td>
</tr>
<tr>
<td>6</td>
<td>Approach locking test</td>
<td>Signal is cleared without approach track occupied. Route release shall take place without time delay after cancellation of route. With approach track occupied cancellation shall take place with time delay.</td>
</tr>
<tr>
<td>7</td>
<td>Red lamp protection test</td>
<td>When signal is cleared and red aspect of signal in ahead becomes unavailable. Previous signal shall change to danger.</td>
</tr>
<tr>
<td>8</td>
<td>Signal lamp cascading test</td>
<td>After signal clearance, each OFF aspect supply is cut off. Signal shall change to more restrictive aspect.</td>
</tr>
<tr>
<td>9</td>
<td>Signal aspect sequence control</td>
<td>After clearing all signals for a line, each aspect of a signal starting from advanced starter is brought down to next restrictive aspect. Change of aspect of signals in rear are observed as per STLT/aspect control chart.</td>
</tr>
<tr>
<td>Test</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>10. Track locking test for points</td>
<td>Each controlling track is dropped and attempt is made for operating the point. It shall not operate. However, emergency point operation shall be possible in this situation.</td>
<td></td>
</tr>
<tr>
<td>11. Crank handle locking test</td>
<td>Attempt is made to transfer the control of each crank handle locked by the signal when the signal is cleared. It is expected that the CH Control is not transferred. Test should also be done to check releasing of CH when point control is not available and/or TC is failed. It should be possible.</td>
<td></td>
</tr>
<tr>
<td>12. LC gate locking test</td>
<td>Attempt is made to transfer the control of each LC gate locked by the signal when the signal is cleared. It is expected that the Gate Control is not transferred.</td>
<td></td>
</tr>
<tr>
<td>13. Route locking test</td>
<td>Attempt is made to operate each point which is locked by the signal, when the signal is cleared. It is expected that the point does not operate. Attempt is made to operate each point which is not locked (Free) by the signal, when the signal is cleared. It is expected that the point shall operate.</td>
<td></td>
</tr>
<tr>
<td>14. SM Key Lock Test</td>
<td>Each Asset Operation is Tested for SM Key Effectiveness.</td>
<td></td>
</tr>
<tr>
<td>15. Point Operation through Route Test</td>
<td>All the controlling points in a route are set opposite to the required condition. Now route is initiated and operation of Points to the required Position and setting and locking of Route are checked.</td>
<td></td>
</tr>
<tr>
<td>16. Timers Test</td>
<td>All Timers are first set to their original value. After setting a Route, Cancellation is applied and the time to release of Route is observed. This test is repeated until all the Timers are covered. Emergency operation of all routes, overlaps, approach/dead approach locking should also be checked.</td>
<td></td>
</tr>
<tr>
<td>17. Square sheet Test</td>
<td>A route is set and every other route is attempted to check whether it is locked / free. This is repeated for all the routes.</td>
<td></td>
</tr>
<tr>
<td>18. Route Checking Test</td>
<td>When all Non control Functions (Tracks, Points, Crank Handles, Gates indications) are dropped. It is expected that the Signal Status remains intact.</td>
<td></td>
</tr>
</tbody>
</table>
Above tests should also be done at the time of FAT.

II. SAT for EI should be done first from panel and thereafter from VDU. SAT certificate should be signed only after testing has been completed both from panel and VDU. SAT certificate should be jointly signed by OEM and Railways. SAT certificate should mention Check-sum as well as CRC code of the final interlocking logic loaded in EI on which station will be commissioned. This certificate should also mention the changes made after the FAT.

III. Above tests may be undertaken using data logger also.

This is issued with the approval of PCST/ NR.

(Tarun Prakash)
Chief Signal Engineer
For General Manager/ S&T
Sub- Guidelines for Signalling Cables Laying on Northern Railway,

Ref: i) RDSO’s Letter No. STS/E/Cable Laying Practices dated 31.10.11 & 07/11.03.14
   ii) This office letter No. 256-S1G/O/SG/Pr-XII dated 01.12.2011.
   iii) ML’s DO letter No. 2011/SIG/SF/I/Cable Laying dated 15.11.2011
circulated vide this office letter No. 256-S1G/O/SG/Pr-XII dated 29.11.2011.
   iv) Railway Board’s JPO/Telecom Circular No. 17/2013 issued vide Railway

RDSO has issued guidelines on Signalling Cable laying under reference (i) & ML’s D.O. letter No. 2011/SIG/SF/I/Cable Laying dated 15.11.2011 circulated vide this office letter No. 256-S1G/O/SG/Pr-XII dated 29.11.2011 under reference (iii). Further, Railway Board has issued JPO/Telecom Circular No. 17/2013 (under reference iv) for undertaking digging work in the vicinity of underground Signalling, Electrical and Telecommunication Cables. These guidelines have been discussed and deliberated upon in the HQ office as per the requirement & existing practice of Cable laying on Northern Railway and accordingly, guidelines for Cable laying to be adopted on Northern Railway have been prepared.

The important items for Signalling cable laying to be adopted on Northern Railway are as under:

1. P/R/R/E/I installations with more than 100 routes:
   a) Dupliacted Power cable arrangement shall be adopted for P/R/R/E/I installation having more than 100 routes for External circuits i.e. 24V DC/ 60V DC External for Track proving & Point detection, 110V AC for Track Feed Battery charger, External 24V DC for Axle Counter, BPAC etc. (Ref Para No. 3.3.3 of RDSO guideline).
   b) Laying of Signalling cable from Home to Home Signal for P/R/R/E/I installation having more than 100 routes shall be done in RCC duct of 500mm width with
removable top cover as per NR Drawing No. NR/Sig/Cable 002 & 003 (Annexure 9 & 10). Beyond Home Signal and upto Distant Signal, Normal trenching as per extant practice shall be continued. (Ref- Para No. 7.3.7 & 7.3.8 of RDSO guideline).

2. **PI/RRI/EI installations with less than 100 routes**: For less than 100 route PI/RRI/EI installations, RCC ducting from Home to Home signal shall be adopted for works sanctioned prior to 2016-17 to the extent possible. Subsequently, from 2017-18 onwards all abstract estimate at PWP level should take care of full implementation of this guideline for all stations irrespective of number of routes. Beyond Home Signal and upto Distant Signal, Normal trenching as per extant practice shall be continued. (Ref- Para No. 7.3.7 & 7.3.8 of RDSO guideline).

3. Only in Automatic Signalling territory, between Advance Starter of one station and Home Signal of other station, RCC duct with 300mm width as per NR Drawing No. NR/Sig/Cable/001(Annexure -8) shall be adopted. (Ref- Para 7.3.8 of RDSO guideline). From 2017-18 onwards, all abstract estimate at PWP level should take care of full implementation of this guideline.

4. In Para No. 7.3.11 of RDSO guideline, RCC duct is to be laid at the depth of 600mm to 1000mm. This para has been modified as “The RCC duct shall be laid at the depth such that the top of RCC cover is at the depth of Minimum 690 mm below ground level.”

5. **Laying cable in Solid & Rocky soil**
   
i) In Para 7.4.1 of RDSO guidelines, following has been added as :

   "However, before finalising tender schedule for Cable laying in solid/rocky soil area, detailed site survey should be conducted by mn. Assistant level Officer, is report to be placed on record & approved taken from JAG level officer executing the work & accordingly quantify and depth of Cable laying in solid/rocky soil area to be finalised."

   ii) Para 7.4.3 has been modified as below:-

   "In case, sharp edge of rocky ground cannot be prevented with sifled earth, GI pipe of medium grade of ISI mark as per IS: 1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge. Inspection of GI pipe shall be done by RITES. In isolated cases. Rocky ground can be given smooth surface by using either masonry bricks or cement concrete."

   Sketch No. NR/SIG/Cable/004 showing Cable Laying in rocky area is enclosed (Annexure-11)

6. **Track Crossing - DWC-HDPE pipe** of suitable diameter as per RDSO specification RDSO/SPR/204/2011 shall be used as per NR drawing.
decided by Engineer In-charge. (Ref: Para 8.2 (iii) of RDSO guideline). Inspection of DWC-HDPE pipe shall be done by RITES.

7. **Road Crossing** :- GI pipe of medium grade of ISI mark as per IS: 1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge. Inspection of GI pipe shall be done by RITES (NR drawing No. NR/Sig/cable/006 as Annexure-13, Ref: Para 9.1 of RDSO guideline).

8. **Cable laying on Bridges/Culverts** :-
   For Cable laying on bridges/culverts with high flood level, reference Para 10.2 of RDSO guideline following shall be adopted:
   i. On approach of Bridges/Culverts, DWC- HDPE pipe of suitable diameter as per RDSO specification RDSO/SPN/204/2011 shall be used. Diameter of DWC-HDPE pipe shall be decided by Engineer In-charge.
   ii. On Bridge/Culvert portion, perforated GI pipe of medium grade of ISI mark as per IS:1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge.
   iii. At junction point of GI and DWC pipe, a GI bend of 112.5 degree, 1 mtr. Length as per IS 1239 (Part-2): 2011 and overlapping 250mm with DWC pipe shall be used.
   iv. Inspection of DWC-HDPE and GI pipe shall be done by RITES. A sketch No. NR/SIG/CABLE/007 showing cable laying on bridges/culverts with high flood level is enclosed (Annexure-15).

9. **Cable laying on Arch bridges** :- For Cable laying on Arch bridges, reference Para 10.4 of RDSO guideline following shall be adopted:
   i. On approach of arch bridge, DWC- HDPE pipe of suitable diameter as per RDSO specification RDSO/SPN/204/2011 shall be used. Diameter of DWC-HDPE pipe shall be decided by Engineer In-charge.
   ii. On Bridge portion, perforated GI pipe of medium grade of ISI mark as per IS:1239 (Part-I) of suitable diameter shall be used. Diameter of GI pipe shall be decided by Engineer In-charge.
   iii. At junction point of GI and DWC pipe, a GI bend of 112.5 degree, 1 mtr. Length as per IS 1239 (Part-2): 2011 and overlapping 250mm with DWC pipe shall be used.
   iv. Inspection of DWC-HDPE and GI pipe shall be done by RITES. A sketch No. NR/SIG/CABLE/008 showing Cable laying on arch bridges is enclosed (Annexure-18).

10. Cable laying on bridges/culvert with low flood level and metallic bridges shall be as per existing RDSO guidelines.

11. **Planning for Cable route** :- A new para 4.7 regarding Planning for cable route has been incorporated. The details are as below:

    **Para 4.7** : The cable trench should be as straight as possible. Cable Route Plan
should be immediately prepared after laying of the cable showing exact location of cables at an interval of every 30 - 40 meters also showing various protective measures provided like RCC duct, DWC pipe, GI pipe, GI trough etc. After the submission of Cable route plan showing protective works, the payment to the contractor for complete trenching and Cable laying of the station to be released. This should be mentioned as special condition of the contract.

12. Laying of different type of cable in same trench :- It is highlighted that for Laying of different type of cables in the same trench, para 7.2 of RDSO guideline to be followed strictly, particularly Signalling cables must be separated from power cables by a row of bricks between them as mentioned in Para 7.2.2. For this sketch No. SDO/CABLE LAYING/004 showing laying of signalling cable & Telecom/Power cable in same trench as enclosed (Annexure-7) should be ensured.

The detailed guidelines for Signal Cable laying (in 47 pages) to be adopted on Northern Railway are enclosed herewith. It is advised that these guidelines are circulated to all field executives to ensure its strict implementation in all future works.

This is issued with the approval of CSTE.

DAV Guidelines in 47 pages
(Based on “Guideline on Signalling Cable laying” Version 1.1 issued by RDSO vide letter No. STSE/Cable laying Practices, dated 07/11/2014)

(V. K. Pandey)
Dy.C.S.T.E./P&D
for G.M./S&T

Copy to:-
1. CSTE/CORE, 1, Nawab Yusuf Road, Civil Lines, Allahabad for kind information & necessary action please.
2. CMD/RVNL, Plot No. 25, 1st Fir, B-Block, August Karanti Bhawan, Bhikaj Cama Place, New Delhi for kind information & necessary action please.
3. CMD/DFCCIL, 5th Floor, MRTS Building, Pragati Maidan, Metro Station, New Delhi for kind information & necessary action please.
4. Chief Workshop Manager, N. Railway, Ghaziabad for kind information please.
5. Principal/STTC, Ghaziabad for information please.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

No. 2012/Sig/ATSS
New Delhi, dt. 10.01.2020

PCSTEs
Zonal Railways
CORE/Allahabad, Metro/Kolkata & KRCL

Director, ED/Sig/Co-ord
IRISET RDSO, Lucknow

Sub: Technical System Application Approval (TSAA) of Electronic Interlocking (EI)
Ref: 1. Rly Bd’s letter of even no. dt. 02.09.2015
2. PCSTE/SECR’s letter No. SECR/S&T/EI/TSAA/1045
dt. 22.10.19

Vide ref 1 above, policy guidelines were issued that the practice of obtaining TSAA
from RDSO, prior to commissioning will continue for electronic interlocking
installation with more than 100 routes.

Vide ref 2 above, SECR has sought clarification in case of alterations in those EIs for
which TSAA has been taken earlier. The clarification has been asked as to whether
TSAA shall be taken for all alterations in EI, or alterations having changes in system
configuration or it is not required at all.

Board has examined the matter. It has been decided that
i. For alterations in EIs having more than 100 routes, TSAA may be
   granted by PCSTE for alterations involved upto 50 routes. For
   alterations involving above 50 routes, TSAA shall be granted by RDSO.
ii. For alterations in EIs having less than 100 routes, for any alteration
   TSAA shall be done at PCSTE’s level till total number of routes
   surpasses 100 routes, in that case TSAA shall be granted by RDSO.

(Arjun Singh Tomar)

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POLICY NO. 1/19

NORTHERN RAILWAY

Head Quarter office,
Baroda House,
New Delhi.

The Divisional Railway Managers,
Northern Railway,
DLJ, FZR, LKO, MB & UMB.

No. 569-Sig/DO SIG/STD DRG

Date: 06.02.2019

CSTE/Construction,
CSTE/Project-East,
CSTE/Project-West,
CSTE/Project-HQ,
Baroda House, New Delhi.

Sub: Provision of dual VDU in place of 1 VDU + 1 Panel at Stations with Electronic Interlocking.

Ref: PCOM’s approval for provision of Dual VDU on Northern Railway.

Presently, for Operation of Signalling gears at Stations having Electronic Interlocking (EI), one Conventional Domino type Panel and one Video Display Unit (VDU) is being provided. Due to many advantages of VDU over conventional Domino type Panel, it has been decided that all future EI installations w.e.f. 01.04.2019 onwards shall be commissioned with Dual VDUs with the following Safeguards:

a. In case of any problem in the operational VDU, ASM will be able to transfer working on 2nd VDU. The process of changeover between the two VDUs, shall be incorporated in the SWR of Station.

b. Position of VDUs shall be such that ASM is able to discharge his duties while sitting on his chair.

c. Sufficient spares shall be provided at every station to ensure trouble free working of VDUs.

d. For small way side stations size of VDU shall be 42” and for bigger yards the size shall be decided on case to case basis.

This has the approval of PCOM and PCSTE.

(V. K. Pahary)

Dy.CSTE/B&D
For PCSTE

Copy to:-

1. PCOM for kind information please.
2. CSTE/CORE, 1, Nawab Yusuf Rood, Civil Lines, Allahabad for kind information & necessary action please.
3. CMD/RVNL, Plot No. 25, 1st Flr, B-Block, August Kranti Bhawan, Bhikaji Cama Place, New Delhi for kind information & necessary action please.
4. CMD/Dfccil, 5th Floor, MBRS Building, Pragati Maidan, Metro Station, New Delhi for kind information & necessary action please.
5. M/s Railet Enterprises Limited, 6th Floor, 3rd Block, Delhi Technology Park, Shastri Park, Delhi-11003.

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CHAPTER – 14

ELECTRICAL AND TRD WORK

14.1 DEFINITION

Power line crossing means an electrical overhead line or under-ground cable placed across railway track(s) for the transmission and/or distribution of electrical energy. It may also be referred to as a “Crossing” in these Regulations.

14.2 SCOPE

The regulations apply to electrical overhead lines and/or underground cables crossing railway tracks operated by the Indian Railways, Railway Companies and Port Commissioner’s Railways, including assisted and private sidings on which rolling stock of Indian Railways may work.

Notes:

i) If any existing crossing infringes the provisions of the Regulations at the time of its issue, the infringement(s) shall be treated as permissible infringement(s) provided that necessary relaxation has been granted in respect of the clearances under clause 21 thereof.

ii) The Regulations do not apply to crossing(s) of railway track(s) laid underground/inside tubes and tunnels.

iii) The Regulations do not also apply to Railway Traction systems (1500 V D.C. and 25 kV, 50 Hz A.C. Single phase) whose feeders/conductors/wires run along or across the tracks for traction purposes.

iv) On sections proposed to be electrified on or to be converted to suit 25 kV, 50 Hz AC single phase traction system, the crossing existing at the time of electrification/conversion proposed shall be specially studied with a view to avoiding modifications to the extent possible without jeopardizing safety. If any modifications are considered essential to obtain the minimum clearances, specified in clause 21 thereof, they shall be carried out.

v) In special cases, where the Electrical Inspector has specifically permitted reduction in clearance under clause 21 thereof, a clear declaration to this effect shall be recorded in the CERTIFICATE OF COMPLIANCE (in the form at Annexure II) to these regulations.

14.3 WORKS TO BE EXECUTED BY THE RAILWAY

Any conduit, culvert or similar work passing under Railway premises shall be constructed by the Railway in such manner and of such materials as it may approve of and the entire cost of such works shall be borne by the owner of the crossing.

14.4 METHOD OF CROSSING –

OVERHEAD LINE OR UNDERGROUND CABLE

For tracks already electrified or to be electrified in the foreseeable future. All low, medium and high voltage up to and including 11 kV crossings(s) shall normally be by means of underground cable(s). While for voltages higher that 11 kV, crossings may be by overhead lines or underground cables, the use of
underground cable to the extent possible would be advantageous, particularly for 33 kV system.

14.5 OVERHEAD LINE CROSSINGS

14.5.1 Angle of Crossing

An overhead line crossing shall normally be at right angles to the railway track. In special cases a deviation of up to 30 degree may be permitted. Deviations larger than 30 degree shall have to be specifically authorized by the Electrical Inspector of the Railway.

14.5.2 Structure

- Structures shall be of the terminal type. For arriving at the crippling load, the wind loads as detailed in the latest edition of IS: 802 (Part-I)- 1977 for “Loads and permissible stresses” shall be adopted. The steel structures shall normally be galvanized in accordance with IS: 2629- 1966 for “Recommended practice for hot-dip galvanizing of iron and steel.”
- The minimum distance (horizontal) of the structures (supporting the crossing span) from the centre of the nearest railway track shall be equal to the height of the structure in meters above normal ground level plus 6 meters in special circumstances, the Electrical Inspector may permit a lesser distance being adopted subject to any conditions he deems fit to impose.
- The crossing span shall be restricted to 300m or to 80% of the normal span for which the structures are designed, whichever is less.

14.5.3 Clearance between the Overhead Line & Railway Track

14.5.3.1 Overhead Line Crossing Location-

An overhead line crossing over railway track already electrified shall be located at the middle of overhead equipment span supported by two adjacent traction masts/statures. The distance between any of the crossing conductors and the nearest traction mast or structure under the most adverse conditions shall not be less than 6m.

Note: If, in unavoidable circumstances, the crossing span cannot be so located, the minimum clearance between any of the crossing conductors of the crossing and the nearest traction mast or structure shall be not less than that specified for buildings in Rule 80 of the Indian Electricity Rules, 1956 (as amended up to November 1984). No overhead line crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.

14.5.3.2 Vertical Clearance:

The minimum height above rail level of the lowest portion of any conductor of a crossing, including guard wire under condition of maximum sag in Electrified/Non Electrified (proposed to be electrified) shall be as follows.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Overhead</th>
<th>Minimum Clearance from rail level</th>
<th>Minimum</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>crossing Voltage</th>
<th>Existing Power line crossing for non electrified territory</th>
<th>New Power line crossing or crossing planned for alteration</th>
<th>clearance between highest traction conductor and lowest transmission line crossing conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2</td>
<td>3 4</td>
<td>5</td>
<td>Other than High Rise OHE High Rise OHE</td>
</tr>
<tr>
<td>1 Upto and including 11kV</td>
<td>Normally by underground cable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Above 11kV &amp; upto 33 kV</td>
<td>10860 mm</td>
<td>14660 mm</td>
<td>16660 mm</td>
</tr>
<tr>
<td>3 Above 33kV &amp; upto 66 kV</td>
<td>11160 mm</td>
<td>14960 mm</td>
<td>16960 mm</td>
</tr>
<tr>
<td>4 Above 66kV &amp; upto 132 kV</td>
<td>11760 mm</td>
<td>15560 mm</td>
<td>17560 mm</td>
</tr>
<tr>
<td>5 Above 132 kV &amp; upto 220 kV</td>
<td>12660 mm</td>
<td>16460 mm</td>
<td>18460 mm</td>
</tr>
<tr>
<td>6 Above 220kV &amp; upto 400 kV</td>
<td>14460 mm</td>
<td>18260 mm</td>
<td>20260 mm</td>
</tr>
<tr>
<td>7 Above 400 kV &amp; upto 500 kV</td>
<td>15360 mm</td>
<td>19160 mm</td>
<td>21160 mm</td>
</tr>
<tr>
<td>8 Above 500kV &amp; upto 800 kV</td>
<td>18060 mm</td>
<td>21860 mm</td>
<td>23860 mm</td>
</tr>
</tbody>
</table>


**NOTE:**

1. While calculating the above clearances, Railways high tension lines running over the 1500 V DC traction structure in some sections have not been taken into consideration. Where such high tension lines exist, the height above the rail level of the highest high tension line shall be taken into account for calculating the clearances.

2. All clearances mentioned above are under maximum sag conditions.

3. If the crossing is provided with a guarding, a minimum clearance of 2000 mm shall be maintained between bottom of the guard wire & highest traction conductor.

4. Power line crossing in yards & station areas shall be avoided.

5. For any electrification work of existing line; doubling/gauge conversion along with electrification, existing crossings can continue, if
dimensions are as per Column (5) above, even if dimensions of Col (3) are not satisfied i.e. for electrification works Col(3) is not applicable.

14.5.3.3 Relaxation by the Electrical Inspector

Power Line crossings should be avoided in station area and yards under normal circumstances. If unavoidable, relaxation by Electrical Inspector of the Railway will be necessary.

14.5.3.4 Insulators

A double set of strain insulator strings shall be used in crossing span in conjunction with a yoke plate where necessary. The factor of safety of each string of insulators under the worst conditions shall not be less than 2.

14.5.3.5 Guarding

The minimum height between any guard wire and a live crossing conductor under the most adverse conditions shall not be less than 2.0 m.

14.5.3.6 Earthing

i) Each structure on either side of the crossing span supporting the transmission/distribution line conductors shall be earthed effectively by two separate and distinct earths and connections. At least one separate earth electrode shall be provided for each earth connection.

ii) All guard and stay wires shall be properly clamped to the structures connected to earth so as to maintain proper electrical continuity to earth.

iii) Where struts are provided, they shall also be effectively connected to earth separately as well as to the main structure earths.

iv) Where the earth resistance of the independent tower/structure is higher than 10 ohms, the owner shall take necessary steps to improve the earth resistance either by providing multiple earth electrodes or by suitably treating the soil surrounding the earth electrode.

v) The earths shall be inspected and tested annually on a hot dry day and results thereof furnished to the Railway for verification and record. If the earth resistance is found to be high, i.e. above 10 ohms, steps shall be taken to reduce it and an advice given to the Railway.

vi) The cross-section of the earth conductor/connections for the earthing system shall be adequate for the application. They shall not be damaged or overheated or melt while carrying the short circuit current.

vii) Buried Rail as per SMI No. TI/SMI/0032 Rev. 02 dated 26.02.2020 should be provided near the switching posts.

viii) Fencing/railing on the platform should be bonded on at least two places, if more than 20 mtr and with separate earth pit also if more than 350 mtr. (Earth Pit resistance Less than 10 Ω (individual) & 2 Ω (combined).

ix) Earthing must be followed to IS: 3043-1987- Code of Practice for Earthing (first revision or latest)
14.6 IMPORTANT ASPECTS FOR RAILWAY ELECTRIFICATION

14.6.1 Railway Electrification Survey

14.6.1.1 Purpose of Railway Electrification

The major advantages of electric traction are economy in operation and maintenance, saving in consumption of scarce diesel oil and increased through put of traffic.

14.6.2 Railway Electrification Works

14.6.2.1 Discipline wise Division of Works

a) Electrical

i) Provision of Overhead equipment.


iii) Remote Control of the Power Supply Equipment.

iv) Electric Locomotive maintenance facilities.

v) Ancillary works of modification to the existing power supply arrangements on the route to immunize the system against induced voltages.

vi) Liaison with Electricity Authorities to modify their power line crossings to suit 25 kV AC traction.

vii) Consequential electrical works for electrification and air conditioning of service buildings and staff quarters.

b) Signal and Telecommunications:

i) Provision of colour light signals.

ii) Provision of underground cables for the Railway’s telecommunication lines and provision of additional traction control circuits.

iii) Liaising with Department of Telecommunications for modification of their circuits to immunize them against induced voltages due to traction current.

iv) Provision of approved SIP and Track bonding plan.

v) Joint marking of Signal installation.

c) Civil Engineering:

i) Yard remodelling, slewing of tracks, sidings and all track works.

ii) Construction of loco sheds, service buildings and staff quarters.

iii) Modification to over line structures such as over bridges, flyovers, through girder bridges, as well as to tunnels, platform shelters and water columns to suit 25 kV AC clearance.
iv) Provision of approved ESP, L-Section drawing and marking of rail level.

v) Provision of designed soil bearing pressure of the formation level.

vi) Joint marking of SRJ and Track centre with respect to fixed reference.

vii) Joint marking of infringement.

viii) Joint marking of rail level.

14.6.2.2 Choice of System of Power Supply

Before designing the power supply arrangements and the type of overhead equipment of a section, a choice is required to be made whether conventional 25 kV system is to be adopted or 2x25 kV Auto Transformer system is to be adopted. The demand of power for the volume and type of the traffic and suitable location available for traction sub-stations.

14.6.2.3 Coordination of Works

Railway Electrification, being a multi-disciplinary project work, needs close coordination amongst electrical, signaling & telecommunications and civil engineering disciplines. It further needs coordination with outside agencies such as Power Supply Authorities, the Department of Telecommunications, the Revenue officials as well as with the Open Line organization or whose section the work is to be taken up.

14.6.3 Selection of Route for Electrification

14.6.3.1 Main Consideration

Routes having high density of traffic, short spurs of, or those lines which interconnect the electrified lines, which improve the mobility of the rolling stock are also taken up for electrification.

14.6.3.2 Financial Evaluation

i) Lower fuel-cost.

ii) Less number of locomotives.

iii) Lower operating cost.

iv) Lower locomotive maintenance costs as compared to diesel traction of the given traffic.

The traffic level in gross Million tonne per route kilometre per annum at which the minimum acceptable rate of return obtained is called the “Break Even Level” for traffic survey.

14.6.4 Survey for Electrification

14.6.4.1 General

It is essential to further examine the chosen route in detail for its suitability for electrification in following aspects:

a) The feasibility of electrification viz. availability of power supply, suitability of the terrain and of the over line structure (or their amenability to
modifications) to suit the electrical clearances, and of terminal yards to be able to provide lines for change of traction.

b) A realistic assessment of the cost of the project.

c) The financial viability of the investment

To ascertain the above details a route is surveyed either be a ‘Reconnaissance Survey’ or a detailed Foot by Foot, ‘Cost-cum-Feasibility Survey’ as the circumstances call for.

14.6.4.2 **Reconnaissance Survey:**

This is a rapid survey examining the salient and vital points.

a) Assessment of existing traffic forecast of projected traffic, both for goods and passenger.

b) Availability of Electric Power.

c) Details of the section covering the terrain, the terminal yards, the signal and telecommunication installations.

d) An idea of the lengths of the route.

e) The information collected by this rapid survey yields a fairly accurate idea of the volume of electrification work content. The quantities of the component works estimated and the project cost is worked out based on the latest cost of inputs, of fuel electric energy, specific fuel or energy consumption and other operating and maintenance norms derived from statistical data, a rate of return is worked out.

14.6.5 **Foot by Foot Survey**

14.6.5.1 **General**

This survey forms the basis of Survey Sheets. These sheets are prepared to scale, the longitudinal scale being 1:1000 in open route and 1:500 within station limits and in yards. The sub-scale chosen for cross sections is 1:200. On these sheets the OHE structures and anchor, foundations are marked according to the Principles for OHE Layout Plans and Sectioning diagrams for 25 KV AC traction. Document No. ETI/OHE/53, issued by RDSO. These plans, called pre pegging plans are then verified at site and modified to site conditions and finalized. The final plan thus issued is called the Pegging Plan, and forms the basis for estimation of quantities, the cost estimates and the schedule of quantities, the cost estimates and for schedule of quantities to tenders for OHE construction Contracts.

14.6.5.2 **Important Features to be noted**

These are:

a) Track centres between all tracks.
b) Track structure i.e. type of sleeper, depth of ballast, width of cess, embankment, and level of cutting.

c) Details of cross section every 250 m.

d) Type and condition of soil every 250 m and at geologic discontinuities.

e) Buried water mains, and cables and their runs alongside and across tracks.

f) Signal cabins and location boxes, signal wires, point rods, cranks and signal cables.

g) Signals: Main Routing, Shunt; their type and track for which meant.

h) Buildings, huts, platforms, other structures such as columns for over bridges, abutments of road over bridges.

i) Platform shelters, their profile across tracks, height and distance of columns, and edges of shelters from adjacent track.

j) Turnouts, crossovers, and diamond crossings, their deviation numbers viz. 1 in 8.5, 1 in 12 or 1 in 16 chainage of the fouling boards / marks, track centres at toes of turnouts and at the fouling boards / marks.

k) Water columns, ash pits and steam blow down pits.


m) Metallic circuits (electric, low or high tension, signal, or telecommunications) running parallel to tracks and their distance from adjacent track centres.

n) Fencing: Metallic or otherwise, running along tracks, chainages of their beginning and end, and their distance to adjacent track at regular intervals; their type of construction.

o) Over head wire crossings of tracks Telecommunications (Railway or belonging to Department of Telecommunications)

p) Over line structures such as Road over bridges. Flyovers, foot over bridges and signal gantries: their vertical clearances from each track spanned, and horizontal distances of their support columns or abutments form the adjacent tracks.

q) Curves: Whether right hand or left hand as seen in the direction of increasing chainage; the degree of curvature, and the chainage of tangent points. Versines in mm are taken every 50 m with nylon cord for the entire curve. The super-elevation as found at site should be recorded.

r) Level crossings, their chainages, and location of gate lodges, whether manned or unmanned and location of gate signals, if any.

s) Locations of gradient posts and signal location marker posts.

t) Culverts and bridges: Chainage of their abutments, piers, trolley and man-refuges, whether culverts or long bridges.
u) Tunnels; their chainages and profile, whether lined or unlined, location of trolley and man refuses.

v) Identification and extent of Exposed Locations: Areas where full wind effects are likely to be encountered by OHE structures and termed ‘Exposed locations’ should be noted down.

w) Identification of polluted locations: Areas, adjacent to factories and power stations having high ambient pollution particles should be identified and recorded.

x) Identification of bridge mast locations on piers by maintaining 10m distance from bridge outer wall face. Measurement of piers to explore the possibility of type of bridge mast arrangement.

y) Identifications of locations with suitable land for Traction substation (TSS)/Switching posts (SP/SSP) as proposed.

14.6.6 Preparation of Pre-Pegging and Pegging Plans

14.6.6.1 General

The plan actually followed for field work, incorporating further details of type of structures used, the style of the cantilevers used, the stagger of the OHE conductors, the run of wires, portal spans as well as the setting distances of the structure legs becomes the ‘OHE layout plan’.

> Pre-requisites for Layout plans:

a) Actual/Designed soil bearing pressure of the formation level.

b) Approved Drawings:

i) Engineering Scale Plan (ESP) and L-Section.

ii) SIP and Track bonding plan.

14.6.6.2 Meteorological conditions

a) The maximum, the minimum and the mean ambient temperatures: The mean temperature adopted over the entire Indian subcontinent is 35 Degree C. A range of 15 Degree C to 65 Degree C as the minimum and the maximum is adopted for India except the northern plains having colder winters for which the range adopted is 4 Degree C to 65 Degree C. For unregulated OHE a contact wire height at supports of 5.65 m is adopted for the former range of temperatures and of 5.75 m for the latter range of temperatures. The contact wire height of regulated OHE is uniformly kept at 5.80 m at supports.

b) Wind Speed Zone: It is to be ascertained from IS 875 as to in which zone area the section to be electrified falls. This dictates the maximum permissible span to be adopted and the relevant employment schedule to be adopted for the design of structures and foundations.

14.6.6.3 Movement of Over Dimensional Consignments (ODC)

The minimum height of the contact wire under heavy over line structures is normally kept such that class ‘C’ over dimensional consignments of Height 4.92 m can be moved at unrestricted speed with electric locomotives.
14.6.6.4 Span Lengths

Span lengths are chosen in multiples of 4.5 m. The shortest span adopted is 22.5 m and the longest, depending upon the particular specification of the wind speed zone and the type of equipment, being a maximum of 72 m (varies as per wind different zones) 67.5 m (as per letter no TI/CIV/MS/18/17 dated 18/05/18). The difference between two consecutive spans should not exceed 18 m to ensure compatible flexibility over the adjacent spans. Non standard span lengths are permitted only if special conditions do not permit choice of standard span sizes, such as while locating on bridge structure.

14.6.6.5 The Setting Distance (Implantation) of Structures

The setting distance to be provided is:

a) For individual masts carrying one OHE:
   
i) On tangent track
      Standard 2.80 m
      Minimum 2.50 m

b) For a Portal upright or a head span leg or a mast carrying more than one OHE and BWA locations, the setting distance adopted should not be lesser than 3.00 m.

- Reference: Rly. Bd. letter No. 2000/RE/161/1 Pt.III 03.11.10 (Annexure 14.02)

14.6.6.6 Location of Obligatory Structure

There are certain features along the track, within a few metre of which an OHE structure should be provided. These are, for example, at turnouts and crossovers or adjacent to over line structures. These OHE structures are called ‘Obligatory structures’. The span under an over line structure should not exceed 54 m to limit the amount of push up of Catenary by the upward thrust of the pantograph; also the structures supporting the OHE should be more or less equidistant from the centre line of the over line structure to ensure maximum clearance between the over line structure and the OHE conductors.

The curvature on the turn out requires stagger of 300 mm in all cases towards the main track. Further, there should be a minimum horizontal separation, between the two contact wires, of 50 mm and a maximum of 200 mm at support to ensure non interference between two OHEs and smooth changeover of contact wire for the pantograph of the locomotive negotiating the turn out.

For best result the track separation should be between 500 mm to 700 mm. However if due to site conditions it is not possible to locate obligatory structure as mentioned, it should be located at the position where track separation is between 150 mm to 700mm.

- Reference: RDSO Maintenance Instruction No.TI/MI/0028 Rev.-2 (Annexure 14.03)

14.6.6.7 Location of OHE Structures in Advance of a Signal:

OHE structure should not be located nearer than 10 m behind and 30 m in advance of a signal. For proper visibility of a signal, a larger setting distance is given to a few OHE structures in advance of a signal.
14.6.6.8 The Location of Overlaps

Location of uninsulated overlaps, the uninsulated overlaps is inserted ensuring longest tension lengths, the effort being to have minimum number of overlaps in the section. There is a limit of 750 m between the anticreep central masts to the corresponding balance weight anchor mast at the overlap for regulated OHE. This limits the tension lengths to 1500 m maximum. For unregulated OHE no anticreeps are required and the maximum tension length of conductors is increased to 2000 m. A half tension length of OHE, having one end as fixed termination may be adopted, omitting the anticreep.

Centre line of Insulated overlaps should be arranged in such a manner that should be min. 120m behind the stop signal and in single line section the best practice to keep within home signal and advance starter signal.

14.6.6.9 Location of Section Insulator

The total weight of the section insulator including the weight of the two insulators on the OHE and the copper runners is 55 kg, to accommodate the two insulators for both the conductors and to permit the locomotive pantograph to glide over the two runners of the section insulators there is a requirement of a minimum dropper length of 450 mm, and a maximum permissible stagger of 100 mm at the location of the section insulator. Since, the maximum encumbrances at the OHE structure is limited to 1.4 m, this imposes a limit to the sag and therefore, the distance of the section insulator from the nearest OHE support.

Provisions of section insulator assembly shall be made at a distance from supporting mast as given in the table below for copper conventional OHE. The pre-sag of the span carrying section insulator shall be zero.

<table>
<thead>
<tr>
<th>Span</th>
<th>72 mts</th>
<th>67.5 mts</th>
<th>63 mts</th>
<th>58.4 mts</th>
<th>54 mts</th>
<th>49.5 mts</th>
<th>45 mts</th>
<th>40.5 mts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible distance from support</td>
<td>7.7 mts</td>
<td>8.1 mts</td>
<td>9.4 mts</td>
<td>12.3 mts</td>
<td>13.5 mts</td>
<td>15.0 mts</td>
<td>18.2 mts</td>
<td>Any where</td>
</tr>
</tbody>
</table>

It should be located beyond the point where the centre distance between two tracks is equal to or more than 1.65m. If the section insulator assembly is erected with the free end of the runner away from the centre of the turnout this distance may be reduced to 1.45m.

14.6.6.10 Bonding and Earthing Plans

Plans for suitable earthing and bonding of the metal work adjacent to track, breaking the long fencing in smaller electrical section, and providing safe passage of traction currents through rails by providing longitudinal and transverse bonds for running rails of electrified tracks are made. All OHE structures are bonded to the non track circuited rail through structure bonds, or if such a rail is not available to an earth wire run on the OHE structures.

Proper arrangement are to be made for bonding and earthing of ROB/FOB Girders at the time of erection by making hole of suitable size.
14.7 PRINCIPLES FOR LAYOUT PLANS AND SECTIONING DIAGRAMS FOR 25KV AC TRACTION

14.7.1 Bond

An electrical connection across a joint in or between adjacent lengths of rail.

i) Bond, Continuity.
ii) Bond, Cross.
iii) Bond, Impedance
iv) Bond Rail.
v) Bond, Structure.

14.7.2 Cantilever (Assembly)

It is an insulated swivelling type structural member, comprising of different sizes of steel tubes, to support and to keep the overhead Catenary system in position so as to facilitate current collection by the pantograph at all speed without infringing the structural members.

14.7.3 Electrical Clearance

The clearance between 25 kV live parts and earthed parts of fixed structures or moving loads shall be as large as possible. The electrical clearances to be maintained under the worst conditions of temperature, wind, etc. are given below:

a) Maximum vertical distance between any live part of overhead equipment or pantographs and parts of any fixed structures (earthed or otherwise) or moving loads:

   i) Long duration 250 mm.
   ii) Short duration 200 mm.

b) Minimum lateral distance between any live part of overhead equipment or pantographs and parts of any fixed structures (earthed or otherwise) or moving loads:

   i) Long duration 250 mm
   ii) Short duration 200 mm


14.7.4 Working Clearance

Minimum clearance between live conductors/ equipments and such earthed structure / live parts of different elementary sections where men are required to work shall be 2 m.

14.7.5 Wind Pressure

Wind pressure/Load for design of all masts and determination of spans are based on wind pressures as prescribed in IS-875(Part-III):1987 (Reaffirmed during 1997). Accordingly, the standard wind pressures adopted for all new works for different zones as indicated in the specification are as follows.
<table>
<thead>
<tr>
<th>SN</th>
<th>Basic Wind speed in m/s</th>
<th>Zone</th>
<th>Basic Wind speed in Km/hr</th>
<th>Design wind pressure in Kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>Red Zone</td>
<td>180.0</td>
<td>178</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>Green Zone</td>
<td>169.2</td>
<td>155</td>
</tr>
<tr>
<td>3</td>
<td>44</td>
<td>Blue Zone</td>
<td>158.4</td>
<td>136</td>
</tr>
<tr>
<td>4</td>
<td>39</td>
<td>Yellow Zone</td>
<td>140.4</td>
<td>105</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>Navy Blue Zone</td>
<td>118.8</td>
<td>73</td>
</tr>
</tbody>
</table>

14.7.6 Spans

14.7.6.1 Restrictions

The following restrictions are applicable.

I) On main tracks, the lengths of two consecutive spans shall not normally differ by more than 18 m.

II) The lengths of spans with unequal encumbrances shall be such that the axial distance between the Catenary and the contact wire at the minimum dropper is not less than 150 mm. For example, the length of the span with 1.4 m and 0.9 m encumbrances at the two ends shall not exceed 67.5 m. This restriction is applicable to the two spans on each side of the structure, equipping a turnout for the main OHE.

III) Spans in the vicinity of over line structures with restricted head room shall be determined with reference to the electrical clearances available.

IV) The lengths of spans loaded with section insulators may require to be restricted.

V) Non-standard spans may be adopted in difficult locations, e.g. in rocky cuttings, on through girder bridges, for locations of masts on bridge piers and within station limits.

VI) With crossed type equipment with actual crossings of OHEs at facing turnouts, the anchor spans shall be restricted to 54 m.

VII) Where earth wire is provided, the maximum span over level crossings should be 54.00 m.

14.7.7 Masts, Portals, Head Spans and Foundations

14.7.7.1 Types of Masts

OHE conductors are suspended from swivelling cantilever assembly generally erected on individual masts.

Different seven types of masts are used. These are designated as (150 x 150) BFB, (200 x 150) RSJ, B-150, B-175, B-200, B-225 & B-250. The first two are rolled sections and remaining five are fabricated masts.
14.7.7.2 Two Track Cantilever

In the yards and sidings when the mast cannot be erected near the track to be equipped, it may be erected span one or two tracks using a two-track cantilever. This is generally used for supporting OHE near turnouts and X-overs. These arrangements should not be used for supporting OHE of two main lines. The OHE can be supported upto a distance of 10.5 m from the upright with this arrangement.

14.7.7.3 Portals

Three types of portals have been standardized. 'N' type portal is used for clear spans of 10 m – 20 m (for 4 tracks maximum). 'O' type portal is for clear spans of 20 m – 30 m (for 6 tracks maximum) and 'R' type portal with spans of 30 m – 40 m (for 8 tracks maximum).

14.7.7.4 Foundations

a) Volume Charts

Selection of the type and size of foundation is done from the volume chart (Drg. No. ETI/C/0058) on the basis of FBM code, type and bearing capacity of soil/shoulder width and the extent of projection above ground level.

b) Type of foundations:

The following types of foundations are for OHE mast and portals:

(1) For masts:

(A) Side bearing (Type B) Drg. No. ETI/C/058 Sh.1
(B) Side gravity (Type : BG) -do-
(C) Pure gravity (Type: MG) -do-
(D) Pure gravity for black cotton soil (Type:WBC) -do-

i) New pure gravity (Type: NG) -do- Sh.2A

ii) NBC type foundation for dry black cotton soil
(16500 & 11000 kgf/m2)
3.0 m depth -do- Sh.3

iii) New pure gravity for different soil and site conditions (500 mm exposed)
(Type: NG or SPL) -do- Sh.4

iv) New pure gravity for black cotton soil
(for 8000 kgf/m2 soil pressure.
2.5 depth (Type :NBC) -do- Sh.5

v) Foundations in soft rock
(bearing capacity 45000 kg/m2) Drg. No. ETI/C/0059

vi) Foundations in hard rock
(bearing capacity 90000 kg/m²) Drg. No. ETI/C/0050

(2) For portals:
   i) In ordinary soil Drg. No. ETI/C/0058/68
   ii) In dry black cotton soil Drg. No. ETI/C/0063

c) Selection of foundations

Side bearing foundations are used for masts where the soil bearing capacity is 11,000 or 21,500 kg/m² and 300 mm wide shoulder is available on the banks.

- New pure gravity foundations may be used for masts where soil bearing capacity is 5500, 8000 and 11000 kg/m² or where adequate shoulder width is not available.
- Side gravity foundations may be used for masts where soil bearing capacity is 8000 and 11000 kg/m² or adequate shoulder width is not available.
- Pure gravity foundations (Type - MG) are used for independent masts where soil surrounding the foundations is loose and cannot exert passive pressure on the foundations. G-type foundations have been designed for soil bearing capacity of 5500, 8000 and 11000 kg/m². Pure gravity foundations (Type P) are used for portals and are designed for soil bearing capacity of 8250 and 11000 kg/m².
- The top of foundation should be 50-100 mm above the surrounding ground level. The length of mast below rail level should be minimum 1850 mm for regulated OHE.

14.7.7.5 Contact Wire Height

Type of OHE Normal height of contact wire at the support point

a) Normal with 10 cm pre-sag 5.80 m

b) Old electrification 5.55 m
   - The height may be reduced under over line structures after a clearance study. The minimum height shall be 4.92 m for the broad gauge and 4.02 m for the metre gauge to permit movement of “C” class ODCs. In case “C” class ODC movement is not required, the height could be reduced to 4.80 m (BG). Height may be further reduced to 4.69 m if rolling stock higher than 4.42 m are not allowed on such lines.
   - At electric locomotive sheds and loco inspection pits; the minimum height shall be 5.80 m for the broad gauge and 5.50 m for the metre gauge.
• At level crossings, the minimum height shall be 5.50 m for both broad and metre gauges.

14.7.7.6 Contact Wire Gradient

Any change in the height of the contact wire should be made gradually and the slope should not normally exceed 3 mm / m on main lines and 10 mm/m on sidings.

14.7.7.7 Stagger

14.7.7.8 Tangent track

On tangent track, the contact wire is normally given a stagger of 200 mm at each support alternately on the side of the centre of the track.

On tangent track, the catenary stagger is zero for masts supporting a single equipment. The catenary is fixed vertically.

14.7.7.9 Un-insulated overlaps

i) The stagger of the in-running contact wire does not exceed 200 mm on tangent track and 300 mm on curve track at any support, at which only one contact wire is in-running.

ii) The two contact wires run parallel to each other between the intermediate supports at a distance of 200 mm from each other.

14.7.7.10 Insulated Overlap

Between the intermediate masts the two contact wires run parallel at a distance of 500 mm from each other.

14.7.7.11 Neutral Sections

The stagger at section insulator type neutral section should be so adopted that the stagger at the section insulator assembly is within the limit of +/- 100 mm.

PTFE type neutral section shall be erected on tangent track only. The stagger shall be zero at support. PTFE should be erected at a minimum distance of 400 m after and 200 m before the signal, to prevent stalling of trains.

14.7.7.12 Encumbrances

Normal The encumbrance shall normally be 1.40 m

14.7.7.13 Minimum Encumbrance

Normally, the axial distance between the catenary and the contact wire at the minimum dropper should not be less than 150 mm.

14.7.7.14 Section Insulators

14.7.7.15 Locations

Sectional insulators should be so located that the following conditions are fulfilled:

i) At location of section insulator, the axial distance between the catenary and contact wire shall not be less than 450 mm.
ii) The section insulator is to be located beyond the point where the centre distance between the two tracks is equal to or more than 1.65m. If the section insulator assembly is erected with the free end of the runner away from the centre of the turnout this distance may be reduced to 1.45m.

iii) The staggering of the contact wire at the location of the section insulator should normally be zero, but in no case should exceed +/- 100 mm.

iv) On loops, the section insulator shall, as far as possible, be located close to the first support of the overhead equipment for the loop.

v) The preferred location of section insulator on main running track is 2 to 10 m from the support in the direction of traffic through its provision on the main line should be avoided.

vi) In double line sections, the runners should be in the trailing direction.

14.7.16 Permissible Speeds

On double line sections, with runners trailing, are fit for speeds upto 120 km/h.

In case the runners of the section insulator are facing or it is not installed within 1/3rd of the span the speed should be restricted to 80 km/h.

14.7.17 Tension Lengths

a) Regulated Equipment

With regulated overhead equipment every tension length is equipped with an automatic tensioning device at each end and an anticreep located approximately midway between the tensioning devices. The distance between the anticreep and the anchor mast / structures on either side should not exceed 750 m or 15 supporting masts.

b) Half Tension Lengths

Half tension lengths of regulated overhead equipment, not greater than 750 m between anchorages, may be adopted where necessary. The equipment is fixed at one end and provided with an automatic tensioning device at the other, the fixed end being determined to suit convenience of erection. The half tension length on either side of the neutral section should not exceed 600 m when the whole or a part of it is located on a curve. The distance of the axis of a 4-span insulated overlap from the anti-creeps/ fixed terminations on either side shall not exceed 600 m.

14.7.18 Bridges and Tunnels

Where the catenary is anchored on the face of an over line structure, the anchor shall be the anticreep point. Termination of overhead equipment or provision of an anticreep should be avoided, as far as possible, inside the tunnels and on the mast set on bridge piers.

As per BS-121 “Guidelines for Provision of OHE mast for Electrification at new and existing bridge pier/abutment : the bridge/bridge pier to be designed must have provision for OHE masts irrespective of whether Electrification is sanctioned or not. The foundation arrangement to be followed should be as per BS-121.
14.7.7.19 Masts near Signals

The visibility of signals should be kept in mind while deciding the setting up masts in their vicinity. The following principles should be observed for deciding the setting of masts near signals:

I. Colour light signals located outside all tracks

a) Colour light signals without route indicators:

i) Where no approach signal is provided

The minimum setting distance of structure before the signal should be 3.55, 3.40, 3.35, 3.20 & 3.05 m for distance up to 80m, beyond and up to 110m, beyond and up to 190m, beyond and up to 270m, and beyond and up to 400 m respectively.

ii) Where approach signal is provided and for signals other than distant signals

The minimum setting of structures before the signal should be 3.55, 3.40, 3.25, 3.10, and 3.05 m for distance up to 50 m, beyond and up to 70 m, beyond and up to 115m, beyond and up to 160 m and beyond and up to 240 m respectively.

b) Colour light signals with route indicators:

i) With HORIZONTAL route indicator

The minimum setting distance of structure before the signal shall be 4.02, 3.80, 3.55, 3.35, 3.20 and 3.05 m for distance up to 60 m, beyond up to 125 m, beyond and up to 170 m, beyond and up to 215 m, beyond and up to 250 m and beyond and up to 310 m respectively.

ii) With OTHER THAN HORIZONTAL route indicator.

The minimum setting distance of structures before the signals shall 3.80, 3.55, 3.35, 3.20 and 3.05 m for distances up to 70m, beyond and up to 130m, beyond and up to 170m, beyond and up to 215m and beyond and up to 280m respectively.

Setting distance may be reduced for starter signals of loop lines and yard lines. The setting can be reduced in special cases, conforming to Fig.6 to 9 of RDSO revised Drg. No. ET/OHE/G/00112.

II. Colour light signals located between tracks

a) Signals without route indicators

No overhead equipment structure should as far as possible be located in the same lane as signals for a distance of at least 600m before a signal.

Drop arms of portals should also not normally be located in the lane where signals are located at least for a distance of 600 m before the signal. Where this is not possible for any reason, the
signal should be mounted on an offset bracket. In addition, a special study should be made in each such case in respect of three drop arms before the signal to see whether the drop arms can be offset from the centre line of the lane in a direction opposite to the arms. Reduction in the signal height must also be examined.

b) Signals with route indicators

The principles mentioned in the preceding paras should be observed in this case also. No part of a colour light signal without a route indicator should as far as possible be higher than 5.2 m above rail level. Great care must be exercised in deciding the location of the colour light signals with route indicators so that the necessary minimum clearances are available between the signals and live out of run wires, or pantograph sway zone.

III. Semaphore signals located outside the track

The minimum setting of structures before the signal should be 3.35, 3.20 and 3.05 m for the first, second and next three structures respectively, starting with the first structure from the signal. For details RDSO’s Revised drawing number ETI/OHE/G/0112 may be referred.

On signal line sections, signals (colour light as well as semaphore) must, as far as possible, be located on the side of the track opposite the overhead equipment structure.

14.8 GENERAL GUIDELINES FOR ANTI-THEFT CHARGING OF OHE

14.8.1 Procedure to be adopted for Energization

14.8.1.1 Publication and Display of Notices

1. At least a month in advance of energization of any section or sections the following public notifications should be got published in all the prominent dailies in English, Hindi and Local language and issued to all concerned as normally done for 25 kV energization.

   (i) General Notification to the users of Railway Lines regarding section/sections to be energized.

   (ii) Notification to the users of level crossings.

2. Display of general caution notices for public and staff at prominent places at each station, stenciling on the diesel / steam locos warning message to not to climb on the top of locos, caution notices at all steam and diesel loco sheds at which locos working in the energized section are maintained.

3. The steam/diesel loco drivers / firemen shall be warned not to climb on the roof of the tender and the engine on the section proposed to be energized.
14.8.1.2 Certificates to be issued

On completion of the work as mentioned in Para above the following certificates from the concerned officers will be obtained.

i) Certificate regarding removal of L.T and H.T infringements by Dy.CEE(G) of the project.

ii) Certificate regarding S&T works.

iii) Department of Telecommunications (DOT) clearance certificate for 2.2 kV anti-theft energisation.

iv) Certificate by Dy.CEE (OHE) or DEE(OHE) regarding completion of OHE works.

v) Clearance Certificate by OHE Contractors.

vi) Certificate by Dy. CE or XEN/RE regarding provision of level crossing height gauges and provision of protective screens on ROBs and FOBs.

14.8.1.3 Joint Certificates

Besides the certificates regarding completion of works to suit 2.2 kV energisation as mentioned in Para above, the following safety certificates shall also be obtained:

(i) Joint certificate by CEE(C), CSTE(C) AND CE(C) regarding safety to traffic.

(ii) Certificate of concerned officers of Division of particular Railway about knowledge of their staff regarding safety.

14.8.2 EIG Sanction

An application to EIG seeking his approval to the proposal of energisation of OHE at 2.2kV as anti-theft measure may be made in advance. While applying for sanction, the up to date status of works to be completed prior to 2.2 kV energisation should be given and the list of certificates for its completion as well as other safety certificates proposed to be forwarded at the time of seeking EIGs formal sanction may also be indicated. EIGs sanction shall be obtained prior to energisation at 25 kV. Period of anti-theft charging will be decided with the approval of PCEE.

14.8.3 Checks and Tests Prior to Commissioning

PCEE and Electrical Inspector to the Government for the Railway may nominate at his discretion one of his officers preferably Sr. DEE (TRD) for joint check and tests of the section proposed to be energized. For such joint check by Dy. CEE (OHE)/ RE will associate from RE side. Alternately he may authorize Dy. CEE (OHE)/RE to conduct checks and tests before energisation.

The following checks and tests shall normally be carried out.

a) Checks
1. That clearance between live and earthed structures is in accordance with the provisions of Schedule of Dimensions.
2. That earthing and bonding of the OHE have been carried out as per Bonding and Earthing code with exception for station area as specified in para 2.1.2 above.
3. That height of contact wire at level crossings is proper and that height gauges have been provided.
4. That protective screens have been provided in FOBs, ROBs and signaling structures.
5. That the earthing and isolation of overhead equipment adjacent to the section to be energized has been carried out properly.
6. AC immunized track relays have been provided.
7. Overhead P&T as well as Rlycrossings have been cabled and wire removed.

b) Tests

1. Megger tests for continuity and insulation of the OHE.

2. With the above checks and tests and after it is certified either jointly by Sr. DEE(TRD) and Dy. CEE(OHE)/ RE that the section can be energized at 2.2KV for test purpose, the following fault tests shall be conducted on the section energized at 2.2kV.

   i. By creating earth fault at the farthest end of energized OHE through discharge rod.

   ii. By creating earth fault at the farthest end of energized OHE touching only ballast.

   iii. By creating earth fault at the farthest end of energized OHE touching only rail. In all these cases of earth fault, it should be ensured that fuse provided at the supply points blown.

   • Immediately on the successful completion of the checks and tests of the OHE, OHE can be energized provided that:
      
      o All the certificates as mentioned in paras 8.3.2/3 above are obtained.

      o DOT’s clearance and EIG’s sanction are obtained.

   • Immediately after energisation, a notification to that effect may be issued as normally done for 25 kV energisation.

14.9 HIGH RISE OHE

Indian Railways decided to adopt Double Stack Containers on Flat Wagons. The maximum height of the stock worked out to 6809 mm from Rail Level. Electrification of route suitable for movement of Double Stack Container had to be worked out. After lots of studies of expected OHE design and behavior of Locomotive Pantograph, Indian Railways decided to erect OHE, where height of Contact wire at midspan would be 7450 mm. The design for OHE, suitable
for running of 7100 mm high consignment has been firmed up after detailed deliberations & site visits. The design also catered for transition zone i.e between normal OHE and high rise OHE. Transition zone OHE is essentially required so that the Pantograph may negotiate the Feeder Routes (with Normal OHE) to the proposed high rise OHE Route without contact loss & ensures smooth current collection.

The High Rise OHE has been developed to strengthen the freight transport capacity of Railways with use of Double Stack Containers. The major advantages of Double Stack Container operation are (i) Increased Throughput; and (ii) Reduction in unit cost. The advent of "Double-stacked" Container transport has changed the entire intermodal freight industry worldwide. It has resulted in cost-effective, secure and reliable freight shipments and provided domestic intermodal Rail capacity that could not otherwise have been possible.

RDSO has issued Design Document (No. TI/DESIGNS/OHE/2014/00001(Rev-1) for Over Head Equipment for running Double Stack Container &Three Tier Car under electrified route (High Rise OHE) with speed potential of 140 kmph.

### 14.9.1 IMPORTANT OHE PARAMETERS FOR HIGH RISE OHE

<table>
<thead>
<tr>
<th>OHE parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of Double Stack Container</td>
<td>7100 mm</td>
</tr>
<tr>
<td>Height of contact wire from support from Rail level</td>
<td>7570 mm</td>
</tr>
<tr>
<td>Height of contact wire at mid span from rail level</td>
<td>7520 mm</td>
</tr>
<tr>
<td>Minimum height of contact wire from rail level at L C Gate</td>
<td>7520 mm</td>
</tr>
<tr>
<td>Height of catenary wire from support from Rail level</td>
<td>8970 mm</td>
</tr>
<tr>
<td>Pre-sag at mid span</td>
<td>50 mm</td>
</tr>
<tr>
<td>Maximum span length</td>
<td>Span length may vary from 54 to 67.5 m depending which has to be decided as per wind zone.</td>
</tr>
<tr>
<td>Type of foundation</td>
<td>As per foundation chart of RDSO drawing no. TI/ DRG/ CIV/ FDN/ 00001/ 13/0 (Sheet 1 to 5) for High Rise OHE</td>
</tr>
<tr>
<td>Maximum stagger at tangent track</td>
<td>(+/-) 150 mm</td>
</tr>
<tr>
<td>Maximum stagger at curves</td>
<td>(+/-) 250 mm</td>
</tr>
<tr>
<td>Standard Encumbrance</td>
<td>1400 mm</td>
</tr>
<tr>
<td>Dropper schedule to be followed</td>
<td>1.400/1.400 metres Encumbrance Generally. (Based on Site conditions other prescribed standard Encumbrance may be followed)</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td><strong>Details</strong></td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Speed</td>
<td>140 kmph</td>
</tr>
<tr>
<td>Mast length</td>
<td>11.40 mtr</td>
</tr>
<tr>
<td>Minimum implantation</td>
<td>2.80 mtr</td>
</tr>
<tr>
<td>Minimum implantation on Platform</td>
<td>4.75 mtr</td>
</tr>
<tr>
<td>Tension in contact wire</td>
<td>1000 kgf</td>
</tr>
<tr>
<td>Tension in catenary wire</td>
<td>1000 kgf</td>
</tr>
<tr>
<td>Maximum tension length</td>
<td>1.5 km</td>
</tr>
<tr>
<td>Catenary wire</td>
<td>65 sq. mm</td>
</tr>
<tr>
<td>Contact wire</td>
<td>107 sq.mm</td>
</tr>
</tbody>
</table>

**MERGING WITH EXISTING OHE**

| **For main line OHE (Height of contact wire at support)** | 5.80 mtr |
| **For High Rise OHE (Height of contact wire at support)** | 7.57 mtr |
| **Difference** | 1.77 mtr |

**ATD DETAILS**

| **Type of Auto Tensioning Device** | Three Pulley modified groove auto tensioning device as per RDSO Specification No. no. TI/SPC/OHE/ATD/0060 with A&C Slip No. 1 to 3- for total tension of 2000 kgf |
| **Stainless Steel Wire Rope** | As per RDSO Specification No. TI/SPC/OHE/WR/1060 with A&C Slip No. 1 & 2 (Length : 10 mtr) |
| **X-Y Adjustment Chart** | As per RDSO drawing no. TI/DRG/OHE/ATD/RDSO/0000 3/99/0-Three Pulley ATD |

**MINIMUM VERTICAL CLEARANCES UNDER OVER LINE STRUCTURES**

| **Heavy overhead structure such as Road Over Bridge** | 8050 mm |
| **Light overhead structure such as Foot Over Bridge** | 8430 mm |
| **Heavy overhead structure at Turn Outs** | 8430 mm |
### 14.10 Annexures:

<table>
<thead>
<tr>
<th>No.</th>
<th>Annexure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii)</td>
<td>Annexure 14.02</td>
<td>Advance Correction slip No. 20 to Railways Manual of AC Traction (ACTM) Vol. II Pt. II Para 20.1 (Tangent Track)</td>
</tr>
<tr>
<td>(iii)</td>
<td>Annexure 14.03</td>
<td>Maintenance Instruction No. TI/MI/0028 REV - 2 Special Maintenance Instruction (SMI) For Overhead Equipment On Turnouts/Crossovers To Avoid Pantoentanglements</td>
</tr>
</tbody>
</table>
GOVERNMENT OF INDIA
(MINISTRY OF RAILWAYS)
(RAILWAY BOARD)

No. 2008/Elec(G)/16/1 Pr. III

The General Manager (Elec.)
All Indian Railways including,
- Metro Railway/Kolkata CORE/Ahmedabad, ICF/Chennai,
- CLW/Chittaranjan, RCF/Kapurthala,
The Chief Administrative Officer,
- Metro Railway at Delhi, Mumbai and Chennai,
- Director, IRIE, Nasik,
- Director, Indian Railway Centre for Advance Maintenance Technology, Oswalir.
- Principal, Railway Staff College, Vadodara
- The Director General, (II) Electrical Standards/PS & EMU), RDSO/ Lucknow
- Chief Commissioner of Railway Safety, Lucknow,
- CR/ Northern Circle/Central Circle/Eastern Circle/Southern Circle/
- South Eastern Circle/South Eastern Circle/Western Circle.
- MD, RVNL, August Kranti Bhawan, Bhikaji Cama Place, New Delhi,
- MD/DFCCIL, 5th Floor, Pragati Maidan, Metro Station Building Complex, New Delhi,
- MD/MRVC, 2nd Floor, Charkgate Station Bldg., Mumbai.

Sub: Advance Correction Slip No. 18 to Railways Manual of AC Traction (ACTM)

Enclosed please find herewith the Advance Correction Slip No. 18,
Addendum/corrigendum to Clause 17.3 & Clause 21.6 of Railways Manual of AC
Traction (ACTM) Vol. II Pt. II, Appendix IV, 1994 (Regulation for Power Line
Crossings of Railway Tracks), for your information and necessary action.

The receipt of this letter may please be acknowledged.

DA: 2 sheets

(Mrs. Manju Gupta)
Executive Director/Electrical Energy Management
Railway Board.

Copy to: PPS to ML, AM(Signal), AM(Y), Adv./L(G), Adv./L(R), EDRE, EDCE(G),
ED(E/T), ED(E/S&T), ED(Safety), DEH(G), DRE, IDEE(R), DP(Spl.),
DEH, DDE, ID(MTP), ED(Safety-II), SORRE, SQ(Elec/TRS),
ELELIBRARY.
17.3 (a) Vertical Clearance for new crossings/or alteration to existing crossing: The minimum height above rail level of the lowest portion of any conductor of crossing, including guard wire, under conditions of maximum sag shall be as follows:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Over head crossing Voltage</th>
<th>Min. Clearance from buildings/structures (as per I.E. Rule 1956, Cl. 80)</th>
<th>Clearance required for 25 kV AC traction</th>
<th>Minimum required from rail level (Clearance as per I.E. Rule 1956)</th>
<th>Clearance at OHE structures (Cl. 80)</th>
<th>Clearance at mid OHE span (Cl.87)</th>
<th>Clearance at mid OHE span (Cl.87)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Up to 11 kV</td>
<td>By cable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Above 11 &amp; upto 33 kV</td>
<td>3700</td>
<td>2440</td>
<td>14600</td>
<td>12384</td>
<td>16580</td>
<td>14084</td>
</tr>
<tr>
<td>3</td>
<td>Above 33 &amp; upto 66 kV</td>
<td>4000</td>
<td>2440</td>
<td>14960</td>
<td>12384</td>
<td>16600</td>
<td>14084</td>
</tr>
<tr>
<td>4</td>
<td>Above 66 &amp; upto 132 kV</td>
<td>4600</td>
<td>3050</td>
<td>15560</td>
<td>12994</td>
<td>17560</td>
<td>15694</td>
</tr>
<tr>
<td>5</td>
<td>Above 132 &amp; upto 220 kV</td>
<td>5500</td>
<td>4580</td>
<td>16660</td>
<td>14524</td>
<td>18160</td>
<td>16224</td>
</tr>
<tr>
<td>6</td>
<td>Above 220 &amp; upto 400 kV</td>
<td>7300</td>
<td>5490</td>
<td>18260</td>
<td>15434</td>
<td>19960</td>
<td>17134</td>
</tr>
<tr>
<td>7</td>
<td>Above 400 &amp; upto 600 kV</td>
<td>8200</td>
<td>7940</td>
<td>21860</td>
<td>17884</td>
<td>20860</td>
<td>19514</td>
</tr>
<tr>
<td>8</td>
<td>Above 500 &amp; upto 800 kV</td>
<td>10900</td>
<td>7940</td>
<td>21860</td>
<td>17884</td>
<td>23500</td>
<td>21584</td>
</tr>
</tbody>
</table>

17.3 (b) Vertical Clearance for existing crossings:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Over head crossing Voltage</th>
<th>Min. clearance on existing non-electrified routes from rail level (as per I.E. Rule 1956, Cl. 80)</th>
<th>Min. clearance on existing electrified routes from rail level (as per I.E. Rule 1956, Cl. 80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>Up to 11 kV</td>
<td>By cable</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Above 11 &amp; upto 33 kV</td>
<td>10860</td>
<td>-14100</td>
</tr>
<tr>
<td>3</td>
<td>Above 33 &amp; upto 66 kV</td>
<td>11160</td>
<td>14100</td>
</tr>
<tr>
<td>4</td>
<td>Above 66 &amp; upto 132 kV</td>
<td>11760</td>
<td>14660</td>
</tr>
<tr>
<td>5</td>
<td>Above 132 &amp; upto 220 kV</td>
<td>13660</td>
<td>15400</td>
</tr>
<tr>
<td>6</td>
<td>Above 220 &amp; upto 400 kV</td>
<td>13460</td>
<td>17900</td>
</tr>
<tr>
<td>7</td>
<td>Above 400 &amp; upto 600 kV</td>
<td>13580</td>
<td>19930</td>
</tr>
<tr>
<td>8</td>
<td>Above 500 &amp; upto 800 kV</td>
<td>18060</td>
<td>23400</td>
</tr>
</tbody>
</table>
Note:

(i) While calculating the above clearance, Railways high tension lines running over the 1100 V EDC traction structure in some sections have not been taken into consideration. Where such high tension lines exist, the height above the rail level of the highest high tension line shall be taken into account for calculating the clearances.

(ii) The working of a Railway crane under an overhead line crossing shall normally be avoided. If it becomes absolutely essential for a crane to work under such a crossing, the minimum clearance required to be maintained between the highest working point of the jib and the lower crossing conductor shall be as under:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Nominal System Voltage (kV)</th>
<th>Min. Safe Clearance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33</td>
<td>1500</td>
</tr>
<tr>
<td>2</td>
<td>66</td>
<td>2000</td>
</tr>
<tr>
<td>3</td>
<td>110</td>
<td>2250</td>
</tr>
<tr>
<td>4</td>
<td>132</td>
<td>2500</td>
</tr>
<tr>
<td>5</td>
<td>220</td>
<td>2500</td>
</tr>
<tr>
<td>6</td>
<td>400</td>
<td>6000</td>
</tr>
<tr>
<td>7</td>
<td>500</td>
<td>7250</td>
</tr>
<tr>
<td>8</td>
<td>800</td>
<td>11500</td>
</tr>
</tbody>
</table>

(iii) All heights/clearances are in mm and under maximum sag conditions.

(iv) For non-electrified, lines where new power line crossing is to be provided/existing crossing to be altered, column 5 & 7 of the table in para 17.3 (a) shall be applicable.

(v) For electrified lines, where new power line crossing is to be provided/existing crossing to be altered, clearances in para 17.3 (a) shall be applicable.

(vi) Clearance given in column 6 & 8 of table 17.3 (a) can be adopted if the OHE structure/fixed structure is beyond 6000 mm of nearest conductor of overhead crossing.

(vii) If the crossing is provided with a guarding, a minimum clearance of 2000 mm shall be maintained between the bottom of the guard wire and highest traction conductor.

(viii) Power line crossings in yard and station areas shall be avoided.

(ix) In case of existing power line where return conductor or feeder wire is not likely to be provided, height of super mast i.e. 2250mm to be reduced from the clearances of para 17.3(a).

21.0 Relaxation for existing Power line crossings

Clause 21.1, 21.2, 21.3 & 21.4 will be replaced as below:

Clause 21.1 It is desirable to provide maximum possible clearances in the case of power line from highest traction conductor used for electric traction. Based on the clearance study, reduced clearances, with approval of EIG, and subject to observance of clearances in Column 4 of Table in Para 17.3 (a) may be adopted.

Clause 21.2 Such reduced clearances would be subject to any special safeguards that may be prescribed by EIG while granting these relaxations.

Clause 21.3 Wherever feasible, special design of traction overhead equipment, return conductor, 25 kV feeder or other power line on traction mast/structure should be developed keeping in view the need for economy and other requirements, if any.

Clause 21.4 The relaxation to adopt reduced clearances shall not be applicable for new power line crossings.

Clause 21.5 Any alteration to the existing overhead power line crossings shall be done to provide the clearances prescribed in para 17.3(a).
No. 2000/RE/161/1 Pt. III
New Delhi, Dt. 03.11.10

The General Manager (Elec.)
All Indian Railways including Metro Railway/Kolkata. CORE/Allahabad, ICF, Chennai,
CLW, Chittaranjan, RCF Kapurthala.

The Chief Administrative Officers,
Metro Railway at Delhi, Mumbai, Chennai, Bangalore.

Director, IRIEEN, Nasik and Director, Indian Railway Centre for Advance
Maintenance Technology, Gwalior.

Principal, Railway Staff College, Vadodara
The Director General, (TElectrical Standards/PS & EMU), RDSO/ Lucknow
Chief Commissioner of Railway Safety, Lucknow,
CRS/Northern Circle/Central Circle/ Eastern Circle/ Southern Circle/
South Central Circle/ South Eastern Circle/Western Circle.

MD, RVNL, August Kranti Bhawan, Bhikaji Cama Place, New Delhi.
MD, DFCCIL, 5th floor, Paragati Maidan, Metro Station Bldg, New Delhi.
MD, MRVC, 2nd floor Churchgate Station Bldg, Mumbai.
MD, IRCON International Ltd C-4 District Centre, Saket, New Delhi.

Sub: Advance Correction Slip No. 20, to Railways Manual of AC Traction (ACTM) Vol.II
Pt. II, Para 20.1 (Tangent Track)

Enclosed please find herewith the Advance Correction Slip No. 20, Simplification
(Modification/Revisions) in Paras of Railways Manual of AC Traction (ACTM) Vol.II Pt. II,
Para 20.1 (Tangent Track) for your information and necessary action.

(Mrs. Manju Gupta)
Executive Director/Railway Electrification
Railway Board.

Copy to: PPS to ML, EDEE(G), Adv.(Signal), Adv.(V), Adv./L(RS), Adv(RE), EDEE(G),
ED(Dev.), EDRE(S&T), ED(Safety), DEE(G), DRE, JDEE(RS), DP(Sol.), Dir(Trg.),
Dir(Electrical)/Dev., JD(MTP), Director(Safety-II), SO(RE), SO(Elec.TRS),
RB(Library).
**ACTM advanced correction slip No. 20 dated 03.11.2010**

**Implantation in case of portal uprights, masts carrying more than one OHE and head span masts**

<table>
<thead>
<tr>
<th>Para 20.1 Existing</th>
<th>Para 20.1 Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>In case of portal upright, masts carrying more than one OHE &amp; head span masts, the setting should not normally be less than 3.00 m for the broad gauge &amp; 2.50 m for the meter gauge.</td>
<td>In case of portal uprights, masts carrying more than one OHE &amp; head span masts, the setting distance on broadgauge lines should not normally be less than 3.0 m which may be relaxed to 2.8 m, with the personal approval of CEE (open line) who may prescribe any special precaution as may be considered necessary.</td>
</tr>
</tbody>
</table>
Annexure 14.03

Government of India
Ministry of Railways
Research Designs & Standards Organisation
Manak Nagar, Lucknow - 226011

MAINTENANCE INSTRUCTION NO.TI/MI/0028 REV - 2

SPECIAL MAINTENANCE INSTRUCTION (SMI) FOR OVERHEAD EQUIPMENT ON TURNOUTS/CROSSOVERS TO AVOID PANTO-ENTANGLEMENTS

1. TITLE
   Adjustment of Overhead Equipment (OHE) on turnouts/cross-overs to avoid panto entanglements.

2. APPLICATION
   All cases of turnouts and crossovers.

3. OBJECTIVE
   Points and crossings are one of the important locations which need special attention in respect of erection as well as maintenance, because wrong erection / maladjustment of the OHEs at the structures, particularly at the obligatory structure may lead to pantograph entanglements causing disruption in traffic.

4. REFERENCE DRAWINGS AND SPECIFICATIONS
   (i) Drg.No ETI/OHE/G/02141 Rev. C - General arrangement of regulated OHE at turnouts(Overlap & crossed type)
   (ii) Drg.No ETI/OHE/G/02151 - General arrangement of regulated OHE at crossovers (Overlap & crossed type)
   (iii) Specification No. ETI/OHE/53(688) – Principles of OHE Layout Plans & Sectioning Diagrams for 25 kV ac traction
   (v) ACTM Vol-II (Part-I) 1994 Chapter-III - Overhead equipment.

5. INSTRUMENTS AND APPLIANCES REQUIRED
   Tower Wagon and other T & P items as usually required for erection/maintenance of OHE.
6. DETAILS SPECIAL INSTRUCTIONS.

6.1 Before checking turnout, check the pantograph of tower wagon for following:-

(a) Clean and check pantograph for grooves, horizontally (with spirit level when raised) or any other abnormality. The permissible depth of groove is 1 mm. If it exceeds, replace the strips. Check whether the strip fixing screws are projecting beyond the strip surface. If yes, tighten loose screws. Check the strips for sharp edges and projecting particles. Round off the edges of strips with a file.

(b) Check the main springs for cracks/breakage. In case of cracks/breakages, replace the springs.

(c) Check the bow plunger for free sliding while pressing. In case of jamming, loosen the sleeves fixing the spring boxes and turn them around their vertical axis until jamming is removed.

6.2 Check that the overhead equipment (OHE) at points & crossings on main lines is overlap type as shown in drawing nos. ETI/OHE/G/02141 Rev. C and ETI/OHE/G/02151. If not, modify it according to the drawings. If for any reason, crossed type OHE is erected on mainline, convert it to overlap type, if possible, otherwise impose speed restriction of 100 km/h.

6.3 Obligatory Structure

(a) Check the track separation at obligatory structure. For best results, the track separation should be between 500 mm and 700 mm. However, if due to site conditions it is not possible to locate obligatory structure as mentioned above, it should be located at the position where the track separation is 150 to 700 mm.

(b) Ensure that the turnout span is 54 m or less in case of overlap type arrangement. In case of crossed type arrangement the limitation of turnout spans shall be as per Drg. ETI/OHE/G/02141 Rev.C

(c) Ensure that the drop bracket is provided for supporting the steady arm assembly with steady arm hook and the vertical distance between register arm axis and contact plane in this case is 300 mm. In case where steady arm with eye piece and steady arm clamp is provided the distance between register arm axis and contact plane should be 250 mm.

(d) Measure the implantation of obligatory structure. If it is less than 3 m, take corrective action to increase it to 3 m.

(e) Ensure that the register arm tubes of the bracket assembly are in horizontal position and not displaced.
6.4 Auto-Tensioning Device (ATD)

6.4.1 For ATD of turnout, crossover and concerned mainline OHE tension lengths the following should be observed :-

(a) Redundant length of hex tie-rod of limiting device should be bridged by inserting pipe of suitable length on OHE side as indicated in SMI No. TI/MI/0035 Rev.1.

(b) Ensure that SMI No. TI/MI/0029 Rev.1 and SMI No. TI/MI/0018 Rev.1 are followed.

6.5 Turnout/Crossover OHE

6.5.1 The turnout OHE adjustments should be done and values of different parameters should be checked with the movements of tower wagon as under :-

i.) From main line to turnout

ii.) From turnout to main line

iii ) On main line

(a) Measure the stagger of contact wires at support at obligatory structure. Compare these values with the values indicated in as erected drawing and adjust if required, taking care that the horizontal separation of two contact wires at support is not less than 50mm. In no circumstances the stagger of contact wire of turnout OHE should exceed 300mm.

(b) Measure sag of contact wires of mainline and turnout OHEs on either side of obligatory structure. If it is not as per standards, redropper the OHE.

(c) Measure the heights of contact wires of the mainline OHE and turnout OHE at support point at obligatory structure without any upward/downward thrust on the contact wires. The contact wire of the mainline OHE should be 50mm below the contact wire of turnout OHE. If not so, then taking the reference of contact wire of main line OHE, the height of contact wire of turnout OHE should be adjusted so that it is 50 mm above the contact wire of main line OHE.

(d) Measure the difference in heights of contact wire of main line OHE and contact wire of turnout OHE in the entire danger zone which falls within 10 m towards turnout from obligatory structure. In the entire danger zone, ensure that the contact wire of turnout OHE is 50 mm above the contact wire of main line OHE. However, at 10 m from obligatory structure towards turnout the
vertical difference in the height of two contact wires shall not be less than 30 mm.

(e) Run the tower wagon on main line and check whether the pantograph touches contact wire of turnout OHE in the over-lapping zone. If yes, adjust OHE of turnout to ensure that pantograph does not touch the contact wire of turn out OHE.

(f) Check with the tower wagon running on turnout track towards main line track, that the pantograph of tower wagon takes up the contact wire of main line OHE smoothly at a point 650mm to 720mm from its centre line. If it does not takeover smoothly, then check the vertical difference between the two contact wires and if required, adjust it.

(g) Check with tower wagon running from main line track to turnout track, that pantograph glides smoothly from main line contact wire to secondary line contact wire. If not, adjust the OHEs to ensure the same.

(h) In case of unregulated OHE, retensioning of conductors should be adopted prior to change of season. The turnout/crossover OHE should be checked up thoroughly and, if required, adjusted to maintain the above mentioned parameters.

(i) In case of crossed type turnout check the following :-

(i) Check that the contact wire of turnout OHE is above that of main line OHE and centrally passes through the contact wire crossing bar in case the contact wire crossing is used. The contact wire of the turn out OHE should not rest over the contact wire of main line OHE and crossing contact wire is free to move. Check that there is no abrasion between the contact wire of main line OHE and that of turnout OHE at the crossing point. Check that the crossing contact wire does not infringe with the PG clamps of the contact wire crossing bar assembly. If it infringes, shift the location of contact wire crossing bar assembly suitably.

(ii) Check the condition of contact wire crossing assembly for looseness of fasteners of P.G. clamps and alignment of crossing bar. Tighten the P.G. clamps, align the crossing bar or replace deformed crossing bar, if required.

(j) In case of diamond crossings with slips equipped with crossed type OHE, measure the distance between two knuckle tube assemblies. It should be 9m. Check that two knuckle tube assemblies are horizontal and located symmetrically on either side of centre line of diamond crossing. If not, adjust the position and alignment of knuckle tube assemblies. Check the knuckle tube assemblies for looseness. If required, tighten the fasteners.
(k) Check that all other fittings/components are sound and free from corrosion, rusting, crack, deformation etc. If any abnormality is noticed the particular component should be replaced.

6.6 'G' Jumper

(a) Check that 'G' jumpers are provided at a distance of 5.6m from obligatory structure. If the distance is less, shift the 'G' jumper to the specified location. The arrangement of 'G' jumper should comply with that indicated in drawing No. ETI/OHE/G/05102 Rev. C

(b) Ensure that the nuts & bolts at PG clamps are neither too tight nor too loose.

(c) Ensure that the length of 'G' jumper is as specified in Drg. No. ETI/OHE/G/05102 Rev.C. If less, replace the 'G' jumper with jumper of specified length.

6.7 Section Insulator (SI)

(a) Ensure that the location of section insulator is as per the principles of OHE layout plan & sectioning diagrams.

(b) Check with spirit level that the runners of section insulator are in the same horizontal plane. If not, the level should be adjusted by section insulator adjustable droppers.

(c) Check that the panto passage under section insulator is smooth and runners are not hit by panto pan.

(d) Measure the track separation at the location of section insulator. It should be equal to or more than 1.65 m if the section insulator is erected with the free ends of the runners towards the centre of the turnout and equal to or more than 1.45 m if the section insulator is erected with free ends of the runners away from the centre of turnout. If these distances are below the values indicated above, location of section insulator should be shifted away from the centre of the turnout. The track separation is measured at the extreme end of the part of section insulator assembly towards the centre of the turnout.

(e) Measure the stagger at section insulator. It should be within +/-100 mm.

(f) Measure the sag of section insulator. It should be zero. If not, adjust it to zero by adjustable droppers of section insulator and/or by re-droppering the OHE of the span.
(g) Check contact wire ending clamp of section insulator and ensure that any slipping of contact wire has not taken place. Take corrective action in case of contact wire slipping.

(g) Check for all the components/ parts of section insulators and replace the defective parts.

7. **PERIODICITY OF IMPLEMENTATION OF SMI**

   The arrangement of OHE at turnouts and crossovers for regulated OHE should be checked annually and adjustments carried out, if necessary, so that the equipment is maintained as per the standards. In case of unregulated OHE, re-tensioning of the OHE should be done prior to change of season and the turnout/crossover OHE should be checked up thoroughly and, if required, adjusted.

   Proper records of turnout/crossover, ATD and section insulator assembly should be maintained as per details given in Annexure ‘A’. If any change in profile due to track shifting etc is noticed, Engg. Branch should be informed and efforts should be made to restore original standards parameters. If it is not possible to achieve the original standard parameters the new values to be set but strict vigil should be kept on such turnouts/crossovers.

8. **AGENCY FOR IMPLEMENTATION**

   Railways and RE project units.
## FORMAT FOR RECORDING THE OBSERVATIONS/MEASUREMENTS

### RAILWAY

### DIVISION

### TRACTION DISTRIBUTION BRANCH

### TURNOUT/CROSSOVER NO.

<table>
<thead>
<tr>
<th>S.N</th>
<th>Description</th>
<th>Std. value</th>
<th>Measured value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Particulars of Turnout/crossover (Give the number i.e. 3/84, 1/12 etc.)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Section</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Location No.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Date Checked</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Type of Arrangement - Crossed type/Overlap type</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Height of Contact Wire above rail level at support at Obligatory Structure</td>
<td>Main Line Contact Wire (mm), (H)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Turnout Contact Wire (mm)</td>
<td>H+50 *</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Turnout span (m)</td>
<td>54 (Max)</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Height of Contact Wire in Overlapping Zone</td>
<td>Mainline Contact Wire (mm) (H)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Turnout Contact Wire (mm)</td>
<td>H+50 *</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Stagger of Contact Wire at Obligatory Structure</td>
<td>Mainline Contact wire (mm)</td>
<td>200 max.</td>
</tr>
<tr>
<td></td>
<td>Turnout Contact wire (mm)</td>
<td>300 max.</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Sag of section insulator of Turnout/Crossover</td>
<td>Zero</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Movement of lower wagon from mainline to turnout</td>
<td>650 mm to 720 mm from centre line of pantograph</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>a) Take off</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>b) Point of take off (in m from O/S)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Movement of lower wagon from turnout to mainline</td>
<td>650 mm to 720 mm from centre line of pantograph</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>a) Take on</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>b) Point of take on (in m from O/S)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Stagger of section insulator at turnout/crossover</td>
<td>+/- 100 mm</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>1.65 Min</td>
<td>1.45 Min</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>14</td>
<td>Track separation at the location of section insulator (m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Runners towards the centre of turnout</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Runners away from the centre of turnout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Condition of ATD of turnout/mainline OHE</td>
<td>Free to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>noise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Length of pipe provided in hex tie rod of limiting device to bridge redundant length of hex tie rod</td>
<td>As per SMI No. TIM/M/0035 Rev.1</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Setting distance (implantation) of obligatory structure (m)</td>
<td>3.0 Min</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Track separation at obligatory structure (mm)</td>
<td>150 to 700</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Distance of 'G' jumper from obligatory structure (m)</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Length of 'G' jumper (m)</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Deviations from SEDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Adjustments done if any</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Remarks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Name of supervisor and designation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Signature of Supervisor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In case of overlap type arrangement.
GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

No.2004/RE/161/IPt-III(ACTM) Dated 24.05.2006

The General Manager (Elec)
All Indian Railways including
Metro Railway/Kolkata, CORE/Allahabad,
ICF, Chennai, CLW, Chittaranjan, RCF Kapurthala
The Chief Administrative Officer,
Metro Railway at Delhi, Mumbai and Chennai.
Director, IRIEEN, Nasik and Director, Indian Railway Centre for Advance
Maintenance Technology, Gwalior.
Principal, Railway Staff College, Vadodara
The Director General, (TI/Electrical Standards/PS & EMU)
RDSO/Alambagh, Lucknow
Chief Commissioner of Railway Safety, Lucknow,
CRS/Northern Circle/Central Circle/Eastern Circle/Southern Circle
South Central Circle/South Eastern Circle/Western Circle.

Sub: Advance Correction Slip No. 14 to Railways Manual of AC Traction
(ACTM) Vol.II Pt.III, Para 3.0 and Appendix IV, 1994 (Regulations for
Power Line crossings of Railway Tracks).

Ref: RDSO Letters No.TI/OHE/PLCROS/99 dt 23.3.06 and 04.05.06

Ministry of Railways (Railway Board) have decided the
additions/corrections/deletions in the enclosed Correction Slip No. 14 dated 19.05.06 of
ACTM Vol.II Pt.III, Para 3.0 and Appendix IV, 1994 may be made.

Receipt of the letter may please be acknowledged.

Hindi Version will follow.

(Mytab Singh)
Executive Director/Railway Electrification
Railway Board

DA: 1 Sheet

Copy to: CRB, ME, ML, MS, MM, MT, FC, Secretary

AM(L), AM(CE), AM(W), AM(B), AM(T), AM(Fin), AM(Sig.), AM(Pig.), AM(MS),
AM(Mech), AM(PU), AM(Tele), Adv.(Vig), Adv.(L&A),
EDF(X)-II, ED(Safety), EDEE(RS), EDEE(G), EDEE(Dev), ED(Works), EDEE(P),
ED(Proj), ED(MD), EDEK(M), EDEK(MC), EDEK(P), EDEE(G), EDEE(B&S),
DRE, DEE(RS), DEE(PS), DEE(G)

656
No.200/RE/161/IPT-III(ACTM)

Indian Railways Manual of AC Traction Volume II Pt. II
Advance Correction Slip No.14 Dated 19th May, 2006

(The following may be replaced in the existing Clause 3.0, Appendix-I)

Clause 3.0  Electrical Clearance

The clearances between 25 kV live parts and earthed parts of fixed structures or moving loads shall be as large as possible. The minimum electrical clearances (vertical and horizontal) to be maintained under the worst condition of temperature, wind, etc. between any live part of the overhead equipment or pantograph and parts of any fixed structures (earthed or otherwise) or moving loads shall be as below:

(i) Long duration 250 mm
(ii) Short duration 200 mm

Note:
(i) The powers delegated to Chief Electrical Engineers vide Board's letter no. 76/RE/240/1 dated 27.03.1980 are withdrawn.

(ii) A clearance study should be made for every overhead structure/tunnel and, if required should be referred to RDSO for advice.
CHAPTER-15

REINFORCED CEMENT CONCRETE

15.1 CEMENT

- The cement selected should be appropriate for the intended use as provided for in the specifications.

- Different types of cement shall not be mixed together. If more than one cement type is used (e.g. OPC 53 Grade/OPC 43 Grade/PPC/Others), a record shall be kept showing the location of use.

15.2 MINERAL ADMIXTURES

15.2.1 POZZOLANAS

Pozzolanic materials conforming to relevant Indian Standards may be used with the permission of the engineer-in-charge, provided uniform blending with cement is ensured.

- Fly ash (Pulverized fuel ash)
- Silica fume
- Rice husk ash
- Metakaoline

15.2.2 Ground Granulated Blast Furnace Slag.

15.3 AGGREGATES

Aggregates shall conform to IS 383. As far as possible, preference should be given to natural aggregates.

- Size of aggregate.

For most works, 20 mm aggregate is suitable. Where there is no restriction to the flow of concrete into sections, 40 mm or larger size may be permitted.

For heavily reinforced concrete members like ribs of main beams, the nominal maximum size of the aggregate should usually be restricted to 5 mm less than the minimum clear distance between the main bars or 5 mm less than the minimum cover to the reinforcement, whichever is smaller.

15.4 WATER

Potable water is generally considered satisfactory for mixing concrete. As a guide the following concentrations represent the maximum permissible values:

(a) To neutralize 100 ml sample of water, using phenolphthalein as an
indicator, it should not require more than 5 ml of 0.02 normal NaOH. The details of test are given in 8.1 of IS 3025 (Part 22).

(b) To neutralize 100 ml sample of water, using mixed indicator, it should not require more than 25 ml of 0.02 normal H₂SO₄. The details of test shall be as given in 8 of IS 3025 (Part 23).

(c) Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90 percent of the average of strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with IS-516

(d) The pH value of water shall be not less than 6.

(e) Permissible limits for solids shall be as given in Table 1 below:

<table>
<thead>
<tr>
<th>S No.</th>
<th>Tested as per</th>
<th>Permissible Limit, Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Organic</td>
<td>IS 3025 (Part 18)</td>
</tr>
<tr>
<td>2</td>
<td>Inorganic</td>
<td>IS 3025 (Part 18)</td>
</tr>
<tr>
<td>3</td>
<td>Sulphates (as SO₃)</td>
<td>IS 3025 (Part 24)</td>
</tr>
<tr>
<td>4</td>
<td>Chlorides (as Cl)</td>
<td>IS 3025 (Part 32)</td>
</tr>
<tr>
<td>5</td>
<td>Suspended Matter</td>
<td>IS 3025 (Part 17)</td>
</tr>
</tbody>
</table>

(f) Water found satisfactory for mixing is also suitable for curing concrete. However, water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds is objectionable.

15.5 CHEMICAL ADMIXTURES

Chemical admixtures are ingredients in concrete other than cement, water and aggregates, which are added to the mix before or during the mixing, to impart certain desirable properties to the concrete mix.

- Admixture, if used, shall comply with IS9103
• The workability, compressive strength and the slump loss of concrete with and without the use of admixtures shall be established during the trial mixes before use of admixtures.

• The relative density of liquid admixtures shall be checked for each drum containing admixtures and compared with the specified value before acceptance.

• The chloride content of admixtures shall be independently tested for each batch before acceptance.

15.5.1 Plasticizers:

Water reducing agents, workability agents or plasticizers, as they are commonly called, are agents which maintain workability without increasing the water content. These are most commonly used chemical admixtures and can reduce water content by 12-20%.

There are 3 possible improvements which can be achieved, which are as under:

• Increase workability without increasing water content to facilitate placing & compaction.

• Increase strength without affecting workability by reducing the water cement ratio.

• Achieve economy by reducing consumption of cement without any detrimental effect on workability/strength.

Dosage of plasticizers is normally limited to 1% of the weight of cementitious material.

15.5.2 Super plasticizers:

They are High Range Water Reducers (HRWR) and perform the same functions as plasticizers.

Super plasticizers can produce flowing concrete with slump as high as 200 mm, which is pumpable and can be used in congested girders/in casting of a piles. Heavy water reduction of over 30% is possible without any workability loss. This produces very strong and durable concrete. Dosage of super plasticizers is normally limited to 2% of the weight of cementitious material.

15.5.3 Mechanism:

Plasticizers/Super plasticizers reduce the inter particle force that exists between the cement particles by imparting similar charges to cement particles which then repel each other and prevent floc formation. As flocculation of cement particles is avoided, water, which otherwise gets trapped in the flocs, is available to impart fluidity. Super plasticizers while plasticizing do not significantly offset the surface tension of water and
hence can be used in higher dosage without air entrainment.

15.5.4 Most commonly used plasticizers:

- Lignosulphonic based.
- Hydroxy-nated carboxylic based.
- Sulphonated Melamine based – Most suitable for cold regions.
- Sulphonated naphthalene based.
- New generation Super plasticizers with a superior performance have been developed. Polycarboxylate Ether or simply Polycarboxylate (PC) based Super-plasticizers that falls in this category, perform better than the traditional Sulphonated polymers in terms of either higher reduction in the water-cement ratio at a given workability, or higher slump level of the given mixture composition and a lower slump loss.

Water reduction up to 40% has been possible with PC based Super-plasticizers.

15.5.5 Side effects:

- Retardation in setting time.
- Air entrainment.

15.5.6 Applications:

- In PSC box/I girders requiring high strength as well as slump.
- In RCC piles, walls, piers &abutments.
- For making flowing concrete when it is required to be pumped.
- When concrete is laid in large piers to avoid handling requirements.
- For large construction projects.

15.5.7 Precautions:

- Selection of adequate dosage/Time of addition.
- Dosage- depending on cement types to be fixed after trials.
- Batch testing to ensure uniformity in properties.
- Low temperature less windy conditions favorable.

15.5.8 Aspects to be verified before approval of an admixture:

- Dosage as a %age by weight of cement, point of application, mode of
applications and time of application.

- Side effects of admixtures.
- Chemical names of main ingredients.
- %age of chlorides/sulphates
- Effect of adding excess/lesser quantity of admixture.
- Admixtures should also be free of myrocynte to avoid corrosion.
- Transportation time required
- Type of compaction proposed

15.6 STEEL REINFORCEMENT

- Independent test check on the quality of steel drawn from each lot should be conducted.
- Lab tests for Physical (tensile tests and bend test) as well as for Chemical Properties to be conducted from NABL Approved Lab.
- Steel for reinforcement to be stored in a way to prevent distortion and corrosion. If required, cement wash to be given for long storage.
- Steel should be free of mill scales, dust, loose foreign matter, rust, coats of paints, oil or other coatings.

15.7 CONCRETE

15.7.1 Production, Mixing, transportation, placement, compaction & curing.

15.7.1.1 Production:

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixes on any site or in any one plant.

- A competent person shall supervise all stages of production of concrete. “Competent person” is one who is authorized by DEN/Sr.DEN/Dy.CE/XEN for executing and supervising the relevant aspects of concreting. Preparation of test specimens and site tests shall be properly supervised.

- The engineer shall be afforded all reasonable opportunity and facility to inspect the materials and the manufacture of concrete and to take any samples or to make any tests.

15.7.1.2 Batching:

In proportioning concrete- Quantity of both cement and aggregate should be determined by mass. Water can be taken by mass/volume. Solid admixtures
may be measured by mass and liquid/paste admixtures by volume/mass. Batching plant, wherever used, should conform to IS:4925. All measuring equipment should be calibrated and be maintained in clean and serviceable condition, and their accuracy checked periodically. Coarse/Fine aggregate to be batched separately. Grading of fine/coarse aggregate to be checked as per the frequency specified by the engineer. Both, fine & coarse, aggregates should confirm to IS:383.

If material uniformity has been established, volume batching can be used for production of concrete up to M-20. Where weigh batching is not practicable, volume batching can be adopted for fine/coarse aggregates (not cement) but allowance should be made for “bulking” of fine aggregates.

Water-cement ratio should be maintained at its correct value. For this moisture content of fine/coarse aggregates should be frequently determined/suitable adjustments made in the water to be added.

No additions/alterations in materials used on the work should be made without additional tests to show that the quality/strength of concrete are satisfactory.

The accuracy of the measuring equipment shall be within ± 2 percent of the quantity of cement and mineral admixtures being measured and within ± 3 percent of the quantity of aggregate, chemical admixtures and water being measured.

### 15.7.1.3 Mixing

Concrete shall be mixed in a mechanical mixers complying to IS: 1791. Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. If there is segregation after decanting the concrete from mixer, concrete should be remixed

Mixing time

\[
\text{Mixing time} = \begin{cases} 
1.5 \text{ to } 2 \text{ min for normal mixer pour} \\
45 \text{ to } 60 \text{ seconds for high rated batching plant.}
\end{cases}
\]

In hot weathers ice is added in the water to maintain the temperature below 35 deg C.

### 15.7.1.4 Transportation

Mixed concrete shall be transported from the place of mixing to the place of final deposition as rapidly as practicable by methods which will prevent the segregation/loss of ingredients.

When concrete is conveyed by chute, there should be continuous flow in the chute. Slope of the chute shall be so adjusted that the concrete flows without the use of excessive quantity of water and without any segregation of its ingredients. The delivery-end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

During hot/cold weather, concrete shall be transported in deep containers.

### 15.7.1.5 Placing

The concrete shall be placed before setting has commenced and shall not be
subsequently disturbed. Concrete shall be placed so as to avoid segregation of material or displacement of reinforcement. Concrete should not be dropped from a height more than 1.5m.

- No Concrete shall be placed in any part of the structure until the approval of the Engineer has been obtained.

- A record should be kept of the time and date of placing the concrete in each portion of the structure.

- Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes, unless a proper construction joint is formed. Concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not exceeding 300 mm in all other cases.

- Concrete cover blocks of the same strength and density as parent concrete shall be used.

- The range of ideal temperatures to pour concrete would be around 10 to 30°C. Concreting close to freezing temperature should be avoided.

15.7.1.6 Compaction

No concrete shall be allowed without vibration except under-water concreting or tremie concreting or in specific cases. Concrete shall be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into corners of the formwork.

Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer, unless carried in properly designed agitators, operating continuously, when this time shall be within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator.

When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation.

15.7.1.7 Mechanical Vibrators
(Type depending on the shape & size of the Members)

Internal Vibrators:

- Shall penetrate up to a depth of 100mm.

- It shall be kept in place till air bubbles cease to escape from the surface and then withdrawn slowly to ensure that no hole is left in the concrete, care being taken to see that it remains in continued operation while being withdrawn.

- Vibrator should not be used to move the concrete as it can cause honey-combing.

- Distance between insertions should be 1.5 times the radius of the area.
visibly affected by vibration.

**External vibrators:**

- Used in case of PSC girders/slabs in addition to internal vibrators.
- Special attention to be given to the design of form work & disposition of vibrators for efficient compaction & to avoid surface blemishes.

Over vibration & under vibration of concrete are harmful and should be avoided.

15.7.1.8 Curing

a) **Moist Curing:**

- The concrete should be kept constantly wet for a minimum period of 14 (fourteen) days. Water should be applied on unformed surfaces as soon as it can be done without marring the surface and on formed surfaces immediately after the forms are stripped.

- The concrete shall be kept constantly wet by ponding or covered with a layer of sacking, canvas, hessian or a similar absorbant material.

- When air temperature is expected to drop below 5°C during the curing period, additional covering of cotton/gunny bags, straw or other suitable blanketing material shall be provided so that concrete temperature at surface does not fall below 10°C.

- Curing Compound: Approved curing compounds can be used in lieu of moist curing with the permission of the engineer. Such compounds shall be applied to all exposed surfaces of the concrete along with stripping of form work.

- Test shall be done to ascertain.

- Loss of m/c in concrete with/without curing compound.

- Cube strength of concrete with/without curing compound.

- Permeability of concrete.

b) **Steam Curing:**

- Can be used advantageously along with moist curing of concrete for transfer of pre-stress.

- Optimum Steam Curing cycle to be determined by trial. However, it has been found satisfactory to use a pre-steaming period of 4 to 5 hours or rate of temperature rise between 22-33°C per hour and a maximum curing temperature of 66-82°C for a period such that entire curing cycle does not exceed 18 hours.
15.7.2 Strength of Concrete:-

- The characteristic strength is defined as the strength of material below which not more than 5 % of the test results are expected to fall.

- The minimum grade of concrete for plain and reinforced concrete shall be as per Table 2 given below.

- Concrete of grades lower than those given in Table 2 below, may be used for plain concrete constructions, lean concrete, simple foundations, foundation for masonry walls and other simple or temporary reinforced concrete construction.

<table>
<thead>
<tr>
<th>Group</th>
<th>Grade designation</th>
<th>Specified Characteristic Compressive Strength of 150 mm Cube at 28 days in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ordinary Concrete</td>
<td>M10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>M15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>M20</td>
<td>20</td>
</tr>
<tr>
<td>Standard Concrete</td>
<td>M25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>M30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>M35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>M40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>M45</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>M50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>M55</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>M60</td>
<td>60</td>
</tr>
<tr>
<td>High Strength Concrete</td>
<td>M65</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>M70</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>M75</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>M80</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>M85</td>
<td>85</td>
</tr>
<tr>
<td>Concrete Grade</td>
<td>Compressive Strength</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>M90</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>M95</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>M100</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. *In the designation of concrete mix M refers to the mix and the number to the specified compressive strength of 150 mm size cube at 28 days, expressed in N/mm².*
2. *For concrete of compressive strength greater than M60, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.*

### 15.7.3 Workability of Concrete:

- The concrete mix proportions chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. Suggested ranges of workability of concrete is measured in accordance with IS 1199.

<table>
<thead>
<tr>
<th>Placing Conditions</th>
<th>Degree of workability</th>
<th>Slump in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding concrete, Shallow sections, Pavements using pavers</td>
<td>Very low</td>
<td>*</td>
</tr>
<tr>
<td>Mass concrete: Lightly reinforced sections in slabs, beams, walls, columns, Floors; Hand placed pavements; Canal lining; Strip footings</td>
<td>Low</td>
<td>25-75</td>
</tr>
<tr>
<td>Heavily reinforced sections in slabs, beams, walls, columns; Slip form work; Pumped concrete</td>
<td>Medium</td>
<td>50-100</td>
</tr>
<tr>
<td>Trench fill; In-situ piling</td>
<td>High</td>
<td>100-150</td>
</tr>
<tr>
<td>Tremie concrete</td>
<td>Very High</td>
<td>**</td>
</tr>
</tbody>
</table>

* *In the 'very low' category of workability where strict control is necessary, for example pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.*

** **In the 'very high' category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).*
15.7.4 Durability of Concrete:

- The factors influencing durability include:
  
  (a) The environment.
  
  (b) The cover to embedded steel.
  
  (c) The type and quality of constituent materials.
  
  (d) The cement content and water/cement ratio of the concrete.
  
  (e) The shape and size of the member.
  
  (f) Permeability of concrete
  
  (g) Workmanship, to obtain full compaction and efficient curing.

(a) Environment Exposure Conditions

The general environment to which the concrete will be exposed during its working life is classified in three levels of severity that is, moderate, severe and extreme, as described below:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Environment</th>
<th>Exposure conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moderate</td>
<td>Concrete surface protected against weather or aggressive conditions. Concrete surface sheltered from severe rain or freezing whilst wet. Concrete exposed to condensation, concrete structure continuously under water. Concrete in contact with non-aggressive soil/ground water.</td>
</tr>
<tr>
<td>2</td>
<td>Severe</td>
<td>Concrete surface exposed to severe rain, alternate wetting and drying or occasional freezing or severe condensation. Concrete exposed to aggressive sub-soil/groundwater or coastal environment.</td>
</tr>
<tr>
<td>3</td>
<td>Extreme</td>
<td>Concrete surface exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. Concrete structure surfaces exposed to abrasive action, surfaces of members in tidal zone. All other exposure conditions which are adverse to exposure conditions covered above.</td>
</tr>
</tbody>
</table>
(b) **Requirement of concrete cover.**

Minimum values for the nominal cover of normal-weight aggregate concrete which should be provided to all reinforcement, including links depending on the condition of exposure shall be as given in Table 4 below.

**Table 4**

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Nominal Concrete Cover in mm not Less Than</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>20</td>
</tr>
<tr>
<td>Moderate</td>
<td>30</td>
</tr>
<tr>
<td>Severe</td>
<td>45</td>
</tr>
<tr>
<td>Very severe</td>
<td>50</td>
</tr>
<tr>
<td>Extreme</td>
<td>75</td>
</tr>
</tbody>
</table>

**NOTES**

1. For main reinforcement up to 12 mm diameter bar, for mild exposure the nominal cover maybe reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by +10/-0mm
3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where Concrete grade is M35 and above.

- However for a longitudinal reinforcing bar in a column, nominal cover shall in any case not be less than 40 mm, or less than the diameter of such bar. In the case of columns of minimum dimension of200 mm or under, whose reinforcing bars do not exceed 12 mm, a nominal cover of 25 mm may be used.

- For footings minimum cover shall be 50mm.

(c) **The type and quality of constituent materials.**

This has been discussed in the beginning of this chapter. However. More idea can be had from the following Para:

For concrete to be durable, careful selection of the mix and materials is necessary, so that deleterious constituents do not exceed the limits.

**Chloride content:** Whenever there is chloride in concrete there is an increased risk of corrosion of embedded metal. The total amount of chloride content (as CI) in the concrete at the time of placing shall be as given in table 5 below.
Table 5

<table>
<thead>
<tr>
<th>Limits of Chloride Content of Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type or Use of Concrete</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete</td>
</tr>
<tr>
<td>Reinforced concrete or plain concrete containing embedded metal</td>
</tr>
<tr>
<td>Concrete not containing embedded metal of any material requiring protection from chloride</td>
</tr>
</tbody>
</table>

Sulphate content: Sulphates are present in most cements and in some aggregates; excessive amounts of water-soluble sulphate from these or other mix constituents can cause expansion and disruption of concrete. To prevent this, the total water-soluble sulphate content of the concrete mix, expressed as \( \text{SO}_3 \) (where \( \text{SO}_3 = 0.833 \text{SO}_4 \)) should not exceed 4 percent by mass of the cement in the mix.

(d) The cement content and water/cement ratio of the concrete.

Appropriate values for minimum cement content and the maximum free water-cement ratio are given in Table 6, for different exposure conditions. The minimum cement content and maximum water-cement ratio apply to 20 mm nominal maximum size aggregate. For other sizes of aggregate they should be changed as given in Table 7 below.

Maximum cement Content: Cement content not including fly ash and ground granulated blast furnace slag in excess of 450 kg/m³ should not be used unless special consideration has been given in design to the increased risk of cracking due to drying shrinkage in thin sections, or to early thermal cracking and to the increased risk of damage due to alkali silica reactions.

Table 6

(Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum size)

<table>
<thead>
<tr>
<th>SNo</th>
<th>Exposure</th>
<th>Minimum Cementitious material content in Kg/m²</th>
<th>Maximum Water-Cement Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PCC</td>
<td>RCC</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
SNo | Exposure | For Bridges in Pre-stressed Concrete and Important Bridges: | For Bridges other than mentioned above and substructure |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PCC Member</td>
<td>RCC Member</td>
</tr>
<tr>
<td>1</td>
<td>Moderate</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>Moderate</td>
<td>M-25</td>
<td>M-30</td>
</tr>
<tr>
<td>2</td>
<td>Severe</td>
<td>M-30</td>
<td>M-35</td>
</tr>
<tr>
<td>3</td>
<td>Extreme</td>
<td>M-35</td>
<td>M-40</td>
</tr>
</tbody>
</table>

Notes: Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 15.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolana and slag specified in IS 1489 (Part 1) and IS 455 respectively.

Table 7
(Adjustments to Minimum Cement contents for aggregates other than 20 mm Nominal maximum size)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Nominal aggregate size mm</th>
<th>Adjustment to minimum cement content in table 6 in kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>+40</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>-30</td>
</tr>
</tbody>
</table>

(e) The shape and size of the member.

- The shape or design details of exposed structures should be such as to promote good drainage of water and to avoid standing pools and rundown of water. Care should also be taken to minimize any cracks that may collect or transmit water.

- Adequate curing is essential to avoid the harmful effects of early loss of moisture.
• Member profiles and their intersections with other members shall be
designed and detailed in a way to ensure easy flow of concrete and
proper compaction during concreting.

• Concrete is more vulnerable to deterioration due to chemical or
climatic attack when it is in thin sections, in sections under
hydrostatic pressure from one side only, in partially immersed
sections and at corners and edges of elements. The life of the
structure can be lengthened by providing extra cover to steel, by
chamfering the corners or by using circular cross-sections or by using
surface coatings which prevent or reduce the ingress of water,
carbon dioxide or aggressive chemicals.

(f) Permeability of concrete

• One of the main characteristics influencing the durability of any
concrete is its permeability.

• With Strong, dense aggregates, a suitably low permeability is
achieved
  o by having a sufficiently low water-cement ratio,
  o by ensuring as thorough compaction of the concrete as possible,
  and
  o by ensuring sufficient hydration of cement through proper curing
    methods.

• The depth of penetration of moisture shall not exceed 25mm.

• Permeability test

  (i) Permeability test shall be mandatory for all RCC/ PSC bridges
      under severe and extreme environment;

  (ii) Under moderate environment, permeability test shall be mandatory
      for all major bridges and for other bridges permeability test is
desirable to the extent possible;

  (iii) Permeability test is required for RCC/PSC structural element only.

  (iv) Test to be done as per Appendix-G of IRS Concrete Bridge Code.

(g) Workmanship, to obtain full compaction and efficient curing.

g.1 Concrete Mix Proportioning:-

The mix proportions shall be selected to ensure the workability of the
fresh concrete and when concrete is hardened, it shall have the required
strength, durability and surface finish.

The determination of the proportions of cement aggregates and water
to attain the required strengths shall be made as follows:-
(a) By designing the concrete mix, such concrete shall be called “Design mix concrete” or,

(b) By adopting nominal concrete mix, such concrete shall be called “Nominal mix concrete”.

Design mix concrete is preferred to nominal mix. If design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used.

**Design mix concrete**

- The mix shall be designed to produce the grade of concrete having the required workability, durability and a characteristic strength. The procedure given in IS: 10262 may be followed for mix design.
- The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times the standard deviation.
- Mix design done earlier not prior to one year maybe considered adequate for later work provided there is no change in source and the quality of the materials.
- **The standard deviation** for each grade of concrete shall be calculated, separately.
- Standard deviation based on test strength of sample:

**Number of test results of samples** - The total number of test strength of samples required to constitute an acceptable record for calculation of standard deviation shall be not less than 30.

**Standard deviation to be brought up to date after every change of mix design.**

**Assumed standard deviation**

Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in Table 8 may be assumed for design of mix in the first instance. As soon as the results of samples are available, actual calculated standard deviation shall be used and the mix designed properly.

<table>
<thead>
<tr>
<th>Grade of concrete</th>
<th>Assumed Standard Deviation in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>M10</td>
<td>3.5</td>
</tr>
<tr>
<td>M15</td>
<td></td>
</tr>
<tr>
<td>M20</td>
<td>4.0</td>
</tr>
<tr>
<td>M25</td>
<td></td>
</tr>
</tbody>
</table>
NOTES
The above values correspond to the site control having proper storage of cement; weigh batching of all materials; controlled addition of water; regular checking of all materials, aggregate grading and moisture content; and periodical checking of workability and strength. Where there is deviation from the above, the values given in the above table shall be increased by 1 N/mm².

For grades above M 60, the standard deviation shall be established by actual trials based on assumed proportions, before finalizing the mix.

Nominal mix concrete-Nominal mix concretemay be used for concrete of M20 or lower. The proportions of materials for nominal mix concrete shall be in accordance with Table9 below.

**Table 9**
(Proportions for Nominal Mix Concrete)

<table>
<thead>
<tr>
<th>Grade of concrete</th>
<th>Total Quantity of Dry Aggregates by mass per 50 kg of Cement, to be taken as the sum of the Individual masses of fine and coarse aggregates, kg, Max.</th>
<th>Proportion of Fine Aggregate to coarse Aggregate (by mass)</th>
<th>Quantit y of water per 50 kg of cement, max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 5</td>
<td>800</td>
<td>Generally 1:2 but subject to an upper limit of 1:1 ½ and a lower limit of 1:2 ½</td>
<td>60</td>
</tr>
<tr>
<td>M 7.5</td>
<td>625</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>M 10</td>
<td>480</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>M 15</td>
<td>330</td>
<td></td>
<td>32</td>
</tr>
</tbody>
</table>
Note: -
The proportion of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

Example: -
For an average grading of fine aggregate (i.e., Zone II of Table 4 of IS 383), the proportions shall be 1:1 ½, 1:2 and 1:2 ½ for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

### g.2 Reinforcement Splicing

**Laps and Joints** – Continuity of reinforcement may be achieved by a connection using any of the following jointing methods:

(a) lapping bars  
(b) butt welding  
(c) sleeving  
(d) threading of bars

- Where splices are provided in the reinforcement bars they shall, as far as possible, be away from the section of maximum stress and be staggered. It is recommended that splices in flexural members should be at sections where the bending moment is more than 50 percent of the moment of resistance and not more than half the bars shall be spliced at a section.

- Where more than one half of the bars are spliced at a section or where splices are made at points of maximum stress, special precautions shall be taken, such as increasing the length of lap and/or using spirals or closely-spaced stirrups around the length of the splice.

- Lap splices shall not be used for bars larger than 32 mm. Bars larger than 32 mm shall be welded or mechanically spliced.

- Lap splices shall be considered as staggered if the center to center distance of the splices is not less than 1.3 times the lap length calculated as described here under.

- Lap length including anchorage value of hooks for bars in flexural tension shall be Ld or 30xDia whichever is greater and for direct tension shall be 2Ld or 30 Dia whichever is greater. The straight length of the lap shall not be less than 15x dia or 200mm.

The following provisions shall also apply:

Where lap occurs for a tension bar located at:

1) Top of a section as cast and the minimum cover is less than twice the diameter of the lapped bar, the lap increased by a factor of 1.4.
2) Corner of a section and the minimum cover to either face is less than twice the diameter of the lapped bar or where the clear distance between adjacent laps is less than 75 mm or 6 times the diameter of lapped bar, whichever is greater, the lap length should be increased by a factor of 1.4

Where both conditions (1) and (2) apply the lap length should be increased by a factor of 2.0.

NOTE: Splices in tension members shall be enclosed in spirals made of bars not less than 6 mm diameter with pitch not more than 100mm.

- The lap length in compression shall be equal to the development length in compression, but not less than 24 times the diameter of bar.
- When bars of two different diameters are to be spliced, the lap length shall be calculated on the basis of diameter of the smaller bar.
- When splicing of welded wire fabric is to be carried out, lap splices of wires shall be made so that overlap measured between the extreme cross wires shall be not less than the spacing of cross wires plus 100 mm.
- In case of bundled bars, lapped splices of bundled bars shall be made by splicing one bar at a time such individual splices with in a bundle shall be staggered.
- Reinforcement couplers for mechanical splices of bars for concrete reinforcement, used, shall be in accordance with IS 16172.

g.3 Reinforcement Placing

- Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502. The high strength deformed steel bars should not be re-bent or straightened without the approval of engineer-in-charge.
  Bar bending schedules shall be prepared for all reinforcement work.

- All reinforcement shall be placed and maintained in the position shown in the drawings by providing proper cover blocks, spacers, supporting bars, etc.

- Rough handling, shock loading (prior to embedment) and the dropping of reinforcement from a height should be avoided. Reinforcement should he secured against displacement outside the specified limits

- Unless otherwise specified by engineer-in-charge, the reinforcement shall be placed within the following tolerances:
  a) for effective depth 200 mm or less ± 10mm
  b) for effective depth more than 200 mm ± 15mm

- Sufficient spacers shall be provided to maintain specified concrete cover to the reinforcement and preventing displacement before and
during the placement of the concrete. Spacers should be of such material and designs as will be durable, will not lead to the corrosion of reinforcement and will not cause spalling of the concrete cover. Spacer block made from cement, sand and small aggregates should match the mix proportion of the concrete as far as is practicable with a view to being comparable in strength, durability and appearance. The use of the pieces of wood, tile or porous material will not be allowed for this purpose.

Concrete cover blocks used shall be of the same strength and density as parent concrete.

- At all intersections, reinforcing bars shall be securely bound together with 1.6mm dia mild steel wire in accordance with IS:280 or with approved reinforcement clips. The free ends of the binding wire shall be bent inwards. For aggressive environment, galvanized binding wire shall be used.

- Max. distance of spacers, chairs etc.- 1m

g.4 Formwork and Shuttering:-

- Formwork and shuttering should be designed for self-weight, weight of reinforcement, weight of fresh concrete and in addition to various live loads during the construction process (workmen, material & equipment).

- Shuttering should have sufficient stiffeners to avoid excessive deflection during placing and compaction of concrete.

- Shuttering Joints to be tightly butted to avoid leakage of slurry. If required, rubberized lining to be provided.

- The shuttering should be provided in such a way that it maintains the tolerances on the shapes and dimensions of the structure.

The tolerances on the shapes, lines and dimensions shown in the drawing shall be within the limits given below:

| a) Deviation from specified dimensions of cross-section of columns and beams | + 10 mm | - 6 mm |
b) Deviation from dimensions of footings
   1) Dimensions in plan
      +50 mm
      -10 mm
   2) Eccentricity
      0.02 times the width of the footing in the direction of deviation but not more than 50 mm
   3) Thickness
      +50 mm
      -10 mm
      or
      \( \pm 0.05 \) times the specified thickness

- Shuttering to be adequately repaired, cleaned and applied with suitable coating or releasing agent before concreting, which acts both as a parting agent and also gives surface protection. Release agents should be applied so as to provide a thin uniform coating to the forms without coating the reinforcement.

- Removal of formwork (Stripping): In normal circumstances where ambient temperature does not fall below 15°C and where adequate curing is done, following striking period may be adopted:

<table>
<thead>
<tr>
<th>SN</th>
<th>Type of Formwork</th>
<th>Minimum Period Before Striking Formwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Vertical formwork to columns, walls, beams</td>
<td>For concrete made using OPC 16-24 h 16-24 h</td>
</tr>
<tr>
<td>Ii</td>
<td>Soffit formwork to slabs (Props to be refixed immediately after removal of formwork)</td>
<td>3 days 7 days</td>
</tr>
<tr>
<td>Iii</td>
<td>Soffit formwork to beams (Props to be refixed immediately after removal of formwork)</td>
<td>7 days 10 days</td>
</tr>
<tr>
<td>Iv</td>
<td>Props to slabs:  1) Spanning up to 4.5 m  2) Spanning over 4.5 m</td>
<td>7 days 14 days 10 days 14 days</td>
</tr>
<tr>
<td>Props to beams and arches:</td>
<td>1) Spanning up to 6 m</td>
<td>14 days</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>2) Spanning over 6 m</td>
<td>21 days</td>
</tr>
</tbody>
</table>

- There shall be adequate provision for the movement and operation of vibrators and other construction plant & equipment.

**g.5 Some other precautions:**

- Storage of materials shall be as described in IS 4082
- Concrete of desired consistency to be ensured by slump test.
- Vertical drop of concrete at any time should not be more than 1.5 m.
- Time between mixing and placing of concrete not to be more than 30 minutes.
- Adequate hand compaction by compaction rods to ensure concrete is thoroughly compacted and worked around the reinforcement, embedded fixtures and corners.
- Needle/External vibrators to ensure de-aeration and effective compaction at a rate commensurate with the supply of concrete.
- Construction joints and expansion joints to be provided as per drawings.
- Concrete, after 1-2 hrs. of laying, to be protected from quick drying by covering with moist gunny bags, sand, hessian cloth etc.
- After 24 hrs. of laying, surface to be cured by ponding with water for a minimum of 7-10 days for concrete exposed to dry and hot weather.

**15.8 Sampling, Strength Testing & Acceptance Criteria of Concrete**:

- Samples from fresh concrete shall be taken as per IS:1199 and cubes shall be made, cured and tested at 28 days in accordance with IS: 516.
- For relatively quick idea of the quality of concrete, optional tests on beams for modulus of rupture at 72+/-2 hours or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose, the values given in Table 10 may be taken for general guidance in case of concrete made with ordinary Portland cement. However, in all cases, the 28 days compressive strength specified in Table 2 shall alone be the criterion for acceptance or rejection of the concrete.
Table 10

<table>
<thead>
<tr>
<th>GRADE OF CONCRETE</th>
<th>COMPRESSIVE STRENGTH ON 15 cm CUBES N/mm²</th>
<th>MODULUS OF RUPTURE BY BEAM TEST Min. N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min. at 7 days</td>
<td>Min. at 72+/−2h</td>
</tr>
<tr>
<td>M20</td>
<td>13.5</td>
<td>1.7</td>
</tr>
<tr>
<td>M25</td>
<td>17.0</td>
<td>1.9</td>
</tr>
<tr>
<td>M30</td>
<td>20.0</td>
<td>2.1</td>
</tr>
<tr>
<td>M35</td>
<td>23.5</td>
<td>2.3</td>
</tr>
<tr>
<td>M40</td>
<td>27.0</td>
<td>2.5</td>
</tr>
<tr>
<td>M45</td>
<td>30.0</td>
<td>2.7</td>
</tr>
<tr>
<td>M50</td>
<td>33.5</td>
<td>2.9</td>
</tr>
<tr>
<td>M55</td>
<td>37.0</td>
<td>3.1</td>
</tr>
<tr>
<td>M60</td>
<td>40.0</td>
<td>3.3</td>
</tr>
</tbody>
</table>

- A random sampling procedure shall be adopted and the sampling should be spread over the entire period of concreting and cover all mixing units.

- Frequency - The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Quantity of concrete in the work, m³</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>1</td>
</tr>
<tr>
<td>6-15</td>
<td>2</td>
</tr>
<tr>
<td>16-30</td>
<td>3</td>
</tr>
<tr>
<td>31-50</td>
<td>4</td>
</tr>
<tr>
<td>51 &amp; above</td>
<td>4 plus one additional sample for each additional 50 m³ or part thereof.</td>
</tr>
</tbody>
</table>

Note - At least one sample comprising of 3 cubes to be taken from each shift.

- Test Strength of Sample – The test strength of the sample shall be the average of the strength of three specimens. The individual variation
should not be more than +/-15 per cent of the average. If more, the test results of the sample are invalid.

Acceptance Criteria:

Compressive Strength
The concrete shall be deemed to comply with the strength requirements when both the following condition are met:

a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 11.

b) Any individual test result complies with the appropriate limits in col 3 of Table 11.

Flexural Strength
When both the following conditions are met, the concrete complies with the specified flexural strength.

a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm².

b) The strength determined from any test result is not less than the specified characteristic strength less 0.3N/mm².

<table>
<thead>
<tr>
<th>Specified Grade</th>
<th>Mean of the Group of 4 Non-Overlapping Consecutive test Results in N/mm² Min</th>
<th>Individual Test Results in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 15 and above</td>
<td>( \geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest 0.5 N/mm}^2) ) or ( f_{ck} + 3 \text{ N/mm}^2 ) (whichever is greater)</td>
<td>( \geq f_{ck} - 3 \text{ N/mm}^2 )</td>
</tr>
</tbody>
</table>

Note:-

1. In the absence of established value of standard deviation, the values given in Table 8 above may be assumed and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

2. For concrete of quantity up to 30 cum (Where the number of samples to be taken is less than four as per frequency of sampling given in 15.2.2 of IS 456), the mean test results of such samples shall be \( f_{ck} + 4 \text{ N/mm}^2 \), minimum
and the requirement of minimum individual test results shall be $f_{ck} - 2 N/mm^2$, minimum. However, when the number of sample is only one as per 15.2.2 of IS 456, the requirement shall be $f_{ck} + 4 N/mm^2$, minimum.

15.9 Pumpable Concrete

Pumpable concrete is the concrete which is conveyed by pressure through either rigid pipe or flexible hose and discharged directly into the desired area. It is especially used where space for construction equipment is very limited.

15.9.1 Pumping Rate and Range

- Depending on the equipment, pumping rate should be 10 to 70 m$^3$ per hour.
- Effective pumping range is up to 300 m horizontally and 90 m vertically.

15.9.2 Proportioning Pumpable Concrete

15.9.2.1 Basic Consideration-

More emphasis on quality control is essential to the proportioning. Concrete mixes for pumping must be plastic. Particular attention must be given to the mortar and to the amounts and sizes of coarse aggregates.

15.9.2.2 Proportioning Pumpable Concrete

The maximum size of coarse aggregate is limited to one-third of smallest inside diameter of the hose or pipe. Provisions should be made for elimination of oversized particles in the concrete by screening or by careful selection of aggregates.

15.9.3 Pumping Operation

- Proper planning of concrete supply, pump locations, line layout, placing sequences and the entire pumping operation be done.
- The pump should be placed as near the placing area as practicable.
- Lines from the pump to the placing area should be laid out with a minimum of bends.
- The pipe line shall be rigidly supported.
- While pumping downward 15 m or more, it is desirable to provide an air release valve at the middle of the top bend to prevent vacuum or air build-up. When pumping upward, it is desirable to have a valve near the pump to prevent reverse flow.
CHAPTER – 16

PILE FOUNDATIONS

16.1 General

Pile foundation Work shall be done in accordance with IS:2911 Parts 1 to 4 unless otherwise specified or mentioned in Drawings and Contract specifications. Under reamed piles shall not be used for Railway bridges but used extensively in clayey and black cotton soils for buildings.

The Construction of pile foundations requires a careful choice of the piling system depending upon sub-soil conditions and loading characteristics and type of structure. The permissible limits of total and differential settlements, unsupported length of pile under scour, impact / entanglement of floating bodies and any other special requirements of project are other important criteria for selection of the piling system. The method of installing the piles, including details of the equipment shall be submitted by the Contractor and got approved by the Engineer before start of work.

16.2 Sub-Surface Investigations

Borings should be carried up to sufficient depths so as to ascertain the nature of strata around the pile shaft and below the pile tip. However, unless otherwise specified or agreed to, depth of boring shall not be less than:

1. 1.5 times estimated length of pile in soil but not less than 15m beyond the probable length of pile
2. 15 times diameter of pile in weak / jointed rock but minimum 15m in such rock
3. 4 times diameter of pile in sound, hard rock but minimum 3 m in such rock.
4. The investigation shall be adequate for the purpose of selection of appropriate piling system and for estimating design capacities for different diameters and lengths of piles.
5. For piles socketed into rocks, it is necessary to determine the uniaxial compressive strength of the rock and its quality.
6. The investigation shall also include location of ground water table and other parameters including results of chemical tests showing sulphate and chloride content and any other deleterious chemical content in soil and / or ground water, likely to affect durability.

16.3 DESIGN CONSIDERATIONS:

16.3.1 PILES

Generally, Pile foundations shall be designed in such a way that the load from the structure can be transmitted to the sub-surface with adequate factor of safety against shear failure of sub-surface and without causing such settlement (differential or total), which may result in structural damage and/or functional
distress under permanent/transient loading. The pile shaft should have adequate structural capacity to withstand all loads (vertical, axial or otherwise) and moments which are to be transmitted to the subsoil and shall be designed according to IS 456.

16.3.2 Design of Pile Cap (IS 2911 Part-I, Section-I)

i. The pile caps may be designed by assuming that the load from column is dispersed at 45° from the top of the cap to the mid-depth of the pile cap from the base of the column or pedestal. The reaction from piles may also be taken to be distributed at 45° from the edge of the pile, up to the mid-depth of the pile cap. On this basis the maximum bending moment and shear forces should be worked out at critical sections. The method of analysis and allowable stresses should be in accordance with IS 456.

ii. Pile cap shall be deep enough to allow for necessary anchorage of the column and pile reinforcement.

iii. The pile cap should be rigid enough so that the imposed load could be distributed on the piles in a group equitably.

iv. In case of a large cap, where differential settlement may occur between piles under the same cap, due consideration for the consequential moment should be given.

v. The clear overhang of the pile cap beyond the outermost pile in the group shall be a minimum of 150 mm.

vi. The cap is generally cast over a 75 mm thick levelling course of concrete. The clear cover for main reinforcement in the cap slab shall not be less than 60 mm.

vii. The embedment of pile into cap should be 50 mm. The design of grade beam if used shall be as given in IS 2911 (Part 3)

16.3.3 Spacing of Piles

The minimum center-to-center spacing of piles is considered from three aspects, namely, a) practical aspects of installing the piles, b) diameter of the pile, and c) nature of the load transfer to the soil and possible reduction in the load capacity of piles group.

NOTE: In the case of piles of non-circular cross section, diameter of the circumscribing circle shall be adopted.

In case of piles founded on hard stratum and deriving their capacity mainly from end-bearing the minimum spacing shall be 2.5 times the diameter of the circumscribing circle corresponding to the cross-section of the pile shaft. In case of piles resting on rock, the spacing of two times the said diameter may be adopted.

Piles deriving their load-carrying capacity mainly from friction, shall be spaced sufficiently apart to ensure that the zones of soils from which the piles derive their support do not overlap to such an extent that their bearing values are reduced. Generally, the spacing in such cases shall not be less than 3 times the diameter of the pile shaft.
16.3.4 Materials

The specifications for steel reinforcement, structural concrete, pre-stressed concrete and structural steel to be used in pile foundations shall be similar to provisions given in the relevant IS specifications.

- **Cement:** The cement used shall be any of the following:
  
  a) 33 Grade ordinary Portland cement conforming to IS 269,
  
  b) 43 Grade ordinary Portland cement conforming to IS 8112,
  
  c) 53 Grade ordinary Portland cement conforming to IS 12269,
  
  d) Rapid hardening Portland cement conforming to IS 8041, 7 IS 2911 (Part 1/Sec 1): 2010
  
  e) Portland slag cement conforming to IS 455,
  
  f) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part 1),
  
  g) Portland pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2),
  
  h) Hydrophobic cement conforming to IS 8043,
  
  i) Low beat Portland cement conforming to IS 12600, and
  
  j) Sulphate resisting Portland cement conforming to IS 12330.

- **Steel Reinforcement:** Steel shall be any of the following:
  
  a) Mild steel and medium tensile steel bars conforming to IS 432 (Part-1),
  
  b) High strength deformed steel bars conforming to IS 1786, and
  
  c) Structural steel conforming to IS 2062

16.3.5 Concrete in Piles

For both precast and cast in situ piles, the grade of concrete, minimum cement content, water cement ration and slump at the time of placement shall as per following table (Clause 1104.2 of MORTH Specs. 5th Rev.):

**Requirements for concrete in piles**

<table>
<thead>
<tr>
<th></th>
<th>Cast in Situ Conc. by Tremie</th>
<th>Precast Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade of Concrete</td>
<td>M-35</td>
<td>M-35</td>
</tr>
<tr>
<td>Min. Cement Content</td>
<td>400 Kg/Cum</td>
<td>400 Kg/Cum</td>
</tr>
<tr>
<td>Min. Water cement Ration</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Slump (mm) as measured at time of placement</td>
<td>150-200</td>
<td>50-75</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------</td>
<td>------</td>
</tr>
</tbody>
</table>

The term min. cement content and min. water cement ratio mentioned in Table above are to be based upon total cementitious material (inclusive of mineral admixtures called additives)

- Suitable and approved admixtures may be used in concrete mix where necessary.
- The minimum clear cover for piles will be 40mm over all reinforcement including binding wire.
- Where piles are to be located in corrosive environment, the cover shall be 50mm.
- Where piles are exposed to action of harmful chemicals or severe conditions of exposure due to presence of sulphate, chloride etc., higher grades of concrete, restricting water cement ratio to 0.45 shall be used. Special types of cement, such as sulphate resistant cement may be used where considered appropriate by Engineer-in-Charge.

16.4 WORKMANSHIP (Clause 8 of IS 2911 Part-1, Section-1:2010)

16.4.1 Control of Alignment:
Piles shall be installed as accurately as possible according to the design and drawings either vertically or to the specified batter. Greater care should be exercised in respect of installation of single piles or piles in two pile groups. As a guide, for vertical piles, an angular deviation of 1.5 percent and for raker piles, a deviation of 4 percent should not be exceeded. Piles should not deviate more than 75 mm or D/6 whichever is less (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) from their designed positions at the working level. In the case of single pile under a column the positional deviation should not be more than 50 mm or D/6 whichever is less (100 mm in case of piles having diameter more than 600 mm). Greater tolerance may be prescribed for piles cast over water and for raker piles. For piles to be cut-off at a substantial depth below the working level, the design shall provide for the worst combination of the above tolerances in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by redesign of the pile cap or pile ties, the piles shall be replaced or supplemented by additional piles.

16.4.2 Setting Out the Pile Points

- Piling points to be marked precisely as per approved drawings.
- As per IS 2911, the max tolerance permissible for piles with diameter 600mm or more is 75mm or D/10, whichever is more.
- The set-out points are marked clearly - for easy identification, and firmly - so as not to affect by any activities around.
- The setting out is done with Total Station or with a theodolite.
- However, cross checking of the points established is done before starting the piling activity. Temporary reference points (TR) are established for this purpose.
• All the piles are grouped into small groups, and each group is locally measured from a temporary reference point.
• All these TRs are inter-connected and the distance between them, distance from them to the pile points, and distance from the base reference etc are measured and recorded.

16.4.3 Sequence of Piling:
• In a pile group the sequence of installation of piles shall normally be from the center to the periphery of the group or from one side to the other.
• Driving a Group of Friction Piles Driving piles in loose sand tends to compact the sand, which in turn, increases the skin friction. In case where stiff clay or dense sand layers have to be penetrated, similar precautions described in above para needs to be taken. However, in the case of very soft soils, the driving may have to proceed from outside to inside so that the soil is restricted from flowing out during operations.

16.4.4 Defective Piles:
• In case defective piles are formed, they shall be left in place and additional piles as necessary shall be provided.
• If there is a major variation in the depths at which adjacent piles in a group meet refusal, a boring may be made nearby to ascertain the cause of such difference. If the boring shows that the strata contain pockets of highly compressive material below the level of shorter pile, it may be necessary to take such piles to a level below the bottom of the zone, which shows such pockets.
• Deviations Any deviation from the designed location, alignment or load-carrying capacity of any pile shall be noted and adequate measures taken to check the design well before the concreting of the pile cap and grade beams are done.
While removing excess concrete or laittance above cut-off level, manual chipping shall be permitted after three days of pile concreting. Pneumatic tools shall be permitted only after seven days after casting. Before chipping/breaking the pile top, a groove shall be formed all around the pile diameter at the required cut-off level.

16.4.5 Recording of Data

A competent inspector shall be maintained at site to record necessary information during installation of piles and the data to be recorded shall essentially contain the following:

a) Sequence of installation of piles in a group,
b) Type and size of driving hammer and its stroke,
c) Dimensions of the pile including the reinforcement details and mark of the pile,
d) Cut-off level and working level,
e) Depth driven,
f) Time taken for driving and for concreting recorded separately, and
g) Any other important observations, during driving, concreting and after withdrawal of casing tube.

16.4.6 Test Piles

a) The piles shall be load tested in accordance with provisions laid down in IS 2911. Part 4.

b) Test piles which are shown on the drawings or specified in the contract or installed by the Contractor on his own to determine the lengths of piles to be furnished shall conform to the requirements for piling as indicated in these specifications, if they are to be incorporated in the completed structure.

c) Test piles which are to become a part of the completed structure shall be installed with the same type of equipment that is proposed to be used for piling in the actual structure. Test piles which are not to be incorporated in the completed structure shall be cut off at least 600mm below the proposed soffit level of pile cap and head finished properly with cover concrete and the remaining hole shall be back filled with earth or other suitable material. If any test pile in a cluster fails, an additional pile will be provided and incorporated in the Cluster at the position approved by the Engineer.
16.5 CAST-IN-SITU CONCRETE PILES

- Cast-in-situ concrete piles may be either installed by making a bore into the ground by removal of material or by driving a metal casing with a shoe at the tip and displacing the material laterally. The two types of piles are termed as “bored piles” and “driven piles” respectively. Cast-in-situ concrete piles may be cast in metal shells which may remain permanently in place. However, other types of cast-in-situ concrete piles, plain or reinforced, cased or uncased, may be used if in the opinion of the Engineer the soil conditions permit their use and if their design and the methods of placing are satisfactory. The metal casing shall be of sufficient thickness and strength to hold its original form and show no harmful distortion after it and adjacent casings have been driven and the driving core, if any, has been withdrawn.

- Concreting and reinforcement work shall be done in accordance with relevant clauses of IS 456:2000.

- Cast-in-situ concrete driven piles shall be installed using a properly designed detachable shoe at the bottom of the casing.

- Any liner or bore-hole which is improperly located or shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Engineer at the cost of the Contractor.

- Bored cast-in-situ piles in soils which are stable, may often be installed with only a small casing length at the top. A minimum of 2.0m length of top of bore shall invariably be provided with casing to prevent any loose soil falling into the bore. In cases in which the side soil lower down can fall into the hole, it is necessary to stabilize the side of the bore hole with drilling mud, or a suitable steel casing. The casing may be left in position permanently specially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of piles could be exposed due to scour.

- For bored cast-in-situ piles, casing / liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length shown on the drawing or as approved by the Engineer. Materials inside the casing shall be removed progressively by air lift, grab or percussion equipment or other approved means. Boring shall be carried out using rotary or percussion type equipment. Unless otherwise approved by the Engineer, the diameter of the bore-holes shall be not more than the inside diameter of the liner.

- Where bored cast-in-situ piles are used in soils liable to flow, the bottom of the casing shall be kept enough in advance of the boring tool to prevent the entry of soil into the casing, thus preventing the formation of cavities and settlements in the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joints of the casing shall be made as tight as possible to minimize inflow of water or leakage of slurry during concreting. Where mud flow conditions exist, the casing of cast-in-situ piles shall not be allowed to be withdrawn. Prior to the lowering of the reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials. Cover to reinforcing steel shall be maintained by suitable spacers, tied in advance to the reinforcement.
16.5.1 **Boring**

a) Mark the location as per drawing. as correct as possible.

b) Insert casing pipe of approx. 1 to 2 m length with top of casing at reference RL

c) Prepare Bentonite slurry of sufficient consistency & pump into borehole continuously till completion of bore.

d) Check the depth of bore (Effective length below cut off level + Diff. of RL & Cut off level)

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16.5.2 **Washing the Bore**

- Pump fresh Bentonite into bore while chiseler is at bottom.
- Check the consistency of out coming mud in-between.
- Continue till specific gravity of mud is <1.2
- Wash again to resume after lowering the reinforcement cage and installing tremie pipes for almost 30 minutes.
- Load capacity of pile depends on friction to be generated, so washing & flushing of bore are main points to pay attention.
- Provide sufficient number of circular cover blocks of same grade mix as of concrete to give proper cover.
• Wherever practicable, concrete should be placed in a clean dry hole. Where concrete is placed in dry condition and there is casing present, the top 3m of the pile shall be compacted using internal vibrators.

• Before concreting under water, the bottom of the hole shall be cleaned of drilling mud and all soft or loose material very carefully. In case a hole is bored with use of drilling mud, concreting should not be taken up when the specific gravity of bottom slurry is more than 1.2.

• Where the casing is withdrawn from cohesive soils for the formation of cast-in-situ pile, the concreting should be done with necessary precautions to minimize the softening of the soil by excess water. Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting and also while extracting the tube shall be avoided.

• The concrete shall be properly graded, shall be self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silty clays and other soils with the tendency to squeeze into the newly deposited concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.

• The placing of concrete shall be a continuous process from the toe level to the top of the pile. To prevent segregation, a tube or tremie pipe as appropriate shall be used to place concrete in all piles.
To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6m (length of pile) per hour. Under water concreting should be done with tremie.

16.5.3 Concreting (Tremie Method)

- Finalize the mix design and get it approved.
- Identify the set of tremie pipes to achieve adequate length as per the pile bore length.
- Install tremie pipes of 200 mm dia. up to bottom of bore hole.
- Lock the top hopper with locking plate.
- Fill the hopper with 150-180 mm slump concrete & open the lock.
- Start surging, initially by slow jerks.
- Tremie should always be inside concrete while surging and should not come out.
- Tremie pipes to be taken out one by one as the concreting progresses.

16.5.4 Concreting and Withdrawal of Casing Tube

- Whenever condition indicates ingress of water, casing tube shall be examined for any water accumulation and care shall be taken to place concrete in a reasonably dry condition.
- The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at cut-off level. The reinforcing cages shall be left with adequate protruding length above cut-off level for proper embedment into the pile cap.
- Where cut-off level is less than 1.50 m below working level, the concrete shall be cast to a minimum of 600 mm above the cut-off level. In case the cut-off is at deeper level, the empty bore shall be filled with lean concrete or suitable material, wherever the weight of fresh concrete in the casing pipe is found inadequate to counteract upward hydrostatic pressure at any level below the cut-off level. Also, before initial withdrawal of the casing tube, adequate quantity of concrete shall be placed into the casing to counter the hydrostatic pressure at pile tip.

16.5.5 Concreting under water

- General requirements and precautions for concreting under water shall be as given in concreting chapter supplemented by following instructions:
  
a) The concreting of a pile must be completed in one continuous operation. Also, for bored holes, the finishing of the bore, cleaning of the bore, lowering of reinforcement cage and
concreting of pile for full height must be accomplished in one continuous operation without any stoppage.

b) The concrete should be coherent, rich in cement with high slump and restricted water cement ratio.

c) The tremie pipe will have to be large enough with due regard to the size of aggregate. For 20mm aggregate the tremie pipe should be of diameter not less than 150mm and for larger aggregate, larger diameter tremie pipes may be necessary.

d) The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of water and concrete.

e) The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

f) The pile should be concreted wholly by tremie and the method of deposition should not be changed part way up the pile to prevent the laitance from being entrapped within the pile.

g) All tremie tubes should be scrupulously cleaned after use.

h) In special circumstances, the Engineer may permit use of any other proved method of concrete placement designed for under water concrete. In such cases, a detailed method statement should be prepared and got approved by the Engineer.

- The diameter of the finished pile shall not be less than that specified and a continuous record shall be kept by the Engineer as to the volume of concrete placed in relation to the pile length cast.

### 16.6 Pile Cap

- The minimum embedment of cast-in-situ concrete piles into pile cap shall be 150mm. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete. The clear cover between the bottom reinforcement in pile cap from the top of the pile shall be not less than 25mm. The reinforcement in the pile shall be exposed for full anchorage length to permit it to be adequately bonded into the pile cap. Exposing such length shall be done carefully so as to avoid damaging the rest of the pile. In cases where the pile cap is to be laid on ground, a levelling course of M 15 or as stipulated nominal mix concrete 100mm thick shall be provided. Defective piles shall be removed or left in place as judged convenient without affecting the performance of adjacent piles or pile cap. Additional piles shall be provided to replace the defective piles.

- Pile caps shall be of reinforced concrete of minimum grade of M 25 unless otherwise stated in drawings or work specifications or directed by
the Engineer. A minimum offset of 150mm shall be provided beyond the outer faces of the outer most piles in the group. If the pile cap is in contact with earth at the bottom, a levelling course of minimum 100mm thickness of M 15 or as specified nominal mix concrete shall be provided.

- The attachment of the pile head to the cap shall be adequate for loads and forces. The top of concrete in a pile shall be brought above cut-off level to permit removal of all laitance and weak concrete before pile cap is laid. This will ensure good concrete at the cut-off level.

- Concreting of the pile cap shall be carried out in dry conditions. The bottom of the pile cap shall be laid preferably as low as possible taking into account the water level prevalent at the time of casting. Suitable leak-proof floating form work shall be used for casting caps over piles in water.

### 16.7 Driven Piles:

#### 16.7.1 Driving Equipment

Piles or their casings may be driven with any type of drop hammer, diesel hammer or single acting or double acting steam or compressed air hammer, provided they penetrate to the prescribed depth or attain the designed resistance without being damaged. The weight or power of the hammer should be sufficient to ensure a penetration of at least 5mm per blow, unless rock has been reached. It is always preferable to employ the heaviest hammer practicable and to limit the stroke, so as not to damage the pile. The minimum weight of the hammer shall be 2.5t. In the case of precast concrete piles, the mass of the hammer shall be not less than 30 times the mass of 300mm length of pile.

Steam or air hammers shall be operated with a boiler or air compressor of capacity not less than the capacity that is specified by the manufacturer of the hammer. The boiler or air compressor shall be equipped with an accurate pressure gauge and safety valves at all times. The valve mechanism and other parts of steam, air or diesel hammers shall be maintained in first class condition so that the length of stroke and number of blows per minute for which the hammer is designed, will be obtained. The boiler shall be inspected by statutory authorities at prescribed intervals. Inefficient steam, air or diesel hammers shall be removed from the work.

#### 16.7.2 Driving

- **General Procedure**

  Piles shall be installed from cranes or derricks standing on firm ground or from temporary supports or from fixed platform. Piles in water shall be installed from cranes erected on pontoons/ barges properly anchored and held in position. The arrangement shall provide sufficient rigidity to ensure accuracy of pile driving under all conditions of tide, stream flow or hammer drop. During driving, the top of pile shall be protected by a
suitable helmet of substantial and well-fitting steel construction. The
helmet shall provide uniform bearing across the top of the pile and shall
hold the pile centrally under the hammer.

- No pile shall be driven unless inspected and approved by the Engineer.
  Forces producing undue bending or torsional stresses in piles shall not
  be applied during driving. The force of the hammer shall be directed
centrally and axially during driving. The stroke of a single acting or drop
hammer shall be limited to 1.2m unless otherwise permitted by the
Engineer. A shorter stroke may be specified when there is danger of
damaging the pile.

- Piles shall not be bent or sprung into position but shall be effectively
guided and held on-line during the initial stages of driving. Attempts to
correct any tendency for the pile to run off-line by the application of
significant horizontal restraint will not be permitted. Shortly after the
commencement of driving and at regular intervals throughout the driving
operation, checks shall be made to ensure that the pile frame does not
exert any undue lateral force on the pile due to restraint within the
helmet.

- To avoid the possibility of premature “set up” pile driving shall be
  continuous in the later stages, without any deliberate stops. Delays of
an hour or less may lead to significant “set-up” in piles i.e. resistance to
further driving increases after driving is stopped.

- If any pile is damaged in any way during driving, it shall be repaired or
  replaced as directed by the Engineer, at no extra cost. If during driving,
the head of a pile is damaged to the extent that further driving is not
possible, the head shall be cut off and helmet replaced and driving
continued. The cost of cutting of the head shall be borne by the
Contractor and where, as a result of such cutting of the head, the pile is
too short, the Contractor, shall, at his own cost, provide extension or
splicing of sufficient length of pile to restore the pile to its correct length.

- Piles should be driven to the minimum acceptable penetration shown on
the drawings. This may require pre-boring and / or jetting as detailed in
the relevant Clause of IS:2911 (Part I/ Section 3).

- Piles shall be driven to nominal refusal or the required ultimate dynamic
capacity specified on the drawings or until the top of the pile is at the
level required and specified on the drawing whichever gives the lowest
toe elevation. The Engineer’s decision in these matters shall be final.
Nominal refusal shall be taken as equivalent to 25mm total penetration
for the final 20 blows using a hammer of driving energy as specified and
shall be used as the criterion for acceptance for piles founded on rock.
Severe driving which results in an average set per blow of less than
0.5mm will not be permitted.

- Where hard drilling is encountered because of dense strata or
obstructions located above the predetermined pile tip level, nominal
refusal shall not be considered to have been achieved unless the
Engineer is satisfied that the total number of blows, required for
achieving the average driving resistance specified for nominal refusal, indicates that further driving will not advance the pile through the dense strata or obstructions.

- The pile shall be driven as accurately as possible to the vertical or to specified batter. Straining the pile into position can damage it and the driving equipment should be adjusted as much as possible to follow the position of the pile. Any deviation from the proper alignment shall be noted and promptly reported to the Engineer. If the deviation is to such an extent that the resulting eccentricity cannot be taken care of by strengthening the pile cap or pile ties, such a pile shall, at the discretion of the Engineer, be replaced or supplemented by an additional pile. If the indications are that a pile will finish outside the specified tolerances, driving operations on that pile will cease. The pile shall be withdrawn, the hole filled and the re-driven at no extra cost.

- Unless otherwise specified, the permissible positional deviation for piles shall be limited to those indicated as follows:

Tolerances for Installation of Piles
(MORTH Specifications 5th Revision)

a) Permissible Tolerances for Piles
i) Precast Concrete Piles
   a) Variation in cross-sectional dimensions : ± 5 mm
   b) Variation in Length : ± 25 mm
   c) Surface irregularities measured with : 5 mm
   d) Bow for total length of pile in mm : 1 mm/m length of pile limited to 20 mm

ii) Driven Piles & Bored Piles
   a) Variation in cross-sectional dimensions : +50mm, -10mm
   b) Variation from vertical from vertical piles : 1 in 150
   c) For vertical piles deviation at piling platform level : 75 mm
   d) Variation in level of top of piles : ± 25 mm

iii) Raker Piles
a) For raker piles from specified rake : 1 in 25

iv) Permissible Tolerances for Pile Caps

a) Variation in dimensions : + 50mm – 10mm
b) Misplacement from specified position in plan : 15mm
c) Surface irregularities measured with 3m straight edge : 5mm
d) Variation of levels at the top : ± 25mm

• When employing a tube which is subsequently withdrawn for the formation of cast-in-situ pile, consideration shall be given to the possibility of doing harm to a pile recently formed by driving the tube nearby before the concrete has sufficiently set. The danger of doing harm is greater in compact soils than loose soils. No pile shall be bored or driven within 3 m of a newly cast pile until at least 24 hours after completion of its installation.

• Driving piles in loose sand tends to compact the sand which in turn increases the skin friction. Therefore, driving a number of friction piles in a group shall proceed outward from the Centre as otherwise it will be difficult to drive the inner piles to the same depth as the others. In the case of stiff clay also, the driving for a group of piles shall proceed outward from the Centre. However, in case of very soft soil, the driving may proceed from outside to inside, so that the soil is restrained from flowing out during driving operations.

• If there is a major variation between the depth at which adjacent foundation piles in a group meet refusal, a boring shall be made nearby to ascertain the cause of this difference. If the boring shows that the soil contains pockets of highly compressive material below the level of the shorter pile, it will be necessary to enforce penetration of all the piles to a level below the bottom of the zone which shows such pockets.

16.8 Pile Tests

a) The bearing capacity of a single pile may be determined from test loading a pile. The load test on a concrete pile may not be carried out earlier than 28 days from the time of casting of the pile. The methodology of carrying out load tests and of arriving at safe load on piles shall conform to IS 2911 (Part IV)
b) There shall be two categories of tests on piles, namely, initial tests and routine tests. Initial tests should be carried out on test piles which are not to be incorporated in the work. Routine tests shall be carried out as a check on working piles. The number of initial and routine tests on piles shall be as determined by the Engineer depending upon the number of foundations span length, type of superstructure and uncertainties of founding strata. In any case, the initial load tests shall not be less than 2 in number, while the routine load tests shall not be less than 2 per cent of the total number of piles in the structure and nor less than 2 in number.

c) The above stipulations hold good for both vertical as well as lateral load tests on pile foundations. However, both initial and routine tests may be suitably increased for important structures or cases with large variation in the sub-surface strata.

d) In case of any doubt of workmanship or load carrying capacity of working piles not subjected to routine tests, or when ordered by the Engineer, or when provided in the Contract, load tests on working piles may be supplemented by non-destructive testing. Such tests may include “Integrity Testing” of concrete in the installed pile and utilization of “Pile Driving Analyzer” which gives an indication of pile capacity in end bearing and side friction.

16.9 Important Considerations, Inspection and Precautions for Bored Cast-In-Situ Piles

i. While concreting uncased piles, voids in concrete shall be avoided and sufficient head of concrete shall be maintained to prevent inflow of soil or water into the concrete. It is also necessary to take precautions during concreting to minimise the softening of the soil by excess water. Uncased cast-in-situ piles shall not be permitted where mudflow conditions exist.

ii. The drilling mud such as bentonite suspension shall be maintained at a level sufficiently above the surrounding ground water level to ensure the stability of the strata which is being penetrated all through the boring operation and until the pile has been concreted.

iii. Where bentonite suspension is used to maintain the stability of the bore-hole, it is essential that the properties of the material be carefully controlled at stages of mixing, circulating through the bore-hole and immediately before concrete is placed. It is advisable to limit:

a) The density of bentonite suspension to 1.05 g/cc and maintain it.

b) The marsh cone viscosity between 30 and 40

c) The pH value between 9.5 and 12

d) The silt content less than 1 per cent

e) The liquid limit of bentonite not less than 400 per cent
These aspects shall act as controlling factors for preventing contamination of bentonite slurry by clay and silt.

iv. The bores shall be washed by bentonite flushing to ensure clean bottom at two stages viz.

a) after completion of boring and

b) prior to concreting after placing of reinforcement cage.

Flushing of bentonite shall be done continuously with fresh bentonite slurry till the consistency of inflowing and outflowing slurry is similar.

v. Tremie of 150mm to 200mm diameter shall be used for concreting. The tremie should have uniform and smooth cross-section inside, and shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal. Other precautions to be taken while tremie concreting are:

a) The sides of the bore-hole have to be stable throughout

b) The tremie shall be water tight throughout its length and have a hopper attached at its head by a water tight connection.

c) The tremie pipe shall be large enough in relation to the size of aggregates. For 20mm aggregate the tremie pipe shall be of diameter not less than 150mm and for larger size aggregate tremie pipe of larger diameter is required.

d) The tremie pipe shall always be kept full of concrete and shall penetrate well into the concrete in the bore-hole with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

e) For very long or large diameter piles, use of retarding plasticizer in concrete is desirable.

vi. When working near existing structures, care shall be taken to avoid damage to such structures. IS 2974 (Part 1) may be used as a guide for studying qualitatively the effect of vibration on persons and structures.

vii. In case of deep excavations adjacent to piles, proper shoring or other suitable arrangement shall be made to guard against undesired lateral movement of soil.

viii. When lowering reinforcement in piles in electrified areas OHE block should be taken.
CHAPTER 17

STEEL COMPOSITE GIRDER FABRICATION

17.1 Relevant literature available on girder fabrication


b. Inspection of welded girders – Quality control dated 06.11.2012

c. BS-110 – Guidelines on fabrication of steel girders.

d. Inspection of steel girder bridges dated 01.10.2004

e. Guidelines for Quality control for ROBs with Composite Steel Girders dated 08.10.2012

f. Welded Bridge Code

g. As per Railway board guidelines dated 15.7.19, “fabrication and supply of all type of steel girder for ROBs of Zonal Railway PSUs, NHAI and other executing agencies, the tendering firm shall be from RDSO approved list of firms for Steel Bridge Girder. In case the tendering firm is not in the list of RDSO approved firms for Steel Bridge Girder, then he will have to get the Steel Girder manufactured through an RDSO approved firm in the RDSO approved premises only.”

17.2 Quality Assurance Plan

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Component/Operation</th>
<th>Characteristic Check</th>
<th>Type of Check</th>
<th>Documents</th>
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<td>Raw Material</td>
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</tr>
<tr>
<td>1</td>
<td>Steel Plates Structural Section</td>
<td>a) Identification &amp; correlation with mill test certificate from supplier</td>
<td>As per Mill TC</td>
<td>Challan, Mill Test Certificate</td>
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<tr>
<td>1.1</td>
<td>Steel Plates Structural Section</td>
<td>b) Physical Condition - Pitting, Rusting, Straightness, Rolling defects etc.</td>
<td>As per mill TC</td>
<td>Mill test certificate</td>
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<tr>
<td></td>
<td></td>
<td>c) Mechanical test - UTS, Yield stress elongation, % reduction area impact &amp; bend test.</td>
<td>Lab test at fabricator works shop &amp; manufacturer's Test Certificate</td>
<td>Challan, manufacturer's Test Certificate</td>
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<tr>
<td>1</td>
<td></td>
<td>d) Chemical Test Max C, Mn, Si, S, P, Cr, Cu, Co Equivalent</td>
<td>Independent Lab Test &amp; manufacturer test Certificate</td>
<td>Challan, manufacturer's Test Certificate</td>
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<tr>
<td>1</td>
<td></td>
<td>f) Dimensional Measurement</td>
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<td>Challan</td>
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<td>a) Dimensions as specifications</td>
<td>Visual / measurement any test as required</td>
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<td>c) Chemical Test - Min. &amp;Max. P/s</td>
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<td>Challan, manufacturer's Test Certificate</td>
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<td>Performance Test Tensile &amp; Bend</td>
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<td>Manufacturing Process</td>
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<td>Layout of Components &amp; Joints</td>
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<tr>
<td></td>
<td>Nominal</td>
<td>Dimensions</td>
<td>Measurement with steel tap and gauges</td>
<td>Approved Drawings</td>
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<td>Camber</td>
<td>Dimensions</td>
<td>Measurement with tested steel tap and gauges</td>
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<td></td>
<td>Master (Replica of Jig)</td>
<td>Dimensions intersection lines, pitch gauge, Dia of holes and no. of holes</td>
<td>Measurement with tested steel tap and gauges</td>
<td>Approved Drawings</td>
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<td>Jigs template and fixtures</td>
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<td>Dimension freedom from defects</td>
<td>Visual / measurement a</td>
<td>Inspection of Inspection Officials and fabricator records</td>
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### 2.3 Welding

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<td>NDT at all butt welds</td>
<td>USFD test</td>
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<td>c)</td>
<td>NDT of Critical fillet welds Web # flange</td>
<td>DP test</td>
<td>IS.3658</td>
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### 2.4 Drilling works for Bolting

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<td>Measurement</td>
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### 2.5 Painting work

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### 3.0 Shop assembling work

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<td>Approved drawings</td>
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<td>Welding and DT / NDT test at lab</td>
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<td>To have moisture free flux and electrodes</td>
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<td>Baking record for E-7018</td>
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### 4.0 Welding Operation

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<td>Measurement of Amperage and electrode</td>
<td>Visual with Ammeter and Voltmeter</td>
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<td>ii) Sequence of welding</td>
<td>To control distortions</td>
<td>Visual and Measurement</td>
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<td>c.</td>
<td>(iii) Electrodes</td>
<td>E-7018</td>
<td>TC/ Baking</td>
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#### 17.3 Welding

**A) Shielded Metal Arc Welding (SMAW)-Primary Members**

Requires solid / tubular (flux cored) electrode. The molten weld and the arc zone are protected from atmospheric contaminations by being "submerged" under a blanket of granular fusible flux comprising of lime, silica, manganese oxide, calcium fluoride and other compounds. When molten, the flux becomes conductive, and provides current path between the electrode and the work, prevents spatter and sparks suppresses UV radiation.

**Shielded metal Arc Welding (SMAW)-Primary Member**

- Automatic
- Semi-automatic
Handheld semi-automatic SAW guns can be also used.

a. **Welding head** – Feeds flux and filler material (electrode) to the welding joint (WJ)

b. **Flux hopper** – Stores flux and controls the rate of flux deposition on the WJ

c. **Flux** – The flux shields and protects the molten weld from atmospheric contamination may be of 3 types - Fused, Bonded, Mechanically Mixed type Consists of fluorides of calcium + Oxides of calcium, magnesium, silicon, aluminum, manganese

d. **Electrode** – SAW filler material is a mix (Thickness 1.6 mm to 6 mm) 4mm copper coated steel wire electrode in use 1.6 mm –

e. (150 – 350) Amp.

f. 3.2 mm – (250 – 800) Amp.

6.4 mm – (650 – 1350) Amp. being used at site 4 mm dia. Copper coated solid steel wire.

g. **SAW Welding Operation – Points of Check in the field**
   - Travel speed – 250 mm/minute (Most important variable affecting penetration & weld bead size)(+/− 15%)
   - Voltage – 30 Volts(+/− 7%)
• Current Rating – 575 Amp.(+/- 10%)
• Use extension piece at start and end of weld to achieve full weld size throughout the length.
• Very high speed, decreases penetration and increase tendencies for under-cut, arc blow, porosity.
• Very slow speed, produce bead shape that are subjected to cracking, excessive open arc exposure for the welding operator rough bead & slag inclusion.
• Electrode extension –
• Distance between contact tip to base metal
• 8 times the wire dia. i.e 8 X 4 = 32 mm

h. Equipments

• Welding gun & wire feed unit :
  • Control switch
  • Contact tip of copper and chemically treated
  • Power cable
  • Gas nozzle
  • Electrode conduit and liner
  • Gas hose
• Wire feed unit supply electrode to work
• Feed rate – 175 to 200 mm/minute

B) Gas Metal Arc Welding (GMAW)-Secondary members
Also known as metal inert gas (MIG) welding. An electric arc is formed between a consumable wire electrode and metal to be welded. CO₂ gas used as shielding gas fed through welded gun protects from contamination of air.

a. Power supply :
   • Constant voltage power supply – 30 V
   • Current Rating – 250 A
   • Constant voltage helps the welder to keep arc length constant as shorter arc length melts wire quickly & thereby restore original arc length.
   • DC supply used and electrode is positively charged.

b. Electrode:
   • Electrode selection is a key factor to ensure weld quality.
   • Electrodes available in 0.70 to 2.4 mm.
   • With above current rating 1.2 mm dia. of electrode being used (D & H India Ltd.)
### Performa for Welding Procedure Qualification Record

<table>
<thead>
<tr>
<th></th>
<th>Description of weld joints</th>
<th>Fillet weld</th>
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<td>Welding procedure specification no</td>
<td>ITE/NR/ dt-</td>
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<td>Name of welder</td>
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<td>4.</td>
<td>Date of preparation of test piece</td>
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</tr>
<tr>
<td>5.</td>
<td>Dimension of test piece</td>
<td>1000 x 300 x 40, 1000x300x14</td>
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<td>6.</td>
<td>Base Metal</td>
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<td>7.</td>
<td>Welding process</td>
<td>SAW</td>
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<td>8.</td>
<td>Welding position</td>
<td>1F</td>
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<td>9.</td>
<td>Welding Current</td>
<td>TYPE: DC, POLARITY: DCEP</td>
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<td>10.</td>
<td>Weld joint design detail:</td>
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<td>11.1</td>
<td>Welding consumables Electrode/wire</td>
<td>Class: ASW:A5.17:EL8 (W-1)</td>
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<td></td>
<td></td>
<td>Dia.: 4.0 mm</td>
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<td>Brand: D &amp; H</td>
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<td>11.2</td>
<td>Flux</td>
<td>Class: SFA 5.17/ AWS 5.17 (F-1)</td>
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<td></td>
<td></td>
<td>Dia.: Agglomerated</td>
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<td></td>
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<td>11.3</td>
<td>Shieding Gas</td>
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<td>Electrode Wire Dia. (mm)</td>
<td>Current (Amp)</td>
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<tr>
<td>1</td>
<td>2</td>
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13. Preheating and interpass temperature | NA

14. Result of Qualification Test

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A  Non-destructive tests:

- i) Visual examination: One Satisfactory
- ii) Dye Penetrant tests: One Satisfactory
- iii) Any other tests: NA NA

B  Destructive Tests:

- i) Macro examination: One Satisfactory
- ii) Fillet weld fracture test: One Satisfactory
- iii) Any other tests: NA NA

**d. TOLERANCES (Fabrication n Finishing)**

- Length: (+/- 2mm upto & including 12m span)
  (+/- 3.5mm over 12m span)
- Width: (+/- 3 mm)
- Depth: (+3 mm/-2mm)
- Metalizing and Painting as per IRS B-1, 2001
- Expansion Joints-Single Strip Seal Joint MOST Type (70 mm)
- POT-PTFE Bearings as per RDSO Dwg
- STUD Shear Connectors as per RDSO Dwg

17.4 Quality Assurance of composite construction using stud shear connectors:

Important consideration for quality assurance of stud shear connectors by automatic welding equipment in composite construction are discussed as under:
17.4.1 Material Quality Assurance:

Studs shall be made from steel conforming to ISO-13918. RDSO drawings have specified SD1 material to be used as per design. Quality of studs shall be assured as follows:

i) The stud supplier shall submit mill test certificate (Mill TC) regarding the steel supplied.

ii) Mass of studs shall be as per table A.4 of ISO-13918:2008 (E). For 25mm diameter shear connectors (SD) with different lengths, mass values in the table are as follows:

<table>
<thead>
<tr>
<th>Nominal length of stud*</th>
<th>Mass in grams(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>66</td>
</tr>
<tr>
<td>175</td>
<td>76</td>
</tr>
<tr>
<td>200</td>
<td>85</td>
</tr>
<tr>
<td>225</td>
<td>95</td>
</tr>
<tr>
<td>250</td>
<td>105</td>
</tr>
</tbody>
</table>

*It is the design value of the welded stud. The loose stud shall be longer than this. For special conditions, e.g. through-deck stud welding, length will be shorter.

\(^3\)Due to the tolerances, the values of mass are only approx. (specific weight = 7.85 kg/dm\(^3\))

iii) Tolerances in length: the length of loose studs shall be verified as per EN code provisions. For 25mm, 200mm long studs commonly used in RDSO drawings, the length of loose studs shall be 205.5mm, with the tolerance of +/- 1.5mm.

iv) Stud tip and Flux: The tip shape of the shear connector may be chosen by the manufacturer. The stud tip is supplied with flux in the form of a press fitted aluminium ball or aluminium spray coating.

17.4.2 Machine/Process Quality Assurance:

Welding machine qualification: any machine, whether running with transformer on three phase AC or single-phase AC or running with DC generator can be used provided its rated current output is adequate for welding the diameter of studs being provided. The welding machine setting for making of a weld shall be specified by the stud manufacturer.

Typical requirement of current for down hand welding for 25mm diameter studs used in design by RDSO is as follows:

<table>
<thead>
<tr>
<th>Diameter of Stud (in mm)</th>
<th>Current (in Amp)</th>
<th>Time (in Sec)</th>
<th>Cycle (In Nos)</th>
<th>Lift (in mm)</th>
<th>Plunge (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1900</td>
<td>1.4</td>
<td>85</td>
<td>0.125</td>
<td>0.250</td>
</tr>
</tbody>
</table>
17.4.3 Process Qualification:

The welding parameters and the welder shall be qualified. For initial qualification, minimum two studs of each type being used shall be welded on sample plates having similar properties to the girder part on which these studs are to be provided. The studs shall be welded in the same position as to be welded in the actual girder part. These studs shall be checked for quality as per sub para below. If these studs are not found satisfactory, the welding parameters shall be adjusted or the welder shall be further trained and sample studs provided again till welding is found satisfactory. After satisfactory qualification, certificates shall be issued by an officer of level Assistant Engineer or above, which shall be further governed as follows:

i) The qualification shall be valid for two years and after that the welder shall be qualified again by the following same procedures.

ii) For any new position/quality/size of stud, the parameters to be used are required to be qualified only once. This need not be re verified as long as the quality of studs is satisfactory in field.

17.4.4 Quality Assurance during Execution:

(Proforma for inspection of welded shear stud is given as Annexure-17.01).

To ensure proper quality of weld following aspects need attention:

1. Proper Position of Welding: As with normal welding, stud welding can be done in various positions like down hand, vertical, overhead etc. as shown in figure below.

![Diagram showing different welding positions](image)

2. Studs of all weld base configurations and diameters can be easily welded in the down hand position. In most applications on Indian Railways, it is possible to weld studs in down hand position. The vertical/over head positions cause an increase amount of welding sparks to fall during welding and suitable operator protection is needed. Special spark retention accessories available from the stud manufacturers deployed to control the weld sparks. Vertical and over heads welds require extra precautions and it is preferable that stud be welded in down hand position even by manipulating the members, if feasible and convenient. As a general rule, studs up to 3/4 inches (19mm) in diameter can be welded in a vertical position with consistent full-strength results. Special ceramic ferrules are used with studs 5/8 inches (16mm) and larger when welding to the vertical position of the plate.
3. Proper Weld Plate Cleanliness: For providing studs, the member surface shall be cleaned by light sand blasting or by scrapping with wire brushes such as to remove the mill scales. If grease or other contaminants are present, the surface shall be cleaned with solvents. The prepared surface shall not be painted or metallised in any way. Where studs are to be welded to steel surface already painted, the welds surface should be brushed, ground or scrapped to completely remove the paint from weld locations. It is not adequate to remove enough paint to make electrical contact and allow the weld arc to get started, since the thickness and volatility of the remaining paint may still have a serious adverse effect on the welds. The surface on which studs are to be welded shall be free from paints for a distance of minimum 50mm from the centre of any stud to be welded.

Earthing connections may be provided by screw type “C” clamps, fast action spring clamps, lever action hold down clamps mounted to the member being welded. The spot where clamp is provided for earthing should also be cleaned on both sides of the plate so that a good current path is established. Earthing spots can be cleaned very quickly with an abrasive wheel, wire brush etc.

4. Restrictions on Galvanising/Other Coatings on Studs: Zinc/paints etc. may contaminate the weld metallurgy. No galvanised/coated studs shall be used on Indian Railways. Good quality concrete or slabs shall provide the necessary protection to the studs.

5. Checking drawings: Before start of work, the drawings shall be checked to see if the same are okay. The following shall be verified:

i. Proper weld plate thickness: The setup requires checking the combination of stud/plates being used. To develop full steel tensile and shear capacity of the stud, plate thickness shall normally be at least 0.5 times the stud shank diameter. For welding plates thinner than this, extra care is required to be exercised in distortion control. For 25mm diameter studs normally used on Indian Railways, distortion will not be an issue for plates thicker than 12mm.

ii. Proper edge distance: Studs should be placed no closer to a base plate free edge than the stud diameter plus 1/8 inch (3mm) to the edge of the stud base. The distance should be at least 1 to 1.5 inch (25-38mm) from each free edge.

6. Selection of Stud Welding Operator: The stud welding operators are important to ensure timely and proper execution of work. Inexperienced welders are likely to spoil lots of welds, causing loss as well as delay in the project. The site engineer shall ensure that the welders being deputed for work are aware of the following:

i. Knowledge regarding general principles of the process, proper equipment setup, weld setup for the studs, general guidelines, and other literature.
ii. Knowledge regarding precautions to be taken during stud welding and

iii. Procedure for visual examination of welds done to determine if the same is satisfactory or requires further investigation.

iv. Possible reasons for the poor weld being done and remedies for the same.

7. Visual Inspection of Ferrules: The raw material inspection shall be done during supply. Even during execution of work, few studs shall be inspected randomly to ensure that:

i. Ferrules are not broken/damaged.

ii. Ferrules are dry.

iii. If Ferrules have been wet or have absorbed moisture, these can be dried by heating them to 250 ° F (121° C) until the moisture is gone. Only dry ferrules shall be used for work.

8. Action to be taken if proper weld is not achieved:

i. Machine Settings: After setting the plunge/lift and time/amperage as per recommendations, few trial welds shall be made to see if proper welds are being made. If any problems are noticed, the time and the amperage settings shall be adjusted.

ii. Proper Alignment: The machine shall be checked for proper alignment control by observing the moment of the chucks/studs before starting the work with the machine. This aspect may be seen if proper welds are not possible to be made with a particular machine despite using proper settings.

iii. Problems due to Grounding/Arc blow: A very important parameter which affects the weld quality is the uniformity of current around the stud. The welding arc is electromagnetically deflected towards the grounding point or towards the larger mass of the base plate configuration being welded.

Typically, the effect of this non uniformity is that there is a lack of fillet weld on the periphery of the stud opposite the direction of the arc blow. This can adversely affect welds strength and quality. In multiple rows of studs in a composite girder, the middle row often has excellent weld whereas the side rows exhibit problems due to arc blows.

To eliminate the problems associated with these effects, the following measures can be taken: Either a copper or a steel plate larger than the base plate to be welded, with a centre ground bolted to the bottom, can be provided temporarily below the base plate to increase the edge distance available. The bottom of this open box shall be properly
machined so as to have good contact with the base plate. This will provide path to current and eliminate the grounding/arc blow effects.

9. Inspection of Completed Weld: During welding, used ferrules shall be broken by hammering and the welds shall be inspected to ensure that the quality is good.

i. Visual Inspection of Shape of Weld: Visual inspection of the profile of weld collar is a very indicator of the quality of the entire process. Guidance may be taken from the illustrations and causes for getting these shapes tabulated below:
ii. Dimensions of Welds: The dimensions of 5% welds shall be measured and verified against the required dimensions. Typical dimensions with tolerance as per some RDSO drawings are as follows:

![Diagram of weld dimensions]

iii. The length of weld which is not fused properly or which has improper dimensions shall be noted. The weld collar is a butt weld.
and a slight variation in the height of collar are normal and don’t affect strength of the weld as long as the proper fusion of the stud with base metal is there. No action shall be required for these.

iv. Occasionally, isolated studs might have reduced collar width/porosity/lack of fusion. These defects shall be noted along with the length of weld affected. Any stud with cumulative weld defect length less than 10% of the circumference shall be considered acceptable and no action shall be taken.

v. Any stud with cumulative weld defect length within 10% and 20% of the circumference shall be considered repairable provided that clustering of such repaired studs does not exceed

a. 1 in 6 in end quarter span.

b. 1 in 3 in middle half span.

vi. If the defective weld clustering is more than above limits, the studs shall be considered not repairable. Any studs with cumulative weld defect length more than 20% shall also be considered as defective and not repairable. All defective/non repairable studs shall be replaced with good quality studs of same diameter/length.

vii. For repairing/replacing studs, paras 10,11 and 12 shall be referred.

viii. Verticality of Studs: Studs shall generally be vertical. If welded studs are inclined, process needs to be checked. Slightly inclined studs having good welds as described above shall be considered acceptable. But generally inclined studs will have problems of fusion etc. and the process might not be completed properly. The problem with machine that is leading to inclined studs will generally need to be addressed.

ix. Ring Test: 1 in 20 (5%) studs shall be tested by ring test. It involves striking the side of the head of the stud with a 2 kg hammer. A ringing tone achieved after striking indicates good fusion whereas dull tone indicates a lack of fusion.

x. Bend Test: 1 in 100 (1%) studs shall be tested by bend test. The test consists of bending the studs after they are allowed to cool, to an angle of approximately 60° from their original axis by either striking the studs with a hammer on the unwelded end or placing a pipe or other suitable hollow device over the stud and manually or mechanically bending the stud as shown in figure below. The bending shall be done in the direction opposite to any arc blow or visual imperfection in the weld. At temperature below 10°C, bending shall preferably be done by continuous slow application of load.
10. Repairs of Repairable Defective Studs: Studs identified to be 'repairable' as per para 9 (ii) points 2, and 3 above by the site engineers, then it shall be repaired by 6mm size fillet weld of good quality taking care in surface preparations and execution as per clause 26.6 of -IRS -B1(2001).

11. Remedy of Non-Repairable Defective Studs: Studs identified to be 'non repairable' as per para 9 (ii) point 4 above by the site engineer whether due to extent of defect or due to population of such defective welded studs, maybe allowed to remain as it is and equal numbers of additional studs of same quality shall be provided as near to defective studs as possible leaving at least 50mm gap between studs to ensure space for reinforcement and good quality concreting. If the defective studs are clustered together, or space for providing additional studs is not available then few studs may be cut by gas/saws. The studs shall be cut around 20mm from the base to ensure that the base material is not affected.

12. Rejection of Member: If the population of defective welds is excessive and providing additional studs and/or cutting of studs as specified above is not desirable from quality considerations, then the member shall be rejected.

17.5 Annexures:

<table>
<thead>
<tr>
<th>17.5 Annexures</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Annexure - 17.01 - Proforma for Quality Assurance for Inspection of Automatic Stud Welding</td>
</tr>
</tbody>
</table>
Annexure-17.01

Proforma for Quality Assurance for Inspection of Automatic Stud Welding

General Data

Name of Inspector: ____________________ Date of Inspection: ____________

Fabricating Agency: ____________________ Workshop: ____________________

Drg.No. __________ Span No. ______ No. of studs per span: ____________

Approved QAP No. __________ Dia of stud: __________ Length of stud: ____________

Inspection Results (If answer to any question is NO, then the process needs to be checked and inspection is to be repeated)

1. Studs Material Inspection Report Nos: ____________
   Satisfactory? Yes/No.

2. Ferrules Material Inspection Report Nos: ____________
   Satisfactory? Yes/No.

3. Name of machine operator: ____________ Date of qualification of operator by officer: Certificate No. ____________ Date ____________ (Not more than 2 years old Yes/No.)

4. Machine brand/serial no used or welding: ____________

5. Machine settings (As per approved QAP or approved qualification record):

<table>
<thead>
<tr>
<th>Current</th>
<th>Duration</th>
<th>Cycles</th>
<th>Lift</th>
<th>Plunge</th>
<th>Special settings, If any</th>
</tr>
</thead>
</table>

6. Surface preparation (100%):

   a) Is surface free from rust/mill scale etc.? Yes/No.
   b) Is surface free from grease/paints etc.? Yes/No.
   c) Is the surface being cleaned of weld splatter/broken ferrules during welding? Yes/No.

7. Visual Inspection of raw material (on random samples, ~2-4%) (Only summary to be given here, Separate register may be made for detailed record, if required)
a) Studs
   (i) Is surface free from paint, galvanizing, grease and moisture?  Yes/No.
   (ii) Is the flux intact at the tip of the stud?  Yes/No.
   (iii) Is the length of stud as per requirement?  Yes/No.

b) Ferrules:
   (i) Are ferrules broken?  Yes/No.
   (ii) Are the ferrules properly dry Yes/No (With over Drying/Without over Drying)

c) General Remarks on storage/handling of materials etc.

8  Ring Test (@5%): (Only summary to be given here, Separate register may be made for detailed record)

   No. of tests done Result: Nos. OK _____________ , Nos. NOT OK __________

9.  Bend Test (@1%): (Only summary to be given here, Separate register may be made for detailed record)

   No. of tests done Result: Nos. OK _____________ , Nos. NOT OK __________

10. Visual Inspection of completed weld (@100%): (Only summary to be given here, Separate register may be made for detailed record, if required)

    a) Is the surface of flash having a shiny blush hue?  Yes/No.
    b) No. of studs with good weld shape? _____________
    c) No. of studs with defects within acceptable limits _____________
    d) No. of studs with repairable defects _____________
    e) No. of studs defective/with not repairable defects _____________

11. Measurement of Welded Studs Height (@5%): (Only summary to be given here, Separate register may be made for detailed record, if required)

12. Is the members with studs acceptable?  Yes/No

13. Changes required in welding process in light of defects observed, if any _____________

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Repair of Defects (if possible)

a) Total Repairable Studs: Nos. _______________________

b) Date of repair: _______________________

c) Quality of repairs:  OK/ NOT OK

14. Replacement of Non Repairable studs (if possible)

a) No. of non-repairable studs: _______________________

b) No. of additional studs provided: _______________________

c) No. of studs cut: ________________________ nos.

d) Additional studs provided (with 50mm gap all around) __________ nos.

e) Quality of new studs:  OK/ NOT OK

*****
CHAPTER-18
MECHANISATION IN TRACK LINKING IN CONSTRUCTION PROJECTS BY USE OF NTC MACHINES, CRAWLER MOUNTED PORTAL CRANES AND TURNOUT LAYING MACHINES (T-28)

18.1 Synopsis

Indian Railways is expanding its infrastructure for higher speeds and increased axle loads. For this Indian Railways is going in a big way for doubling, tripling and quadrupling of existing lines, besides construction of new lines and gauge conversion. On DFCCIL, linking of entire track is being done using NTC (New Track Construction) Machines, which not only ensures fast track construction speed but also ensures best quality track. To meet the challenges of faster pace of construction on IR, NTC machines can be gainfully used in construction projects. In some of the world Railways, Crawler Mounted Portal Cranes are also being used for laying the new track with long rail panels. One of the systems being used is QUBO TL. This machine is a compact, small and versatile machine and can move on crawlers and can lay the new track at a competitive cost. T-28, Point and Crossing changing/laying machine can be used for yard remodeling works during BNI/NI period when there is space and time constraint. Its use will facilitate faster and quality construction. Continuous Track Lifter (CTL) may be used to do the initial lifts required behind track construction. After unloading the ballast on track, it can provide a 100+ mm lift at 3-5 km/h. Rail Threader can also be used for Rail laying/ TRR works. Details about these various machines will be helpful in familiarizing the field engineers about new methodology for fast track construction speed ensuring best quality of track.
18.2 PRESENT WORKING OF NTC MACHINES ON DFCCIL

Presently all track on DFCCIL in block sections are being laid with NTC Machines. In yards also all lines are being laid with these machines. Connections from one line to another line for machine movement is given by temporary laying false alignment or by cut and connection method. Turnouts in Main lines and other lines are laid later by cutting the track and placing the pre-assembled turnouts.

Details of working of this machine are enclosed as Annexure-18.01.

18.3 ADVANTAGES OF MECHANISED LAYING OF TRACK WITH NTC MACHINES

i) Best quality track with desired track parameters like sleepers spacing, squaring and alignment of track.

ii) Fast construction speed (Track linking of 1.5 km per day is possible).

iii) Directly 260 m long rail panels laid at site.

iv) Handling of new wider sleepers weighing about 350 kg will be easy.

v) No manual packing of track; No sleeper damage.

vi) Construction of Auxiliary track not required.

vii) Minimum requirement of skilled and unskilled manpower.

viii) No damage to prepared formation, sleepers and rails etc during carting to site.

ix) Less possibility of infringement of construction machinery with running track.

18.4 PRE-REQUISITES FOR NTC MACHINES:

i) Continuity of offered formation from one end to another.

ii) Requirement of space for depot working of about 500-600 m length and 50-60 m wide at a suitable place in between the project.

iii) Requirement of long stretches for laying the track from economy point of view.

More details of NTC machines are given in Annexure 18.01
### 18.5 Comparison of DFCCIL working and IR Construction Projects working

<table>
<thead>
<tr>
<th>S.N.</th>
<th>DFCCIL Projects working</th>
<th>IR Projects working</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Track linking is being done after completion of bridges and readiness of complete formation from one end.</td>
<td>At present track linking is done at many locations in parallel to bridge construction. <em>With NTC machines, track linking can be started only after completion of all bridges, ROBs/LHS and readiness of formation from one end.</em></td>
</tr>
<tr>
<td>2.</td>
<td>Large contracts having sufficient length giving enough scope for track work.</td>
<td>Generally, projects are opened in small lengths of 05-25 kms as they get ready. <em>So, requirement is of giving long stretch at a site and sufficient annual scope of work to the NTC machine.</em></td>
</tr>
<tr>
<td>3.</td>
<td>Fewer depots requirements as work being done in continuity</td>
<td>Since scope at a site at a time may be limited, hence one NTC machine will be required to cater more no. of projects sites. So more requirements of setting of depots.</td>
</tr>
<tr>
<td>4.</td>
<td>Longer lengths of Depots upto 2.5 kms as large length (100-200 kms) of project in DFCCIL is being tackled from one site.</td>
<td>Shorter length of depots upto 500-600 m length may be sufficient as less scope of work. So gantries, sleepers, rails and fittings can be reused while setting another depot.</td>
</tr>
<tr>
<td>5.</td>
<td>No shifting of NTC machines are required from one Project site to another Project site.</td>
<td>Frequent shifting of NTC machines will be required as work of 15-25 kms at a site can be finished in a period of 1-1.5 months.</td>
</tr>
<tr>
<td>6.</td>
<td>Least challenges of LCs as mostly ROBs are being built.</td>
<td>Large no. of LCs approx. after every 500 m. Shifting of lifting barrier in advance and other preparatory works will be required at each LCs in coordination with S&amp;T department.</td>
</tr>
</tbody>
</table>

### 18.6 Comparison of Manual and NTC working in Construction Projects

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Manual Linking of Track</th>
<th>NTC Working</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Preparation of ballast bed manually (200 mm ballast cushion)</td>
<td>Preparation of ballast bed manually (250 mm ballast cushion for final cushion of 350 mm)</td>
</tr>
</tbody>
</table>
2. Carting of sleepers and S/H rails at site by road. | Sleepers and Long rail panels are carted to base depot and carting to site not required
---|---
3. Linking with second hand rails, unloading of long rails panels at site and again TRR with new rail panels. | Track linked directly with 260 m long panels.
4. Manual 2 round of packing with lifting of track and 2-3 round of machine tamping for giving final cushion of 350 mm. | 3 round of machine tamping and lifting of track by machine to provide final cushion of 350 mm. No manual packing required.
5. Ballasting manually or through ballast DMT. | Ballasting through ballast hoppers.

### 18.7 Typical Analysis of Cost of working of NTC Machine

#### 18.7.1 Cost of setting of base depot:

Approx. cost of setting up a Base Depot is Rs. 6-8 Crores. But since Gantries, rails and sleepers and fittings from one base depot can be shifted to another base depot, so cost of each base depot is taken as 40 % of total cost of setting up a base depot.

**Hence cost of setting Base Depot has been taken as Rs. 3 Cr per depot.**

#### 18.7.2 Cost per year:

i) Approx. cost of one set of NTC machine with one rake: Rs. 40 Cr

ii) Annual interest on Rs. 40 Cr with 15 % market interest : Rs. 6 Cr

iii) Depreciation cost of Machine in one year = 40/15 : Rs.2.67 Cr  
(assuming life of machine as 15 years)

iv) Establishment expenditure including salaries of staff : Rs. 2.40 Cr  
(assuming roughly Rs.20 lakhs per month expenditure of about 30 staff at base depot and at site working)

v) Thus fixed charges per year = ii) + iii) + iv) : Rs. 11.07 Cr

vi) Assuming contactors profit of 15% = Rs. 11.07*0.15 : Rs. 1.65 Cr

vii) **Total fixed cost per year = v) + vi)** : Rs. 12.65 Cr
### Typical Analysis of Cost
(assuming 100 kms linking in a year by NTC Machine)

<table>
<thead>
<tr>
<th>SN</th>
<th>Item</th>
<th>UNIT</th>
<th>Qty.</th>
<th>Cost per depot in Cr.</th>
<th>Cost per 100 kms in Cr.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cost of setting of base depot</td>
<td>Nos.</td>
<td>2</td>
<td>3.0 (from 18.7.1 above)</td>
<td>6.00</td>
<td>Assuming 2 base depot for 100 kms linking</td>
</tr>
<tr>
<td>2.</td>
<td>Fixed cost per year</td>
<td>Lump-sum</td>
<td>12.65</td>
<td></td>
<td></td>
<td>from 18.7.2 above</td>
</tr>
<tr>
<td>3.</td>
<td>Cost of working including all consumables cost</td>
<td>Km</td>
<td>100</td>
<td>0.03</td>
<td>3.00</td>
<td>Assuming Rs. 0.03 Cr per km</td>
</tr>
<tr>
<td>4.</td>
<td>Cost of shifting of NTC machines from one depot to another</td>
<td>Shifting</td>
<td>4</td>
<td>0.25</td>
<td>1.00</td>
<td>Assuming 4 shifting of machines for 100 kms linking</td>
</tr>
<tr>
<td>5.</td>
<td>From above, Cost of 100 kms of linking with NTC Machine (Adding all the four above)</td>
<td></td>
<td></td>
<td><strong>22.65</strong></td>
<td></td>
<td>This excludes ballast bed making, Machine tamping, ballast profiling and other works</td>
</tr>
</tbody>
</table>

Therefore, Typical Cost per km of linking with NTC Machine is : Rs 0.2265 cr.

### Cost of corresponding items in manual linking per km

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Item</th>
<th>UNIT</th>
<th>Quantity</th>
<th>Cost in Cr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Cost of manual linking of track on service rails including carting of S/H rails and two manual packing.</td>
<td>Km</td>
<td>1</td>
<td>0.1281</td>
</tr>
<tr>
<td>2.</td>
<td>TRR cost with 20 rail panels</td>
<td>Km</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Picking up S/H rails and stacking</td>
<td>Km</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Thus, it is seen that there is cost difference in linking with NTC machine and manual linking is Rs. \((0.2265 - 0.1281) 0.0984\) Crs per km or Rs. 9.84 lakhs per km, say Rs. 10 lakhs per km.

But in view of added advantages of NTC Machines of better track quality, fast construction, no damage to heavier sleepers and 90 UTS rails, direct use of 20-rail panels and more safety at site etc, use of NTC machine in construction projects is to be preferred.

18.9 Crawler Mounted Portal Cranes:

18.9.1 In some of the world Railways, crawler mounted portal cranes are also being used for laying the new track with long rail panels. One of the systems being used is QUBO TL (a smaller version of the T-28 machine) designed and developed by M/s Ameca Engineering Srl, Italy. This machine is a compact, small and versatile machine and can move on crawlers and no auxiliary track is required for it. Hence, it can lay the new track in a mechanized manner in a competitive cost and it can also be used for track renewal in open line. This machine has high output of upto 1.0 kms per day for new track construction, based on material availability and site conditions. Salient features of this machine are enclosed as Annexure-18.02.

18.9.2 Cost comparison of NTC Machine working with Crawler Mounter Portal Cranes and Manual Working:

A typical comparison of per km cost of linking manually, with Crawler Mounter Portal Cranes and NTC Machines is summarized as under:
<table>
<thead>
<tr>
<th>S.N.</th>
<th>Type of linking</th>
<th>Cost of linking per 100 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Manual Linking</td>
<td>Rs. 12.81 Crore</td>
</tr>
<tr>
<td>2.</td>
<td>Linking with Crawler Mounted Portal Cranes</td>
<td>Rs. 16.25 Crore</td>
</tr>
<tr>
<td>3.</td>
<td>Linking with NTC Machine</td>
<td>Rs. 22.65 Crore</td>
</tr>
</tbody>
</table>

Thus, cost of linking with Crawler Mounted Portal Cranes is more than manual linking cost but quite lesser than cost of linking with NTC Machines.

18.9.3 Comparison of NTC working & Crawler Mounter Portal Cranes working:

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Item</th>
<th>NTC Machine</th>
<th>Portal Cranes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Per 100 KM Linking Cost</td>
<td>Rs. 22.65 Crore</td>
<td>Rs. 16.25 Crore</td>
</tr>
<tr>
<td>2.</td>
<td>Output per day</td>
<td>Upto 1.5 Kms</td>
<td>Upto 1.0 Kms</td>
</tr>
<tr>
<td>4.</td>
<td>Working in existing yard</td>
<td>Cannot be used in remodelling of existing yards in Doubling/Tripling etc.</td>
<td>Can be used in existing yards remodelling for isolated patch linking.</td>
</tr>
<tr>
<td>5.</td>
<td>Ease in shifting of machine</td>
<td>Need track connectivity for shifting and huge efforts required in dismantling and later assembling for shifting by road.</td>
<td>Easy to load in any rail or road vehicle and can clear any discontinuity by moving on crawlers.</td>
</tr>
<tr>
<td>6.</td>
<td>Scope in Doubling/Tripling/Quadrupling Projects</td>
<td>No scope in yard works. So can work in block sections only.</td>
<td>Can work in yards also partially other than working in block sections.</td>
</tr>
<tr>
<td>7.</td>
<td>Scope in Open Line</td>
<td>No scope as it is for new works only.</td>
<td>It can be used for CTR/TSR/TRR and TTR works in open line also.</td>
</tr>
</tbody>
</table>
18.9.4 So, Crawler Mounted Portal Cranes seems to be more useful for construction projects and can be used in small projects also. NTC machine has more scope in large construction projects.

18.10 T-28 Machine for laying of Points and Crossings:

T-28 is a point and crossing changing/laying machine manufactured by M/s Amecarof Italy. It consists of 2 nos, self-propelled Portal Cranes, 2sets of motorized/non-motorized rail trollies and one jib crane. The portal crane permits adjustment of span and height and can be worked on crawler chains.

At present it is widely being used in Open Line for Through Turnout Renewal works. But many zonal railways are using this machine for yard remodeling works during BNI/NI when there is space and time constraint. In this method, turnout is assembled outside the track at suitable location where there is enough space for linking of whole PSC turnout and during block period it is laid after dismantling the existing track. Its use will facilitate faster and quality construction as manual insertion is time consuming, more labour oriented and quality of work is also not good. At major junction yards where large no. of turnouts are to be laid in BNI/NI period, this machine can be effectively used.

Considering the time and space constraint, whole work of laying point and crossing by T-28 machine can be planned into two categories when new turnout to be inserted in running track:
(i) **Work to be executed before block:**

(a) New turnouts to be assembled with complete fittings at suitable location near the work site so as to avoid any infringement to other work.

(b) All required signalling work which can be done in assembled turnouts to be done.

(c) All required survey and measurements of geometry, marking of reference point like SRJ, ANC, etc. are marked at site at the location of laying new turnout.

(d) Approach track may be lifted with provision of proper ramp so as to provide matched profile.

(ii) **Work to be executed during block:**

(a) Existing turnouts/straight track to be dismantled.

(b) Ballast bed to be screened and levelled properly to accommodate extra dimensions of Fan-shaped PSC sleepers.

(c) Shifting of new turnout's assembly with portals and bringing it to near possible location where it has to be laid.

(d) After preparation of ballast bed, the whole assembly to be laid in position.

(e) Visible kinks, if any to be eliminated and ballast to put back and one round packing done.

(f) All measurements of the turnouts to be checked and rectified if disturbed during laying.

18.11 **Continuous Track Lifter:**

Continuous Track Lifter (CTL) completes the initial lifts required behind track construction, ballast cleaning, and track renewal operations. After the track is flooded with fresh ballast the CTL can provide a 100+ mm lift at 3-5 km/h. A chain drawn below the sleepers distributes the ballast across the sleeper beds and cribs. This low maintenance machine is typically towed behind the last ballast wagon to complete the initial lift immediately behind the ballast train.
This machine can be very useful for lifting the track after laying with NTC Machine or with Crawler Mounted Portal Crane to give required cushion otherwise ballast attrition takes place due to each round to extra machines tamping for raising the track for providing required ballast cushion.

18.12. Rail Threader

Rail Threader can be used in construction projects for lifting the long rail panels from either side of the track onto the sleepers and positioning them and laying
into the track. It can also remove old second-hand rails and renew it with new long rail panels. Rail Thresher of different makes like Geismar, Robel etc are available. It minimizes the operational costs as it is operated by a single worker. The machine can position up to 2 long welded rails simultaneously. It can also slew the alignment of track if track is unballasted. It is self-propelled and can off-track without additional lifting equipment.

It has lifting force of 4.5 T and output is 800 m per hour. Its weight is about 1100 kg. Travels by means of hydraulic engines which allow excellent rail laying output even in steep gradient or cant conditions.

18.13 Annexure

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<td>Annexure - 18.01 - DETAILS OF NTC MACHINE</td>
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<tr>
<td>(ii)</td>
<td>Annexure – 18.02 - SALIENT FEATURES OF THE CRAWLER MOUNTED PORTAL CRANE</td>
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</table>
DETAILS OF NTC MACHINE

1. Composition of NTC Machine rake is as under:
   1. Truss Beam
   2. Powered/Reception wagon
   3. 2 UT Machines
   4. Transition wagon with rail pullers
   5. Material Train (consisting of 22 converted flat wagons)
   6. 1 UTV machines at the rear.

1.1 Truss Beam
   i. It houses the ‘sleeper conveyor system’ and ‘sleeper laying work-head’ for laying the sleepers on prepared bed.
   ii. It also threads long rail panels onto the sleepers through a system of guide rollers.
   iii. Its one end is supported on Reception wagon running on newly constructed track and lead end on a crawler running on the prepared track bed. The crawler is used to steer the machine. Lead end is also fitted with trolley which is used for movement of machine at site.
1.2 Powered/ Reception wagon:
   i. One end of the Truss beam rests on Powered/ Reception wagon.
   ii. Engine, hydraulic and electric system are located on it.
   iii. It contains the start of the sleeper conveyor system.
   iv. All PSC sleepers are brought by gantries to this wagon and fed into the sleeper conveyor system.

1.3 Transition Wagon with Rail Pullers:
   i. It follows the Powered/ Reception wagon.
   ii. It is primarily for rail handling.
   iii. Rail Puller car with it pull the rails from sleeper wagons (rake behind it) and transition them to outside of reception wagon towards front side.
   iv. Either 20 rail panels or 10 rail panels are fed into the system.
1.4 Material Train (consisting of 22 converted flat wagons)

i. Each BFR carries:
   a. 12 long rail panels (260 m each) in one layer.
   b. 120 sleepers above rail panels in 3 layers.

ii. Thus, one rake carries 1.56 track kms of rail panels and 2640 sleepers along with fittings.

iii. Sleeper wagons are equipped with gantry rails along both sides to form continuous running rails on which 2 self-propelled gantries operate for feeding the sleepers from wagons to sleeper conveyer.
1.5 UTV Machines (3 Nos.)

3 UTV machines (2 between reception wagon and transition wagon and one in the back) are used for powering the rake during site working and during movement from depot to site and back.
2. **NTC Depot:**

i. A staging area / depot has to be created which is accessible from existing track. A temporary connection shall be established to enable the 260-meter-long rail panels to reach inside the staging area.

ii. The staging area should also be accessible by Road to allow easy delivery of sleepers / other track material.

iii. The area required for base depot shall be of minimum 500 m length and 50-60 m wide with min 3 nos. parallel tracks of about 500 m length each (One reception line, one dispatch line and one for misc activities) to allow for smooth loading, shunting, stabiling and maintenance of machines and wagons sets, with sufficient storage space between the tracks.

iv. Concrete platform between two tracks (having C/C distance as 10.60 m) for unloading and stacking 20 rail panels.

v. A set of 21 synchronized gantries with hoists for loading, unloading and stacking of 260 meter panels at Rail panel stacking area.

vi. Suitable space for stacking sleepers with enough space in between two sleeper stacks to allow Hydra crane/Forklifts to move as to facilitate loading.

vii. Covered space for small fittings, spare parts and Track material store.

viii. Stabling yard for the NTC, wagons, UTV’s, Surfacing Equipment’s.

ix. Proper illumination for working at night/Proper Drainage/Proper service roads.

x. Covered space and other facilities for resting of staff.
Rail and Sleepers loading in NTC Depot
3. **Sequence of working at site:**

   i. On prepared formation, ballast bed of 250 mm thickness is prepared before taking NTC machine to the site.
   
   ii. Centre line of the track is marked with piano wire and Chalk using GPS coordinates.
   
   iii. Panels of 260 m length (one on each side) are pulled by rail puller from the material wagons to the front side of the NTC Truss Beam.
   
   iv. Simultaneously, sleepers from material wagons to sleeper conveyer are carted through 2 self-propelled gantries. These gantries run on rails fixed along both sides of BFRs to form continuous running rails.
   
   v. The sleeper dropping mechanism of the NTC machine places one sleeper at a time with proper spacing and squaring.
   
   vi. The pre-distributed panels are threaded into the rail seats of the sleepers by the liner assembly of the NTC machine.
   
   vii. Then rubber pads, liners and ERCS are fixed manually.
   
   viii. 260 m long panels are fixed with 1 m long fish plates at the joints.
   
   ix. This process is continuous and repeated throughout the day. In a day, complete construction of approx 1.5 kms of track is done.
   
   x. After completion of linking work by NTC machine, further ballasting and packing with track machine
   
   xi. is done to ensure 350 mm ballast cushion. Proper ballast profile is made using ballast regulator machine.

4. **Laying of Track at special locations:**

   **A. Laying of track on level crossing:**

   i. Prior intimation will be given to local authorities and permission taken for closure of the L/C to enable laying track across the same.
   
   ii. The formation shall be prepared up to bottom layer of ballast spread and compacted and levelled.
   
   iii. Special sleepers will be laid in the same manner as main line track using the NTC. *Proper planning to be done in advance before approach of level crossing so that level crossing sleepers are fed at the right location only.*
   
   iv. Check rails shall be installed manually following the NTC.
   
   v. Ballast will be spread in between sleepers and interlocking concrete blocks laid for easy movement of vehicles manually.
   
   vi. Two lookout men shall be deputed on both side of level crossing for traffic control during the installation of level crossing.
B. Laying of track on bridges:
   i. Bridge sleepers will be loaded on designated wagons and laid at bridges in the same manner as main line track using the NTC.
   ii. Guard rails shall be installed manually following the NTC.

C. Laying of Turnouts / crossings:
   i. The NTC will lay straight / curved track.
   ii. Turnout will be assembled on the track side.
   iii. Straight track section will be cut and removed.
   iv. Assembled turnout will be inserted and connected.

Marking of center line of track by Piano wire and chalk
Pulling of rail panels with Rail Puller
Spreading of sleepers and fixing of rail panels

- The pre-distributed panels are threaded into the rail seats of the sleepers by the Liner Assembly of the NTC.
Annexure-18.02

SALIENT FEATURES OF THE CRAWLER MOUNTED PORTAL CRANE

1. Each unit has 20T load handling capacity and in twin system working it has capacity of upto 40 T load handling.
2. This machine allows picking and installing of up to 25 sleepers at the required distance with one machine.
3. It can unload 20/10 rail panel from rake and can align that at site and lay the panel on the sleepers. Can remove the existing rails from the track also for TRR work.
4. Can remove old turnouts and laying of the new turnout when used in sets of two synchronized units.
5. Can be transported on roads without special permits and vehicles. Can fits on any standard railway wagon without exceeding the maximum moving dimensions.
6. Can perform self-loading/unloading from the wagon (or any other transport vehicle). Once unloaded, the machine can easily move at the site without any auxiliary track as it is moving on crawlers.
7. Speed of crawlers (between 4-6 kmph) and speed on railway wheels (between 10-12 kmph).

Working at site:
1. Like NTC machine, rake of sleepers and rails (20/10 rail panels) will be loaded in the base depot and carted to site.
2. Ballast bed of 200-250 mm will be kept ready at site with marking the centre line of track in advance of rake arrival at the site.
3. Unloading of the sleepers at the site using the machine: Upon arrival at the site, the hydraulic arm of the machine can be used to pickupupto 25 packed sleepers from the wagons in one go and then carry them to the exact location at the site for laying. Once the centre line has been matched, the machine is lowered and then the clamps are opened automatically by the operator using the remote control and the sleepers are placed at the relevant location.
4. The objective should be to lay atleast 1 kms worth of sleepers in a single go, so that the rails of similar lengths can be carried on the trolleys.
5. Unloading of the rails at the site onto the sleepers: The bottom clamps of the machine would pull the rail out from the trolleys or wagons. Roller clamps would be installed to ensure smooth transfer of the long rails from the trolley to the site of work.
6. **Fixing of the track with the fittings:** This is done using a clip applicator to insert the clips and fasten the rail to the sleepers.

7. **Laying of the Turnout:** Even as a set of two synchronized units, these can be controlled by one single operator. One turnout can be split into two or three parts and can be laid by two QUBO TL machines working in tandem.

8. **Output of one Machine:** This machine has high output of upto 1.0 kms per day for new track construction, based on material availability and site conditions.
### List of officers who has updated, checked and edited ‘Handbook on Railway Construction’ Second Edition June 2020

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