Handbook

Rail Handling and Maintenance (R350HT)

Indian Railways Institute of Civil Engineering

Pune - 411001

Foreward

The axle load and speed of freight trains and speed of passenger trains has been increasing world over and Indian railways is no exception. Indian Railway has a mixed traffic with freight and passenger trains running on the same track. The axle load of freight trains was increased from 20.32 T in year 2006 to 25 T in year 2010 i.e. in a small span of 6 years. All this has an impact on rail, causing premature failures and impairing the safety of trains. Various grade and sections of Rails are in use on Indian Railways. In addition to single rail, the rails are welded as 10 rail panel (130m) and 20 rail panel (260m) in depots and plants and directly unloaded at the work site. Any carelessness in loading, unloading, handling and laying is liable to cause damage which will not only contribute towards bad running but also result in irreparable damage or incipient failures of rails. Indian Railway is now going for R350HT rail which is having minimum hardness of 350BHN as against 260BHN of the 90 UTS rails (880MPa and R260). More care is required in handling such hard rails which has relatively less ductility.

This handbook is based on RDSO specification of flat bottom Rail (IRST-12-2009) and RDSO report on “Guidelines on Handling and Stacking of Rail” issued by CT-35 report of February-2023. To make it useful for field officials, photographs depicting correct and wrong method of handling has been extensively used. This handbook, prepared by Shri Satya Prakash, Dean, Shri Anil Choudhary, Sr Professor/TM and Shri Supragya Tiwari/SI/Track-7, IRICEN, aims to serve and be a valuable resource for field officials, providing them with helpful insights and information.

Any suggestion for improvement is most welcome.

R.K Yadav

Director General

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Introduction

- Rails that are being used on Indian Railways and their important properties are tabulated below (Ref: IRS-T-12 -2009):

Table 1.1 Different grades of rail

Grade	UTS (kg/mm^2) Min.	Hardness (BHN) Min.	Elongation (%) min.	Toughness (MPa√m)
880 Mpa	90	260	10	29
1080 HH	110	260	10	32
R260	90	260	10	29
R350HT	120	350 (head)	9 (head)	32

- While R350HT rail has less ductility and thus more susceptible to initiation of surface crack due to bending/kink etc., the higher fracture toughness resists the propagation of flaws under an applied stress.

Figure 1.1 : Critical Points; Edge of Rail foot and Head bottom

- Any damage/deformation at the edge of the rail foot has been found to create point of stress concentration leading to premature rail failure. In addition, dent at bottom of rail head can also become critical. (Fig 1.1)
- Normally these damages are caused due to metal-to-metal rubbing & impact during handling and transportation. However, it may occur during service also.
- P. Way officials at all levels must understand the precautions to be taken during unloading and handling of rails to prevent premature or sudden failure.

General Precautions during Handling

A. Ensuring straightness of rail:

- Straightness: Offset of rails of 0.75 mm over 1.5 m makes the rail unacceptable.

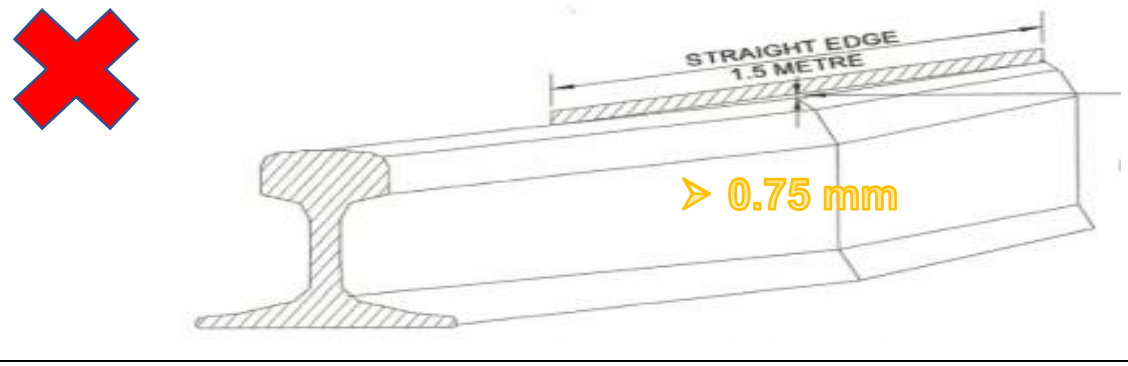

Fig 2.1: Straightness of rail, offset >0.75 mm on 1.5 m not allowed

- Rails should not be subject to heavy static loading or sudden impact.
- Excessive rail end overhang is not allowed while loading/unloading of rails.

Fig 2.2: Excessive overhangs are not allowed.

- When stacking rails, avoid localized point or line contact loading and crisscross stacking.

Fig 2.3: Stacking creating localised point and line contact.

- Rail should be kept horizontal and straight during lifting and transportation.
- Rail ends to be protected against damages due to impact. Wooden shoes may be provided.
- Overlapping of flange in unloaded rail should be avoided.

Fig 2.4: Stacking of rails without overlapping flange

B. Protection of rail surface:

- A notch as small as of size 0.25 mm can cause rail failure.

Figure 2.5 : Notch of 0.25 mm can cause failure.

- Electromagnetic lifting devices should be used for lifting of rails in workshop and manufacturing plant.

Figure 2.6: Electro-magnetic lifting device for lifting of rails in work shop.

- Any rail support, handling, or clamping device (like rail tongue) and rail rollers should not apply localized or point contact to the rail and must not have sharp edges.

Figure 2.7 : Rail dolly for carrying rail

Fig 2.8 : localised point contact by crow bar

- Do not use rail as Anvil and refrain hammering it.

Fig 2.9 : Hammering of Rail

- Flat Link chains (not Rounded) fitted with fabric sleeves can be used for lifting rails.
- The profile of rail support, handling and clamping device should be contoured to rail profile.

Figure 2.10 : Properly profiled Rail Tongue for lifting Rail

- Avoid any light scoring or abrasion of rails, as it can be extremely dangerous.
- Avoid impact or abrasion of rails and rail bundles against structures, buildings wagons and vehicles.

C. Prevention of metallurgical damage to rails:

Rails are sensitive to heat and can develop metallurgical defects if exposed to localized heating. Localised heating produces extremely hard and brittle metallurgical structure which may lead to sudden failure. Therefore,

- No work involving heating, flame cutting, or spot welding should be done on or next to the rails.
- Rail should not be in contact with molten splashes from adjacent welding or cutting operations.

Figure 2. 11 : Gas cutting splashing molten metal on other rails

- Rail should not meet loose electric cables producing arcs.

D. Protection from contact of injurious substances :

- Rails are sensitive to corrosion and pitting due to contact with harmful substances like acids, salts, and fertilizers. Such contact should be avoided to prevent rail fracture.

Fig 2.12 : Corrosion of Rails

Fig 2.13 : Corrosion and Pitting due to harmful substances

- Rails should not be unloaded in areas near open dumping grounds and sewerage, as well as in goods yards where fertilizers are often stored.

Figure 2.14: Rail stacked in cutting with logging problem and vegetation.

E. Protection to staff:

- Staff must use protective gloves and clothing to minimize the risk of skin abrasion, cut/tear of skin, and extremes of temperature.

Fig 2.15 : Protective clothing but without protective gloves

- Handling of rails shall be done using proper tools and equipment.
- Staff must wear distinctive coloured helmets and clothing for easy identification by cranes and other machine operators to avoid accidents.

Fig 2.16 : Protective wear for staff

- Staff shall use steel toe-capped protective footwear.
- Staff shall be professionally trained and cautioned to avoid standing under suspended loads, sudden dropping, and impact of rails.
- Safe working in the vicinity of electrical conductors and cables shall be ensured.
- Rails should never be carried by staff on the head or shoulder.
- Necessary precautions for working at heights need to be taken.

Bulk storage locations

These locations include Manufacturing plants and Flash Butt welding plants. Following should be ensured to prevent rail damage:

A. Stacking of rails-

- Level and well drained base platform with unserviceable 90R or 52 kg rails embedded upside down at 4.0 m intermediate distance in concrete bed of M 20 as shown below.

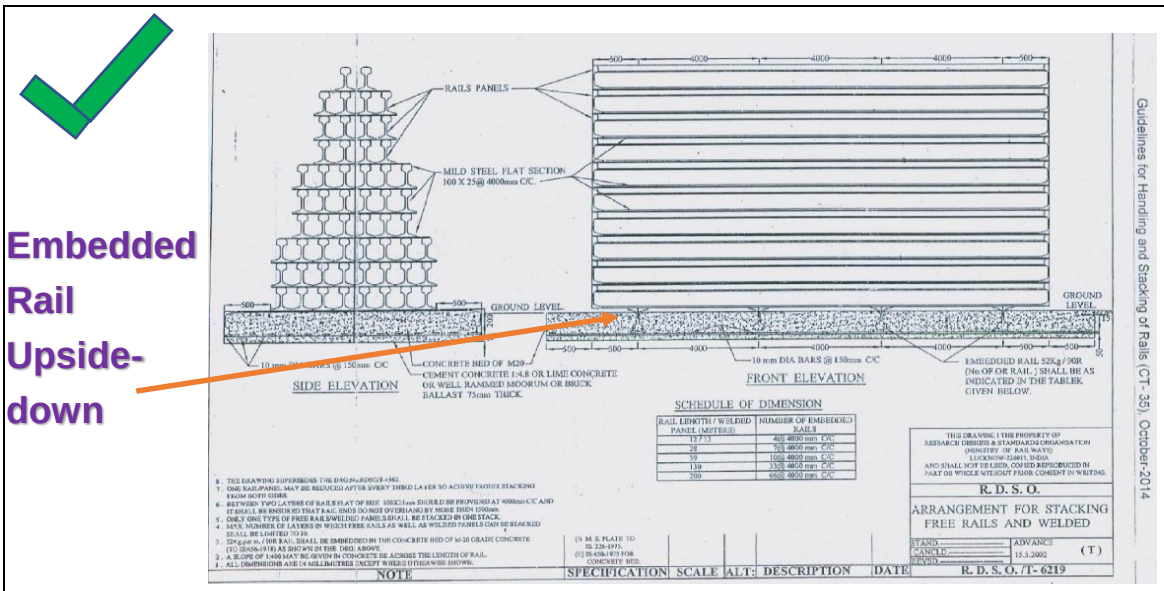

Fig 3.1 : Bulk stacking of free rails and welded panels

- Rail flange should project above concrete surface.
- Slope 1:400 for drainage along the rail
- MS flats 100x25 mm between two layers @ 4 m c/c.
- Number of layers in a stack NOT MORE THAN 10.
- One rail panel should be reduced every three layers.

Fig 3.2 : MS flat between rail missing

B. Handling of rails :

- Lifting of rails should preferably done through magnetic chucks in workshop.

Figure 3.3 Magnetic Chucks for lifting steel

In sections:-

- Synchronised electric hoist and spread beams can also be used.

Fig 3.4 : Spread Beam for Rail Lifting

- The overhang part of rail beyond lifting point should not be > ½ x distance bet two adjacent lifting pts.

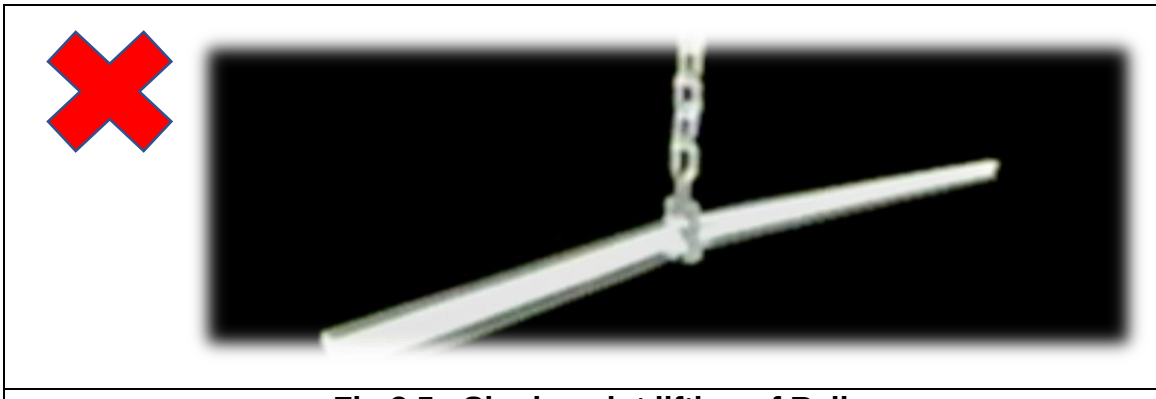

Fig 3.5 : Single point lifting of Rail

- The recommended locations of lifting points for various rail lengths shall be as per given below.

Table 3.1 Rail overhang distance

Rail length (m)	No. of lifting points	Distance between two adjacent lifting points (m)	Max. rail end overhang (m)
12-13	2	6-6.5	3-3.25
26	4	6.5	3.25
39	6	6.5	3.25
130	20	6.5	3.25
260	40	6.5	3.25

Fig 3.6 : Lifting Location for 6.5 m Rail

Loading of single rails /three rail panels on wagon

A. Suitable Wagon:

- Should be fit to run.
- Should have Minimum three bolsters/cross beams one at centre and others at max 5.0 m inter-distance.
- Both end bulkhead should be available

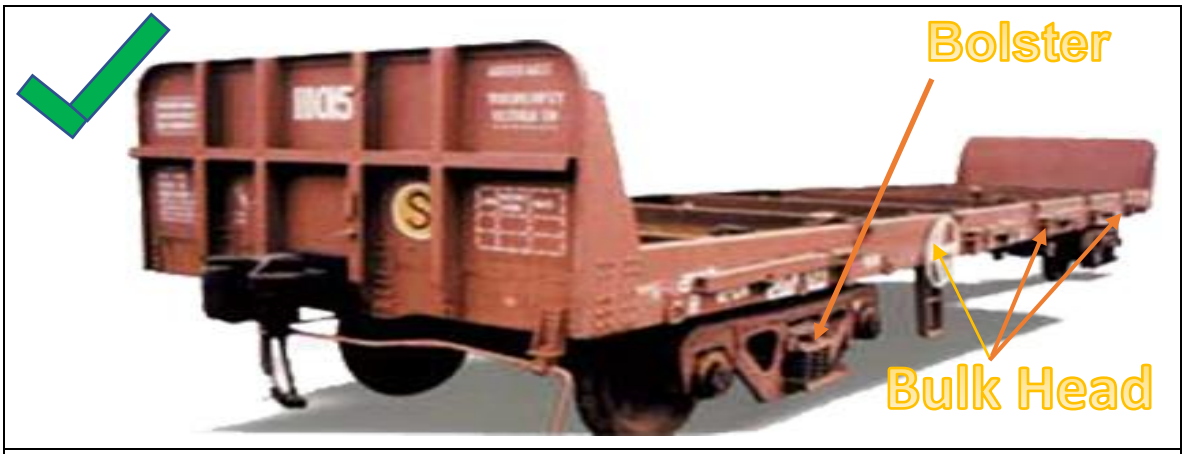

Fig 4.1 : wagon for carrying Single Rail

B. Rail Loading :

- Rails should have equal overhang at each end beyond end bolster.
- MS flat spacers 100x25 between two layers @ 4.0 m.
- Shorter rails should be placed in upper layers.
- Loaded rails should be tightened by MS strips.
- A non-metallic material, such as cardboard, should be placed between the rails and strip to prevent abrasion/corrosion.
- Rails should be loaded by Utility vehicle with proper holding arrangements and overhangs within limits specified.

Fig 4.2: Loaded Rails tied together.

C. Rail (single rail) unloading from wagon :

- Rail should not be subjected to any impact during unloading. For this it should be delicately unloaded by crane in UTV. The holding position should be such that overhang is within the limit specified.

Fig 4.3: Unloading by UTV with lifting at centre

In emergency if required to be unloaded without UTV then,

- Two or more ramps should be made in the middle of BFR (max dist. 6.5 m).

Fig 4.4 : Rail ramp for unloading of rail

- Use gunny bags at bottom to reduce impact.
- Proper greasing on top surface of ramps for lubrication and easy sliding of rails downwards.
- 2-3 Rail tongue should be used in middle and rail should be placed on ramp with both ends tied by manila rope. Rail to be slid slowly by releasing rope.

Fig 4.5: Manila rope being tied to rail being unloaded.

Loading and unloading of Long Rail Panels

The rail sections welded as ten rail panel (130m) to twenty rail panel (260m) are loaded in plant in End Unloading rakes (EURs) and unloaded at the work site. Following procedure and precautions be taken to prevent any damage to rail in loading and unloading.

A. Formation of Long Welded Rail loaded EURs rakes :

The formation will consist of following –

- Eighteen BRHs/BRNs/BRN-A/BRNAHS (modified) for loading of 10/20 Long Rail panel.

Fig 5.1: EUR rake with 20 Rail panel

- Ensure proper End Unloading Rake with valid speed certificate before loading rails.
- On each wagon rails are supported at three locations, two at end and one at centre.

Fig 5.2: Three supports with rollers in between rails and Bulkhead with flap door

- Twelve rails are placed on freely rotating rollers in five layers i.e., sixty rail panels can be transported (Few old rakes can load up to four layers i.e., forty-eight panels)
- The first and the eighteenth wagon is called Bulkhead wagon and is the end wagon with flap door for each five layer which prevents rails from sliding during transportation. The flap doors are opened during unloading.
- At the unloading end, changed three empty BRHs/BRNs/BRNA/BRNAHS called threader wagon with adjustable ramper, ramp wagon and chute wagon are provided. This needs to be attached for the purpose of unloading only and should be in the sequence shown with chute wagon being the unloading end wagon.

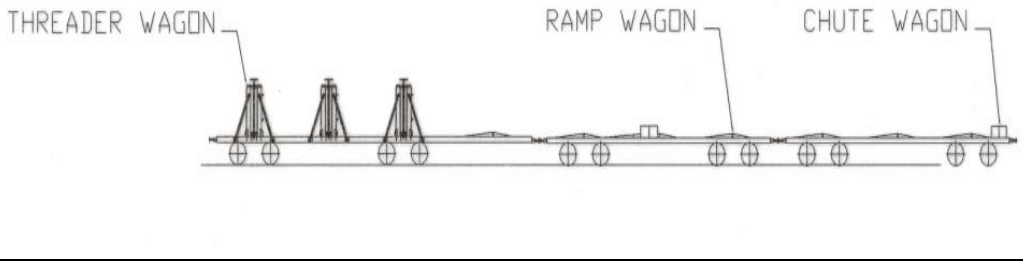

Fig 5.3 : Threader, Ramp and Chute wagon at the unloading end

- A covered wagon/Coach for carrying materials, tools & men should also be part of composition as shown below. The wagon should be either detached during unloading or should be attached on other than unloading end.
- The rake will run as one complete rake and no wagon should be detached enroute. In case of any wagon being marked sick enroute, whole rake should be considered as sick and should be attended on priority.
- Brake van be attached in rear except while going ahead for unloading purpose.

B. Loading of long rail panels in End Unloading Rakes (EURs) :

- Use multiple slinging arrangement with a maximum inter-distance of 6.5 m to lift rails for loading in EUR rakes.

Fig 5.4: 20 RP being loaded on EUR rake

- Load shorter length panels in pairs on the same tier, equidistant from the centre for synchronized unloading.

C. Precautions while on run/movement of EUR :

- No loose shunting or sudden brake applications allowed.
- Ensure proper closure of bulkhead doors and positioning of rail stoppers during motion.
- EUR rake must not run backward or forward with open bulkhead doors, except during unloading in a block.
- Panels should not be pulled into ramper and threader wagons prematurely.
- Fix chain hooks for bottom panel layers on-site to avoid entanglement with coupling assembly.
- Avoid movement of 20 Rail Panel rakes on second and subsequent loops to prevent derailments.
- Staff should travel only in 8-wheeler staff coach/covered wagon during EUR movement.
- Follow 30 kmph speed restriction on gradients steeper than 1 in 80.
- Restrict EUR speed to 15 kmph when passing through platform lines and negotiating turnouts.

D. Unloading of long rail panels from EURs :

- Current rails have bolt holes at both ends, but future rails will be supplied without holes.
- The unloading system covered here is for rails with holes.
- The first pair of rail panels to be unloaded should be tied with manila rope using HTS bolts through rail holes.

Figure 5.5: First Rail tied to track through chute

- Tie the other end of the manila rope to the track/fixed structure, passing it through the arrangement in ramper, threader, and guiding chute.
- Adjust the height of rampers for smooth unloading, decreasing towards the end of the wagon.

Figure 5.6: The adjustable ramp in threader wagon

- Connect a wire sling with loops at both ends (around 2 m) at the unloading end of each rail, except the first pair.
- Attach the wire sling to the rail using a U-clamp type clamp with a bolt and nut.

Fig 5.7: Long wire rope at unloading end of each rail.

- Carefully move the rake for rail unloading, as the rail is held in position and gets unloaded.
- Connect the next and subsequent pairs of rails to be unloaded using pre-provided slings to the back end of the rail being unloaded.
- Stop the rake each time to establish this connection.

Figure 5.8: The next rail being connected after stopping the rake.

E. Position of unloaded Long Welded Rail :

- The unloaded rails should be unloaded within the running rails as far as possible and kept vertical.

Fig 5.10: 20RP Unloaded in between running rail

Fig 5.11: Wooden block provided at end

- Before unloading rails between rails, it should be ensured that crib ballast is levelled and does not rise above sleeper.
- The end of rail to be provided with wooden block to prevent any hanging part from entangling with rail.

F. Precautions during unloading of Long Welded Rails from EUR rakes :

- Unload rails in pairs during traffic blocks, maintaining equidistance from the center line.
- Start unloading from the top layer panels, opening bulkhead flap doors only for the targeted layer.

Fig 5.12: Two Layer Flap door opened for unloading Rail

- Securely close and lock flap doors of layers not being unloaded before moving the rake. In the above photo, the fourth layer flap door to be closed.
- Use tested slings and HTS bolts for all connections during unloading.
- Operate the rake at a maximum speed of 15 kmph, with the ability to immediately stop in unsafe situations.
- Never move the EUR rake backward during unloading.
- Unload only at locations with a vertical clearance of at least 4500 mm from ground level to fixed structures.
- Avoid unloading in platform areas and on ballast-less open web girder bridges.
- Minimize the use of turnouts and crossovers during unloading.
- If unloading at night, provide sufficient lighting for safety.
- Ensure staff safety during longer rail unloading from EUR rakes:
  - ❖ Staff should travel in a tool van or separate wagon, not on BFRs.
  - ❖ Staff should not be on ramper/threader while the rake is moving for non-block activity.
  - ❖ Staff should not stand between bulkhead doors and panels while the rake is in motion.
  - ❖ Standing on threader, ramp, and chute wagons during unloading is prohibited to avoid injury from sling or swinging rail.

Figure 5.13: Men on threader wagon

- As an alternative, the Auto Rail Panel Linker discussed in Annexure-I may be used.

Placement of single rails and welded rails

- Unload new single rails on one side of the track leaving the other side free for stacking released rails.
- If placed on cess, place rails away from the toe of the ballast profile.
- Keep rails straight or give a smooth curvature to cross any obstruction.
- On multiple line section, the rails should be kept in between rails on running track or between tracks on wooden gutka to avoid any kink formation.

Fig 6.1: Rails supported on wooden block

- Avoid unloading rails on top of each other to prevent bending.
- Spread rails evenly along their entire length on closely spaced supports to prevent kinks.
- Place rails with head in the upward direction and support them at least four points. Also, the support should not be at more than 4 m distance.

Fig 6.2 : Rails placed on cess in vertical position and supported @ 4m, spreader

- Ensure that signaling bonds are not disturbed while placing rails.
- Handle rails carefully to prevent contact with both rails of the track to prevent track circuit failures in track circuited territory.

Special precautions for handling R350 HT

All the above instructions shall apply to all high strength rails i.e., 880 MPa, R260 and R350HT rails. Special precautions for R350Ht rails are

- It should not be straightened by Jim-crowing.
- The head of R350HT rail due to heat treatment are thermally more sensitive and thus should not get exposed to any local heating due to rail cutting or welding nearby.
- It is more prone to corrosion and need extra precautions while stacking the rail at certain locations

Fig 7.1 : Using Jim Crow on High Strength Rail

Other Precautions

A. Lubrication :

- The effective reduction of wear on the outer rail of curves can be achieved by lubricating the gauge face, maintaining correct curve geometry and Super-elevation, providing suitable checkrails, and providing slack gauge PSC sleeper as per RDSO drawings based on track curvature.
- On routes where rail grinding is not being done Automatic Gauge Face Lubricators should be installed on curves with a radius of 875 meters (2°) or sharper.
- On routes where rail grinding is done, Automatic Gauge Face Lubricators should be installed on curves with a radius of 1400 meters (1.25°) or Sharper.
- Lubrication should be applied to both new and old rails that are free from Gauge Corner Cracking or head checks.

B. Welding :

Manual for Fusion Welding of Rails by the Alumino-Thermic Process and **Manual for Fusion Welding of Rails by the Alumino-Thermic Process,** issued by RDSO should be followed for getting good weld.

C. Grinding :

- Rail grinding effectively eliminates surface defects, irregularities, and controls rail wear, thereby preventing damage to both wheels and rails, while significantly prolonging the life of the rail.
- For 880 MPa & R260 rails, the grind frequency to be followed in Indian Railway in routes selected is tabulated below:

Cumulative GMT in the section from start of grinding	Cycle #	Track Classification			
		Tangent (Straight) Track	Mild Curves	Sharp Curves	Test Sites
0	Grind 1	Single Pass at 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile
25 (Approx)	Grind 2	Single Pass at 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile and RCF
75 (Approx)	Grind 3	Single Pass at 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile and RCF
125 & so on (Approx)	Grind 4 & so on	Single Pass at 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile and RCF

- Grinding Strategy for 880 MPa & R260 rails.

  Tangent track: Implement a single pass Preventive-Gradual grinding strategy without prior rail surface cleaning for cost-effective preventive grinding.

  Curves: Utilize a 3 pass corrective grinding strategy for curves with deep rail flaws, followed by a shift to a single pass Preventive grinding approach for effective maintenance.

- For 350 HT rails, which are harder and stronger than 880MPa and R260, grinding becomes even more crucial; however, the grinding strategy, i.e. the intervals will be decided in due course.

D. Checking Rail Before Laying:

Rails must be inspected visually for any dent/rubbing marks on the edge of rail foot. Such rails shall be placed on the track only after removal of damaged part.

E. Handling Rail in Electrified Section:

Fig 8.1: Electrified section

- Do not touch fallen wires unless the power has been switched off and the wire has been properly grounded.
- Loading and unloading of rails must be done under the supervision of an Engineering official not below the rank of SSE/PWay.
- Workers and their tools should not come within 2m of the overhead electrical wires.
- Rails should not touch each other to form a continuous metallic structure of more than 300m.

Annexure-I

Auto Rail Panel Linker

The Auto Rail Panel Linker is an item developed and designed to automatically connect two long Rail Panels during unloading without any human involvement.

It consists of two components:

- **Linking Blocks:** This is to be fixed at the end of rail panels except first rail.

Fig A1 : Linking Block

- **Linking U-clamps:** This consists of two U-clamps with neck provided at end for sliding over Rail head, connected by a chain through connector.

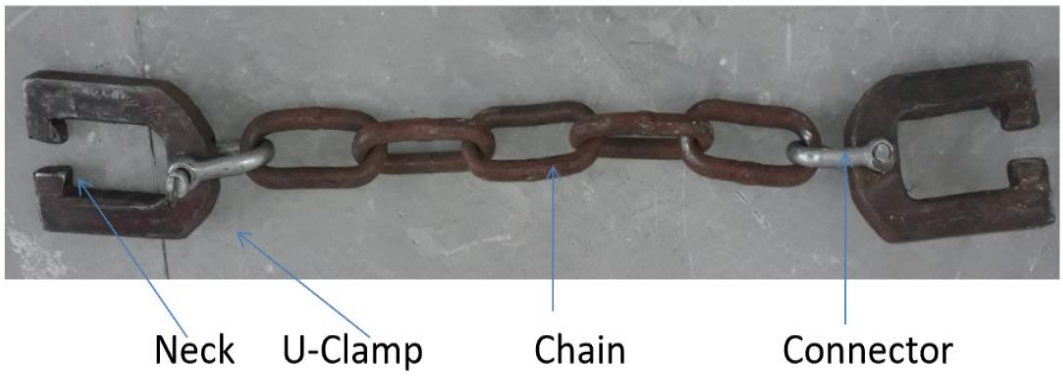

Fig A2 : Linking U-clamps

- First rail as in existing system is unloaded by connecting the rail to track by wire rope.

- The Auto Rail Panel Linker is placed in advance (in yard) as shown below.

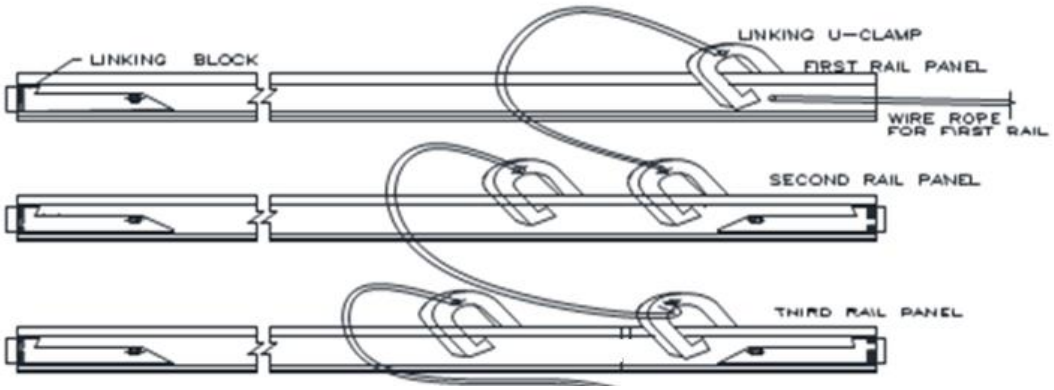

Fig A3 : Rails interlinked using U-clamps and Linking Block

- Unloading is done in pairs.
- As the rake moves, the unloading of the first pair of rail starts.
- The U-Clamp slides over the rail head getting unloaded.

Fig A4 : Automatic linking of left rail and sliding over right rail

- As the first rail end crosses the front end of the next rail to be unloaded, the U-clamp connects the two linking blocks of unloading rail and next rail as shown below.

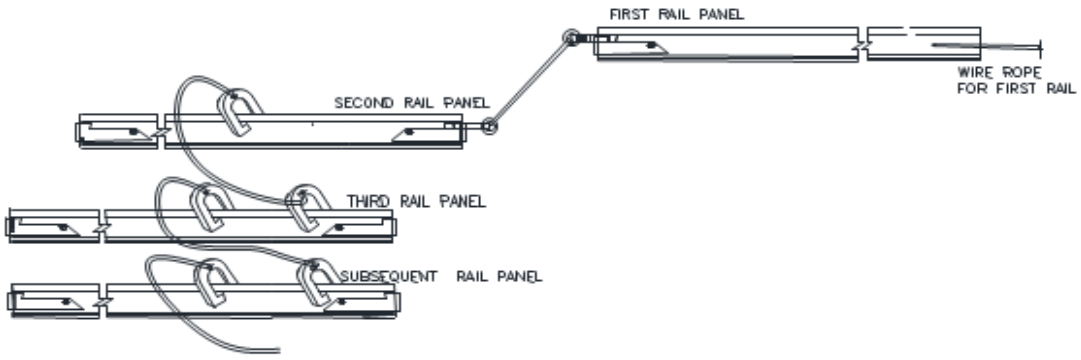

Fig A5 : Automatic linking of two rails being unloaded

- The later rails get linked as the rake moves further.
- The drawings of the linking block and U-Clamp is given below and should be followed else the U clamp may get entangled at the FB joint of rail getting unloaded and drag the next rail before the first rail gets unloaded:

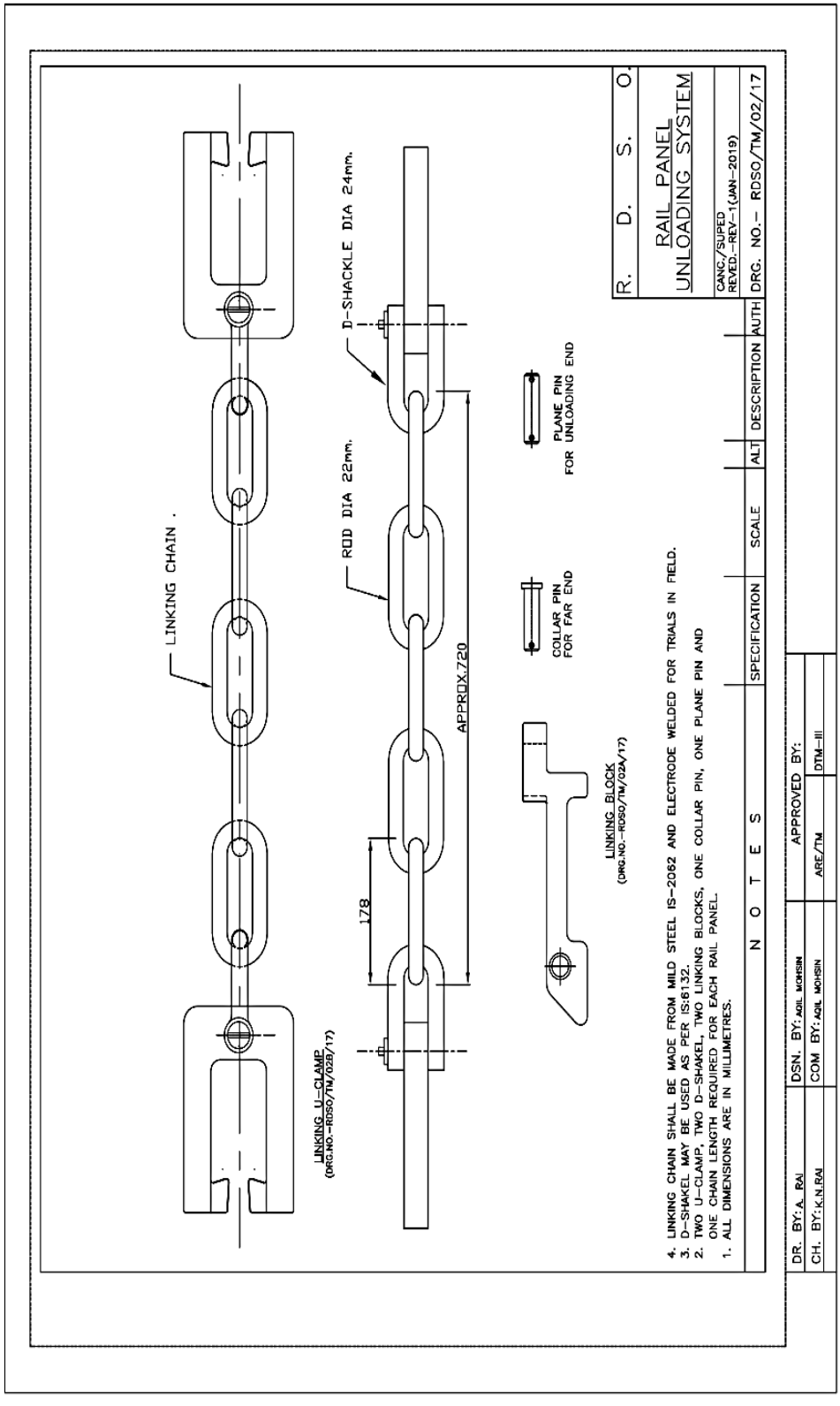

Fig A6 : The assembly drawing

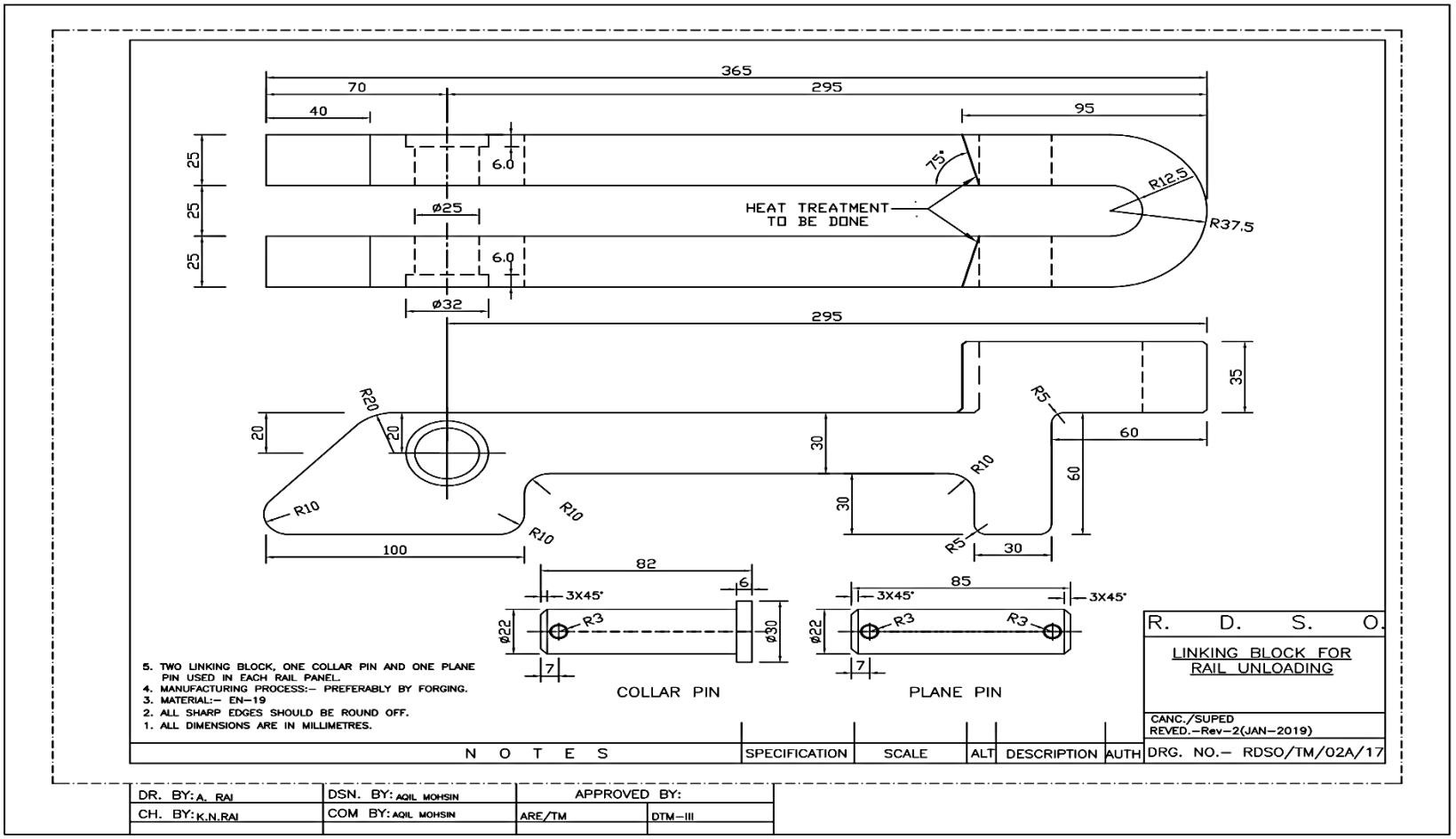

Fig A7 : Dimension of Linking block

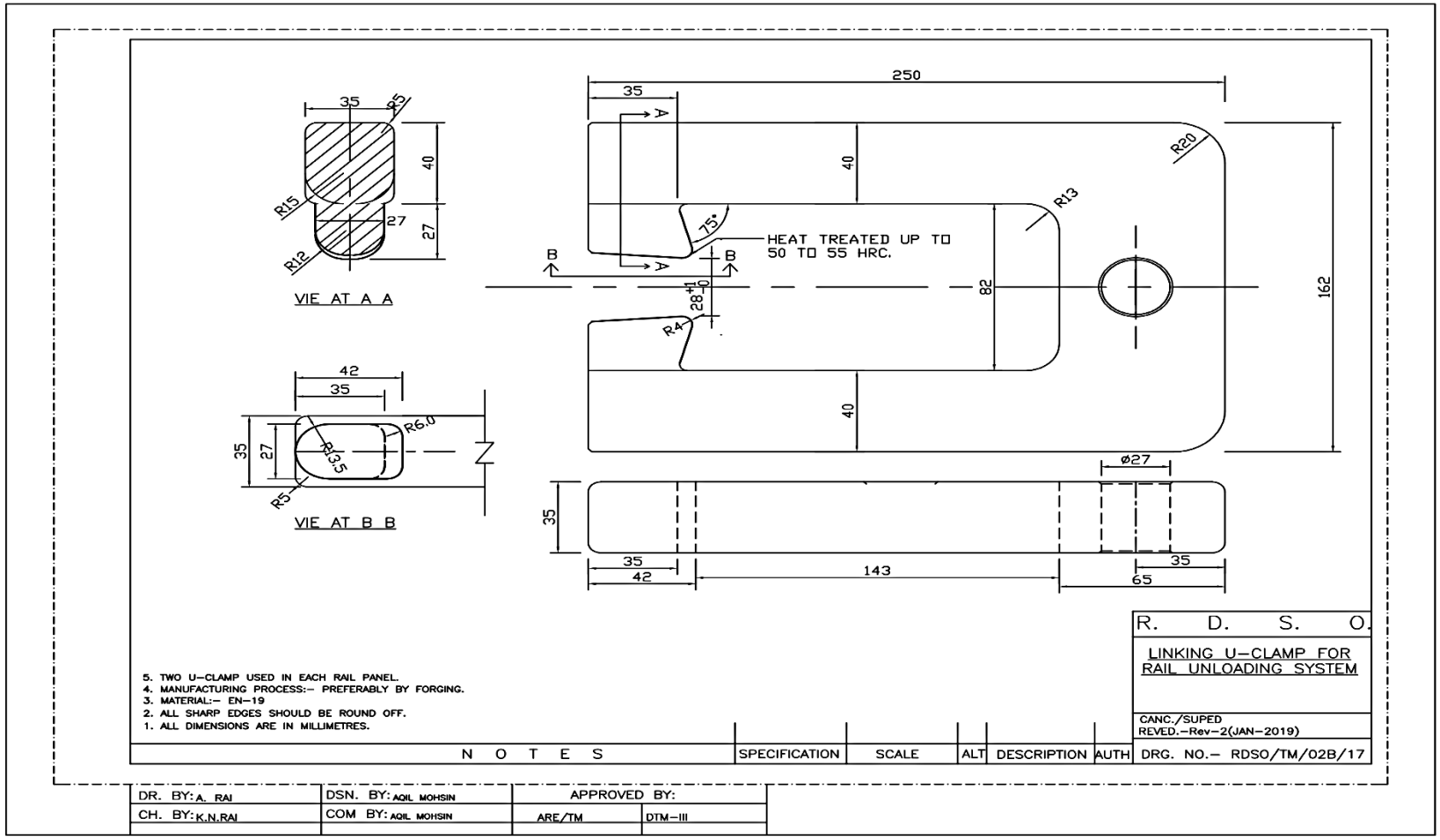

Fig A8 : Dimension of U clamp

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