ज्ञान ज्योति से मार्गदर्शन

To Beam As A Beacon of Knowledge

FUNDAMENTALS OF BUILDING ORIENTATION AND GREEN BUILDING FEATURES

October 2015

Indian Railways Institute of Civil Engineering
Pune 411001

First Edition	:	October 1995
Second Edition	:	June 1998
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Foreword to the Fourth Edition

The book on “Fundamentals of Architecture for Railway Civil Engineers” was first published in 1995. With the emphasis on sustainable habitats as key solutions to growing infrastructure needs, Indian Railways has also embarked upon making the energy efficient buildings. Therefore, the comprehensive features of Green Building have been added along with updating the book.

To make this book more useful to Civil Engineers, a case study of IRICEN Building has been included. Therefore, the title of the book has been appropriately revised as “FUNDAMENTALS OF BUILDING ORIENTATION AND GREEN BUILDING FEATURES”.

It is hoped that this book will be useful to Engineers while planning the new buildings in the Railways. Endeavour has to be to construct New Buildings by spending a little extra, in the initial stages which get set off in a short period of time.

21st October, 2015

Vishwesh Chaubey
Director
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Preface to the Fourth Edition

The Book "Fundamentals of Architecture for Railway Civil Engineers" was first published in year 1995. Subsequently it was revised and enlarged as 2nd Edition in 1998. It further incorporated a chapter on Green Buildings in its third Edition in 2007.

During the last 8 years, there have been quantum jump in the field of Green Buildings in India in different sectors of residential, commercial and Government Buildings. In Indian Railways, few Green Buildings added during this period, most important of which are, the Administrative office building of CAO/C at Secunderabad and the Institute Building of our Alma Mater , IRICEN at Koregaon Park, Pune.

In this Edition, the text has been revised and updated. Major changes are there in chapter 4 on Green Building, in which we have introduced the comprehensive case study of IRICEN Green Building. Accordingly, we have renamed this book as "FUNDAMENTALS OF BUILDING ORIENTATION AND GREEN BUILDING FEATURES".

It is expected that it would be useful for Railway Officers and mainly Civil Engineers while planning for new buildings as Green Building.

In spite of every care taken to ensure accuracy, some errors might have crept in. Suggestion for further improvement of the text would be gratefully acknowledged.

Date: 21st October 2015

S.K.GARG
Sr.Professor Works
IRICEN

Preface to the Third Edition

The first edition of the book "Fundamentals of Architecture for Railway Civil Engineers" published in Oct 95 was very popular among the field engineers as all aspects concerning Fundamentals of Building Architecture were well documented in the book. Its revised and enlarged 2nd edition was also published in June 1998.

During last few years, eco-friendly and energy efficient buildings had gained importance on account of impact of development on environment. Buildings incorporating these features are called as Green Buildings due to use of energy efficient features and environment friendly materials. Different rating systems have been developed in various countries for rating these buildings.

Keeping in view of the above, in this 3rd and revised edition, a new chapter on "Green Building" has been added. Also to make this book more useful and interesting to Civil Engineers, the other chapters have been modified by adding case study. In view of these changes, the title has been changed as "FUNDAMENTALS OF BUILDING ORIENTATION AND LAYOUT PLANNING".

Efforts have been made to make the book more useful for the field engineers. In this effort, the IRICEN faculty and staff have contributed immensely, notably among them are Mrs. Lata Sridhar and Mr. Sunil Pophale. I am particularly thankful to Shri A. K. Rai, Professor Works who has contributed immensely in updating and adding a new chapter on Green Building in this book and also carrying out proof checking. I am also thankful to Shri Rajesh Kumar, Professor Track-1 for providing logistics assistance for printing this book.

Above all, the author is grateful to Shri Shiv Kumar, Director IRICEN for his encouragement and guidance in bringing out the publication.

March 2007

N. C. SHARDA
Sr. Professor Works
IRICEN

Foreword to First Edition

It is a long felt need that Railway Civil Engineers be given adequate exposure to fundamentals of architecture so as to achieve a better reflection of aesthetics and userfriendliness in customer satisfaction. With this objective in view, IRICEN has compiled this treatise in basic architecture through Sh Dhananjay Datar, a practicing Architect in Pune. I hope this will serve a long way in improving the aesthetic sense of Railway Civil Engineers and will also assist them in interacting with architectural consultants.

October, 1995

S. GHOPALAKRISHNAN
DIRECTOR / IRICEN

Foreword to Second Edition

This edition has been revised and additional information has been added by Shri S. Gopalakrishnan, formerly Director, IRICEN and Shri Rajesh Agarwal, Professor, IRICEN. This is now treated as Volume 1 with the intention of bringing out more information in Volume 2 in future.

June 1998

VINOD KUMAR
DIRECTOR / IRICEN

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INTRODUCTION

In many parts of our country except for the metros and cities, the vocation of architecture is relatively unknown. In the villages, it is the local mason who draws lines with a stick directly on the plot of land and physically explains the structure to the end user. After preliminary approval, the construction work commences straight away.

As the function, size and requirement of a structure increased, the need for a person who can plan and design is felt. This has led to architecture being evolved as a full fledged profession. An architect undergoes training for approximately five years, which makes him capable of understanding the importance of planning, design and aesthetics. Alongwith these, he also gets well acquainted with supporting systems, techniques of construction, etc.

Architecture, therefore can be defined as a fine blend of art, creativity and logic, reinforced with a backbone of structural technology. Art and creativity essentially mean sensitivity to form, colours, textures, volumes, compositions, homogeneity, etc. while the technical part includes structural soundness, sanitation and drainage, acoustics, fire fighting, electrical services etc.

An architect's role is to design an environment (inside & outside), which caters to human needs, both physical and psychological, human comforts and luxuries.

In today's context, with the complexity of structures increasing rapidly, it is virtually impossible for an architect to cater to all these needs. Specialisation in architecture now, has mushroomed all over the large cities, whereby an architect branches out and becomes an expert in a specific field. Some of the specializations are housing, urban design, town planning, landscape, construction management, industrial architecture and public health. Large projects are being now handled by an

architect and his team of consultants. Due to this, it has become imperative that an architect should have the following strengths in order to succeed in practice :

i) strength of conceptualization
ii) aesthetic sensitivity
iii) communication skills
iv) management acumen
v) sound technical knowledge.

A good designer always respects factors which play a major role in designing which are unchangeable and works in tandem with them to come up with a solution which blends rather than upsets the surroundings. Some of these factors are climate of place, local building materials, local landscape, living style of the people and other physical attributes of the site.

Manmade factors which can influence design are the building type, the funds available, the number of users and special facilities and requirements.

■ ■ ■

CHAPTER 1

FUNDAMENTALS OF LAYOUT DESIGN AND BUILDING ORIENTATION

1.1 PROCESS OF DESIGN

Before undertaking a layout design assignment, one should start off the process of design in a methodical manner. One should consider a number of aspects and factors that are likely to influence design. Some of these factors are related to the location of the site, the prevalent climatic conditions, local materials etc., while others are space requirements, functions of each space, etc. The former are guided by nature and cannot be changed while the latter are man made and can be marginally flexible. Since the number of building types are large, it is impossible to master all building types, and many a times assignment ends up with building type which has never been done previously. The procedures which are followed can be briefly summed up as follows :

1.1.1 Site Selection/Condition of the Site

It may happen that a designer might be asked to make his choice of the site from the available options. In this case, advantages and disadvantages of each location should be compared and then the most suitable site should be selected. The process should be governed by :

- access to site
- character of structures around the site
- availability of services like water connection, drainage lines, power supply, garbage disposal, etc.
- existing greenery, if any
- dimensions of the site, so as to get an idea of foreground, side margins etc.
- openness from point of view of ventilation, light and view

- sound and air pollution
- elevation of the ground (contours) with respect to the existing roads, if any.
- highest flood level and pattern of surface flow of rain water.

If the site has already been selected, then all physical features like contours and levels, water sources, available greenery, if any, presence of cables, poles, pipelines, etc., should be recorded. The view offered by various authorities should also be kept in mind. The directions and alignment of the plot (length and breadth) with respect to north, determines the location of spaces within the structure, with respect to orientation principles.

1.1.2 Data Collection

Design of any building type is based on the data which needs to be collected before commencement of actual work e.g. a hospital building has a very specific pattern of circulation, which if violated, can cause pandemonium. Smooth movement of people is the key in such a case. Data can be collected by studying various books pertinent to the subject.

Anthropometric data is available in special books which gives ready references and information, and thus save time.

It is also beneficial to visit similar existing structure which has been put into operation. A case study, based on actual visits, discussions and observations can give the designer very good insight into plusses and minuses of the case. A lot of problems can be identified while conducting a case study. Multiple case studies expose the designer to a larger database and comparison of cases can lead to valuable data.

1.1.3 Bubble Diagram

After completion of above two steps the actual process of design commences. Spaces are represented by

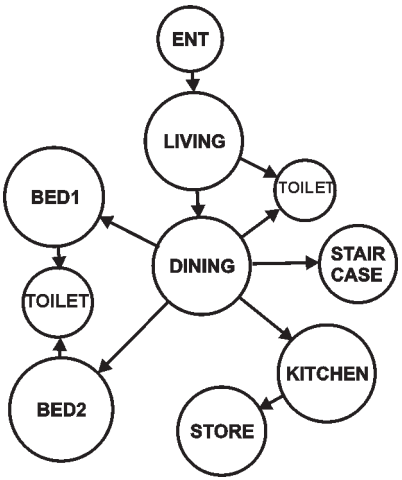


Fig. 1.1 Bubble Diagram for a Two Bedroom Residential Unit

circles (Refer to Fig. 1.1) with names of the spaces written within the circles. The circulation/movement within the structure, from one space to the other is represented by arrows. On completion, a bubble diagram represents the basic circulation pattern. The sizes of circles are proportionate to the area of various spaces. This forms a basis for planning. Different alternatives can be explored, leading to more than one alternative.

1.1.4 Sketch Scheme

These involve the translation of each bubble into a room or space with dimensions (lengths and widths) leading to a conceptual plan. It is at this stage that the light and ventilation for each space needs to be attended to. Along with the sketch plan, the effect of the plan on the elevations which evolve are to be studied, i.e. a three dimensional effect of the volumes which are created should be considered simultaneously. Many a times designer tend to give more priority to planning and the elevations

are ignored or neglected. This leads to a structure, with an effective plan, but with non-descript elevations. It is equally an undesirable practice to aim at elevation, sacrificing the conveniences of planning.

The actual skill lies in visualization of the volumes that are created, and only then can interesting structures be created. Process of a design should progress in all three axis simultaneously.

1.1.5 Scale Drawing

Thumb nail sketches of plans, elevations and perspectives should be drawn to a convenient scale and various presentation techniques could be used. A few of presentation techniques are listed below :

- rendering in pen and ink
- rendering in crayons on handmade paper
- rendering in colour pencil on glossy white paper
- use of water colours, in the form of washes on handmade paper
- collage
- computer aided techniques

Presentation techniques are responsible for arousing the interest of the viewer and it helps to enliven the scheme by virtue of colours, sociography, etc.

1.2 INTERNAL LAYOUT AND CIRCULATION

After a basic circulation pattern is established by means of bubble diagram, the next step is to formalize space by assigning dimensions to the bubble. However, there are other considerations involved in formalizing the space. One of the major aspect is circulation within the room and the internal layout. It is dependent on the function of the space and the location of the objects like furniture inside the room. The

dimensions of furniture will have to be predetermined for good planning. The openings in a room like doors and windows are also important as they determine the part of movement, i.e. passages in space. In an ideal plan, this passage space should be kept to the minimum, as this area is effectively unusable for any activity. Corridors bounded by walls on both sides should be minimized. It should be possible to take a stretcher along corridors and negotiate turnings.

The overall functional values of a space are determined based on optimum movement space and maximum usuable space. The movement pattern changes with the various functions. For example, in a library or reading hall, movement or circulation assumes a very important role. This is because a quiet, undisturbed working environment has to be created in public space or the movement of visitors coming and leaving a hospital, the movement of patients within the hospital etc., directly affects the day to day working of the hospital.

Location of entries and exits to and from a space needs to be worked out based on the furniture layouts. Fig. 1.2 shown below effectively illustrates the importance of circulation. In today's time, where the size of the structure is getting smaller and smaller in the metros, wastage of circulation areas and passages is an uneconomical proposition.

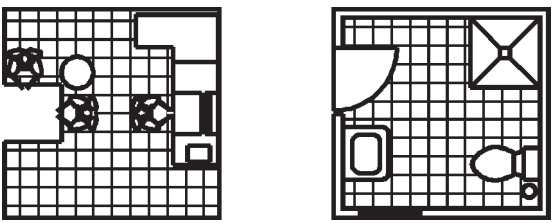


Fig. 1.2 Importance of Circulation

A thumb rule that can be followed for this is to filter crowds, (i.e. traffic due to movement of people) and gradually decrease the traffic as one progresses from public areas to

private spaces. This led to circulation pattern in which the main entrances directly lead to public areas and a semi-public space is introduced between the public and private zones.

As an example, a railway station can be designed as follows :

1. As regards passenger handling, it should be remembered that there are four categories of people. The first one belongs to those who come for boarding, the second one for those who arrive by some train and depart by some other train by changing platform, the third one for those who arrive and disperse and the fourth for the friends and relatives of passengers who come to receive or see off the passengers. Taking cue from airports, it should be possible to separate and streamline the movements of arrival, departure and transit passengers in designing major station.

2. The circulating area should cater for different kinds of vehicles, viz., cars, taxis, autorickshaws, buses, etc. Vehicular movements into/out of paid parking areas should be isolated from free access lanes.

3. The main entrance hall or foyer is a large area, enough to accommodate hundreds of people, who form a permanently mobile crowd. Most of the people are directly concerned with the purchase of tickets, thus making it important to locate ticket and enquiry windows as close as possible to the foyer. Notice boards, train schedules, enquiry counters, etc., are always part and parcel of this foyer. This ensures that other than travellers, outsiders do not penetrate the interior, thus increasing congestion inside the station.

4. Separate access and infrastructure are provided for accepting parcels for trains. A road leads directly from the outside to the parcel office. However, parcel booking of accompanied baggage by the passengers should be catered for, near the foyer.

5. Entries and exits should be so provided so as to be

controlled by ticket checking staff. Station manager should be so located that people can meet him without the need to purchase platform ticket and also that access exists for Station Manager to enter main platform.

6. The foyer opens out into platforms with a foot overbridge located close by. All trains which have a heavy daily commuter traffic, berth on the platform which is closest to the foyer. By doing this large crowds crossing from one platform to the other is avoided. Through trains, which stop for short time periods, with less number of arriving and departing passengers berth on the subsequent platform. Therefore, by proper use of platforms, human traffic and the walking distances are effectively reduced.

7. Goods train have separate goods sheds, offices, loading and unloading yards. This should have proper road access and facilities for agents, commercial organization and labourers.

8. Toilets, drinking water facilities and tea stalls are located in positions which are central and have maximum and easy accessibility. Providing small toilet blocks at various locations instead of large central one, reduces cross circulation of people. Railway's own facilities not directly related to train operation, such as Signal & Telecom stores, rest rooms, motor trolley sheds, trade union office, etc should not be located in platforms. Number of stalls on platforms should be kept to the minimum. Pictograms for passenger guidance and signages should be adequately used. On careful observation, one realizes that the smooth functioning of a public place like a railway station largely depends on the circulation within the station and is a study in itself.

Architectural designing always proceeds designing from the whole to the part. As mentioned earlier, a bubble diagram now progresses to a full fledged plan, with proper and logical circulation. All spaces now have specific sizes and locations, and the skeleton of the building is ready. A plan can be compared to a human body, wherein blood vessels represent the passages

and the parts of the body are the various spaces. All blood vessels originate or culminate in the heart, which is like the main entrance.

The next stage in the planning process is the study of each individual space. The function of each space, movement of people to and from the space, i.e. passages, and proper location of entries and exits are established. Locations of windows are based on the quality of light, ventilation and view offered by a particular position. Preparation of furniture layouts for each space is an effective process for achieving this.

This completes the planning process, and now, a fully functional plan is ready.

1.3 ORIENTATION OF BUILDING

Orientation of building 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.

Radiation + Temperature = Heat experienced

Optimum orientation reduces the radiation to the minimum.

As per IS code No.SP-41 (S&T) – 1987, four types of climatic conditions are mainly found in India:

(i) Hot and dry
(ii) Hot and humid
(iii) Warm and humid
(iv) Cold

Orientation principles with respect to the various climatic conditions are listed below along with building features and can be used as guidelines:

i) Hot and dry climatic zones:

This climatic condition generally occurs at latitude between 15 degrees to 30 degrees on both the hemispheres. Maximum day time summer temperature goes as high as 45 degree centigrade and relative humidity as low as 20 %. Major areas falling in this climatic zone are Delhi, U.P., Bihar, Rajasthan, parts of Punjab and Madhya Pradesh. These areas are far away from coast and do not experience very heavy rainfall. Desirable features of building in this zone are:

1. Orientation : 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 leeward side of the building to avoid circulation of hot air and smell from the kitchen.

2. Windows and fenestration : Large openings with heavy shutters should be provided on northern and western faces as light coming from north is always diffused and indirect. Also direction of breeze, which is from west at most of the places enters from opening on west side. Windows area should be 15 to 20 percent of floor area. Internal courtyard caters for cross ventilation & thermal buffer. Suitable radiation barriers in the form of canopies, chhajjas, long verandahs etc. should be provided on the west side of the building. Sufficient number of ventilators close to the bottom of slab should be provided.

3. Walls : Thick walls are preferred to act as insulating barrier. Walls with light and shining paints on outer surface have good reflective quality and do not absorb heat. The surface of walls should be smooth and non-dust catching type. Cavity walls also can be provided as they provide very good thermal insulation. Hollow bricks available in the market can also be used for making hollow - insulated walls.

4. Roofs : Should be built up with good insulating material having slope in windward direction. False ceiling can be used to improve thermal performance of building. Terracing should be provided on the flat roof with mud phuska, lime concrete, foamed concrete or burnt clay block paving over roof slab. Top roof surface should be made reflective by providing whitewashing or any reflective paint.

5. Vegetation : Large shady trees whose roots do not strain foundation and basement should be planted near external walls to provide shade (Fig 1.3).

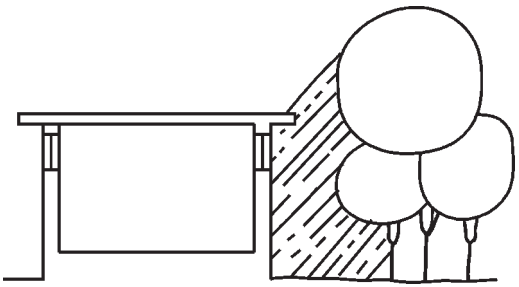


Fig 1.3 Shady Trees Near External Wall

6. Special needs : Outdoor sleeping area for summer nights preferably be provided. Desert coolers and fans can be used during summer months. Therefore, proper space to provide coolers should be planned in the building.

ii) Hot and humid climatic zone:

In these regions the climate is hot and air contains moisture. Sun's glare is more and undesirable. Relative humidity is above 40% and temperature is above 32 degree centigrade. Mostly interior peninsular region fall under this category. Interiors should be protected from hot Sun and dusty winds. The thermal characteristics are almost identical to hot & dry zone except that desert coolers are not suitable for hot & humid zone. The

orientation and other features of the building would remain the same as in hot and dry climatic zone.

iii) Warm and humid climatic zone:

This type of climate is normally found in the coastal areas. Mean maximum temperature during summer does not rise beyond 32 degree centigrade and relative humidity ranges between 70% and 90%. Because of less diurnal variation of temperatures along with high humidity, the emphasis should be on prevailing winds. Coastal regions of Gujrat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orrissa and West Bengal fall under this category. Desirable features of buildings in this zone are:

1. Orientation : should be preferably in North-South direction for habitable rooms i.e. longer walls should face north & south so that shorter sides are exposed to direct sunlight.

2. Windows and fenestration : Proper cross ventilation of building is of extreme importance, therefore large openings should be positioned on windward and leeward direction. However, openings should be provided with suitable protection like sunshades, chhajjas etc. from Sun and rain. Windows area should be 15 to 20 percent of floor area. The sill height of windows should be at low level between 0.5 to 0.7 m. Fixed windows should be avoided. Internal doorways between drawing & dining and dining to passage etc. may be left open without shutters/leaves. Ventilators should be provided as near to ceiling as possible. Provision of mechanical ventilation for circulation of fresh air as well as exhaust of used air should be made.

3. Walls : Low thermal capacity material be used in construction and walls can be thinner as temperatures are not very high. Compound wall on the windward side should be low. Bare fencing or light screen walls are preferable. RCC jallies are more advantageous as they allow passage of air through them and at the same time provide privacy by obstructing the vision.

4. Roofs : should have large overhangs to avoid rainwater hitting the wall. Roof should be finished with materials of low thermal conductivity. Top roof surface should be made reflective by providing whitewashing or any reflective paint / tiles. Proper slope is essential for effective removal of rainwater.

5. Vegetation : Shrubs of medium height or coconut trees grove or casuarinas, which do not act as wind barriers are recommended.

6. Special needs : Good rain-water drainage is essential. Desert coolers are not suitable in these areas.

iv) Cold climatic zone:

Cold climate occurs in mountainous regions and plateaus 800 to 1200 metres above sea level. Snowfall and rainfall is also heavy and mean daily temperatures is 6 degree or less. Minimum temperature may fall up to minus four degrees or even less at some locations. Mountainous regions of Jammu & Kashmir, Himachal Pradesh, Uttaranchal and North Eastern States and other hilly and mountainous regions of the country fall under this category. Main requirement of this region is heating during winter months and protection from chilling winds. Walls and roofs should be protected against heavy rain and snowfall.

1. Orientation : Should preferably be in north – south direction i.e longer walls should face north & south to receive more solar heat during winter months.

2. Windows and fenestration : Glazing windows upto 25% floor area may be provided. Double glazing is preferable to avoid heat losses during winter nights.

3. Walls : Thin walls with insulation from inner side (2.5cm thick insulation) are preferable. Some of the insulating materials are listed in Table 2 of SP41-1987 Part 2 of BIS titled as Handbook on functional requirement of Buildings - Heat insulation. The insulation should be protected against the risk of condensation by providing sufficient vapour barrier like 2 coats

of Bitumen, polythene sheet 300 to 600 gauge or aluminium foil on warm side. Hollow and light weight concrete blocks are also quite suitable.

4. Roofs : should be preferably made of asbestos cement or G.I. sheets backed by false ceiling of wood, 2.5cm wood-wool board or equivalent material. The roof should have sufficient slope for quick drainage of rainwater and snow. Vapour barrier should be used depending on location and possible wind pressure.

5. Special needs : Provision for heating of building should be kept like fire places etc. Ceiling fans are not normally required, but may be used during summer on special occasions. Outdoor sleeping area is not required.

■ ■ ■

CHAPTER 2

HOUSING AND SEMI-PUBLIC BUILDINGS

2.1 HOUSING:

Housing or shelter is one of the basic needs of man. History of mankind shows the evolution of a habitat or a shelter from the pre-historic caves to modern housing complex of the present age. Housing also happens to be the most primary and basic building type, and the range of housing covers everything between a single room tenement to large townships. Since man is a social animal, his preference for staying in groups has led to the formation of clusters, with common facilities finally developed into small settlements. As the size of the settlements grew, towns were born. Today housing has become a highly specialized form of building design and now is a specialized subject in architecture.

2.1.1 Two main factors govern design of residential units, namely, the cost and the type. Based on the cost of a residential unit, it is categorized as :

i) Housing for the Economically Weaker Sections (EWS)
ii) Housing for the Lower Income Group (LIG)
iii) Housing for the Middle Income Group (MIG)
iv) Housing for the Higher Income Group (HIG)

EWS housing :

This usually include rehabilitation/slum redevelopment schemes promoted by the Government/local bodies/ cooperatives and usually provide for the barest basic amenities namely one multi purpose room and a common toilet block.

LIG housing :

This too is designed for the economically lower classes like industrial works, menial labourers, etc., whereby the user can pay a very limited sum of money towards the total developmental costs. It usually comprises a multi-purpose room, kitchen and a toilet block, either separate or common.

MIG Housing :

This is the ideal housing solutions for nuclear families, essentially for the middle income group in cities, where land costs are prohibitive and plot size are small. Usually, it has 3 rooms plus toilet or 4 rooms plus toilet. e.g. an apartment block. All amenities are provided within the tenement, but luxuries are hardly catered to.

HIG housing:

Luxury housing includes single tenements with large rooms, well equipped with utilities and facilities like servants quarters, gardens/terraces, exclusive parking, etc, e.g. independent bungalow.

2.1.2 Different types of houses :

i) Detached

ii) Semi-detached

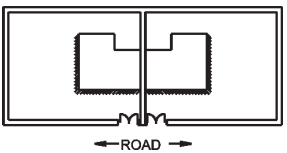
iii) Row housing

iv) Group housing.

Detached housing :

Detached housing is a single tenement located exclusively in a plot of land. It is an independent structure, usually a bungalow, which enjoys its own privacy (Fig.2.1A).

A) DETACHED

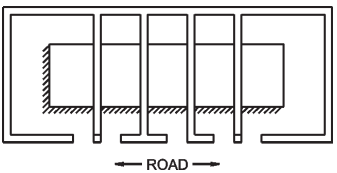


B) SEMI DETACHED

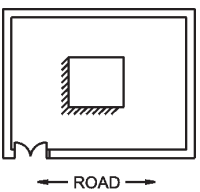
Fig 2.1 Types of Houses

Semi-detached housing :

Semi-detached is a slight variation of detached housing in which two tenements share a plot, whereby each user enjoys half the plot. For example, twin bungalows shown in Fig. 2.1B.



A) ROW HOUSING



B) GROUP HOUSING

Fig. 2.2 Types of Houses

Row housing :

Row housing enables the user to have his exclusive front court, rear court and terrace and share common walls on the both the sides (Refer Fig. 2.2A).

Group housing :

In group housing the plot and boundaries are shared by number of tenements which are built one atop the other in the form of floors, For e.g. Condominiums, apartments. See Fig. 2.2B.

2.2 INFRASTRUCTURE REQUIRED FOR LARGE SCALE HOUSING :

The success of a housing project, primarily depends on certain factors. The absence of any of these creates a disadvantage, which can discourage a prospective user. They are :

1. Water Supply : A rich water source (river, well, municipal, supply etc.) is the most primary requirement as this is the only factor which is beyond human control. The water requirement for the total number of users should be worked out well in advance, and the yield of water source should be ascertained. The standards for water consumption are mentioned below :

WATER CONSUMPTION

a.	Per capita requirement :	135/liters/person/day
b.	Flushing requirement :	270/liters/w.c. + 180 liters per additional w.c.
c.	Domestic storage capacity:	500/liters/tenement
d.	Downtake fittings :	taps : 70 liters/tap shower: 135 liters/shower bath tub : 200 liters/tub

2. Access : The site should be properly accessible by road and proximity to the railroad, airport, etc., are added advantages. The access should be shortest from the nearest development, and should be sufficiently wide.

3. Power : Electric supply should be worked out in advance.

4. Parking space: Sufficient open spaces/covered spaces should be created in order to have proper parking facilities within the scheme. Parking standards are :

One parking space for every	Cars	Scooters	Cycles
2 tenements of carpet areas 101-200 m^2	01	04	02
1 tenement exceeding 201m^2	01	02	04
1 tenement having carpet area between 40 m^2 and 100 m^2	—	02	04

Parking Areas :	Type	Area
	Car	2.5 x 5 m
	Scooter	3.0 sqm
	Cycles	1.4 sqm

5. Drainage/Sewerage : Availability of a municipal sewer line should be checked. If no such facility is available, then a self sufficient sewage disposal system has to be provided. The effluent generated by the system can be recycled effectively for water requirements of landscape. The minimum sanitary requirements are:

1.	Bathroom	:	1	no. with tap
2.	Water closet	:	1	no. with tap
3.	Sink	:	1	no. with tap
4.	Water tap	:	1	no.

6. Amenities : The proximity of amenities is also of great importance, as this tends to make day to day life a little less arduous for the inhabitants. Amenities should be developed within the scheme, if the scale of development is large. Provision can be made for

a. Canteens
b. Bank
c. Hotels and restaurants
d. Post Office
e. Tea shop
f. Essential shopping
g. Fire station
h. Public phone
i. Hospital/primary health center
j. Primary school
k. Electric sub-station
l. Bus stop
m. Repairing facility
n. Petrol pump
o. Town hall/theatre/sports facility
p. Parks and gardens.

7. Landscape : Good natural vegetation, scenic location of the site and well developed landscape are conducive to growth. The local temperature also drops substantially. In case of a good tree cover, open space should be converted into parks, and road sides, etc., should be landscaped as this can make the entire complex more appealing and beautiful.

2.3 DEVELOPMENT OF A RESIDENTIAL UNIT

Individual residential units, as we saw earlier, can range from a single room tenement to a palatial private residence. Each unit has to have good planning and circulation, sufficient light and ventilation, indoor and outdoor spaces and proper facilities. Each space has to function according to its designated use.

The general planning principles have been described

in the earlier chapters. The evolution of a residential unit from a single room tenement to a four rooms tenement is shown in Fig 2.3 A & B.

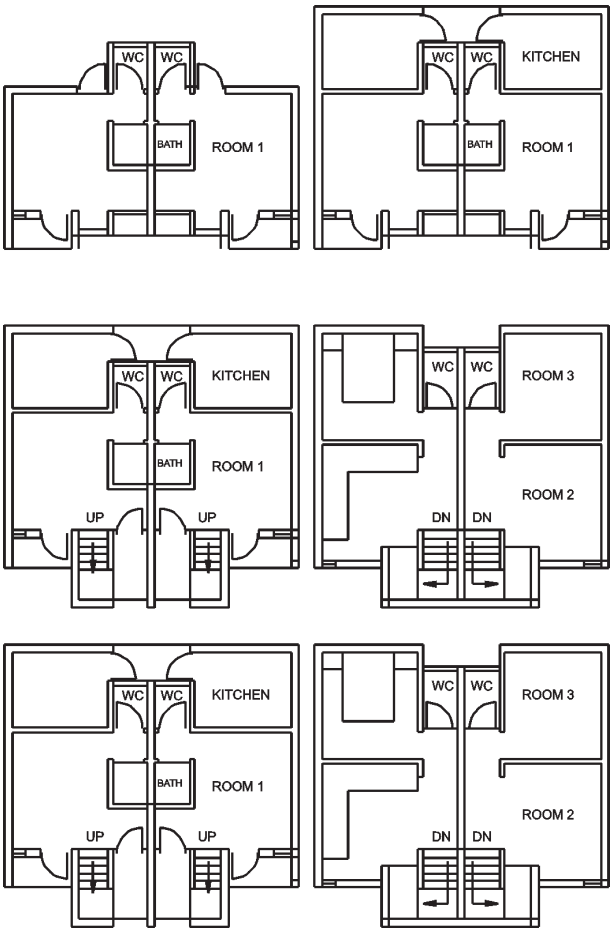


Fig 2.3A Evolution of Residential Unit

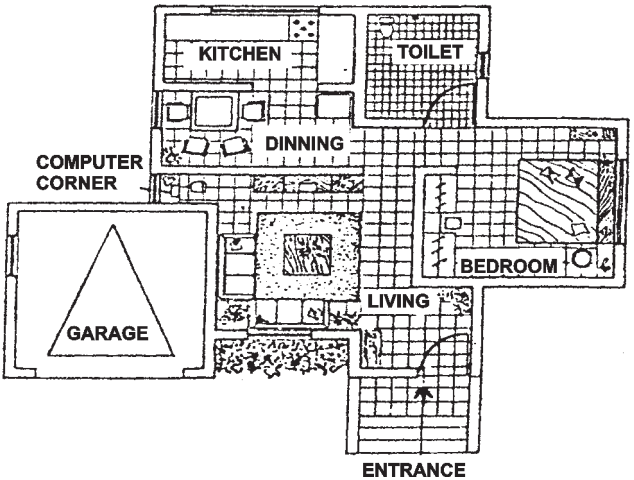


Fig. 2.3B Evolution of Residential Unit

2.3.1 Important Dimensions for the Residential Buildings :

1. HABITABLE ROOMS

minimum plinth	:	45 cm above road level
minimum height (clear)	:	3 m
minimum ventilation	:	1/8th of carpet area
minimum sizes	:	9.5 sqm
minimum dimension	:	2.4 m

2. KITCHENS

minimum size	:	5.5	sqm
minimum width	:	1.8	m
minimum ventilation	:	1.0	sqm

3. KITCHEN + DINING

minimum size	:	9.5	sqm
minimum width	:	2.4	m

4.	BATHROOM		
	minimum size	:	1.8 sqm
	minimum width	:	1.2 m
5.	WATER CLOSET		
	minimum size	:	1.1 sqm
	minimum width	:	0.9 m
6.	TOILET		
	minimum size	:	2.8 sqm
	minimum width	:	1.2 m
	minimum height	:	2.2 m
7.	STAIRCASE		
	flight width	:	1.0 m
	minimum tread	:	0.25 m
	maximum riser	:	0.19 m
	maximum rises/flight	:	12 nos
8.	PASSAGE		
	minimum width	:	1.0 m
9.	DISTANCE BETWEEN BUILDINGS		
	minimum	:	6.0 m
10.	IDEAL SETBACKS		
	front	:	4.5 m
	rear	:	3.0 m
11.	PARAPET		
	minimum height	:	1.05 m
12.	WEATHERSHED		
	minimum projection	:	0.60 m

2.4 DEVELOPMENT OF A LAYOUT

A housing layout can be designed and developed in a very systematic manner. In this the principle of “part to a whole and a whole to a part” is followed. A layout of houses consists of:

(i) the individual unit

(ii) the implications of a cluster of units and

(iii) the infrastructure

After a site is accessed for all its infrastructural values, the requirements of the project come into play, whereby the size, number and density of units is considered as the basis for planning. Individual unit plan alternatives are prepared, and their grouping is worked out. The unit and its grouping, both, have to be considered simultaneously, giving rise to a cluster of buildings. When such clusters are grouped together, a sector emerges which has to have its own micro infrastructure and amenities like parking, open space, access, etc.

Many such sectors go on to form a layout (Refer to fig. 2.4 below).

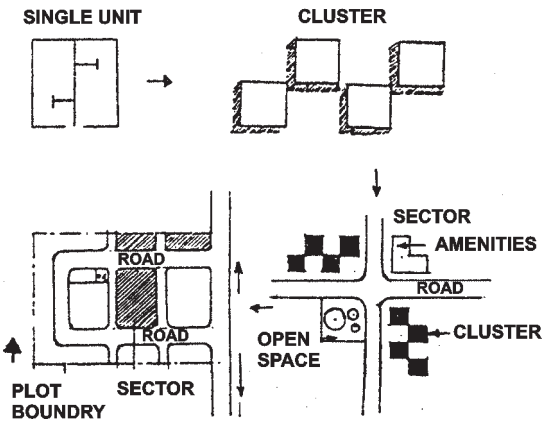


Fig 2.4 Layout Development

Even planned cities are developed along the same lines. Infrastructure and amenities are provided to each and every unit, cluster and sector and are classified as individual

amenities and common amenities. In general, out of the gross area of a housing site :

10% should be left as open space
15% as amenity plots and
15% for roads and pathways.

2.5 BUILDINGS FOR SEMI PUBLIC USE

These are buildings which have the functions of a residential unit, but wherein the users are continuously changing. Such building types include rest houses, hotels and lodges, waiting rooms, holiday resorts etc. A few of these are studied below, with respect to the broad planning guidelines and circulation patterns in the form of bubble diagrams wherever needed.

2.5.1 Waiting rooms :

These are found at almost all public buildings like stations, hospitals etc. The planning of the same should be guided by the following (Ref Fig. 2.5) :

1. Location : Ideally in the center with easy accessibility and should be away from noise and traffic generating spaces like lobbies, foyers and parking spaces. Good lighting and ventilation are important, and a pleasant view from the windows could be an added advantage.

2. Features : A wide entrance with self closing doors, with a cloak room/luggage store next to it is recommended. The interiors should be cheerful, with comfortable seating and easy chairs etc., for optimum numbers. Passageways should be wide and well lighted, with sanitary blocks at suitable locations. A good drinking water facility is a must. Specifications should be comfortable and maintenance free.

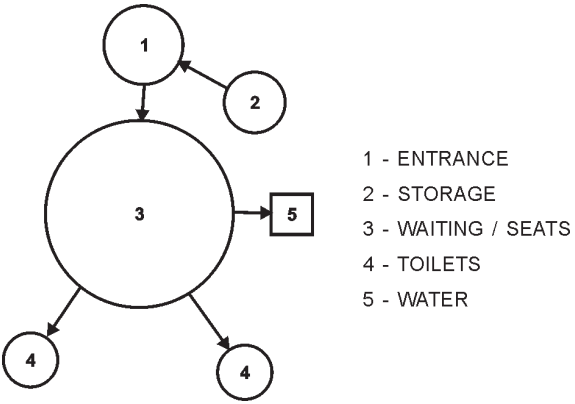


Fig. 2.5 Bubble Diagram of Waiting Room

2.5.2 Railway Rest Houses :

The rest houses in Railway organization serve two purposes, namely, as official accommodation to officers on tour and as Holiday home for the benefit of employees. Since the utility of both the places is different, the planning concepts will also be different.

The first category rest houses should be closer to the Railway Station so that it is convenient to walk to the platforms without requiring any road vehicles. The close vicinity to station also facilitates availing of railway catering. It is desirable to locate rest houses on the upper floor of the station building so that the noise level is reduced. Such rest houses are used for short duration stay hence, each suite needs to be provided with only bedroom and toilet. Wherever possible, it is better to provide separate bath and closet in each suit instead of combined toilet. A small lounge separated by a curtain in each suite or a centralized lounge may be provided with adequate furniture, because many times officers may like to discuss issues among themselves or with their subordinate staff. It is necessary that

along with such rest houses, at a suitable location arrangements are made for the Steno and other staff accompanying officer on tour.

The Holiday Home type rest houses should be located at centers of tourist importance, beaches and hill stations. In the latter case, the location should be at a vantage point such that good view of beach, hills and valley is available, through a wide window in each suite. Care is to be taken not to locate it at an inconvenient distance from the city's hub-center, not connected by public transport.

These rest houses are meant for longer duration stay and most of the time will be occupied by families of the staff. Such places should be provided with good lawn and greenery. A common recreation room, kitchen, caretaker's room, parking place, servant rest place etc., are also to be located. Each suite must have a sit-out and kitchenette.

The furniture in each suite has to be appropriate to accommodate atleast four members of a family. Foldable cots can be used if the space has to be economized.

2.5.3 Running room :

Running rooms are the rest houses for the crew and guards of the trains, who have to take adequate rest before working a train. The requirements of a running room are enlisted as follows (Ref fig. 2.6) :

1) It should be located at a short walkable distance from the railway station/crew booking center.
2) Location should be so selected that noise level is low. Green fencing/high hedging should be used to reduce noise level.
3) The plot size should be big enough to accommodate some greenery.
4) The plan includes provision of sleeping areas, dining

hall, kitchen, bathrooms, toilets, dressing room, reading room, store room and caretaker's desk.

5) It is essential that sleeping area get least disturbance in view of the fact that operational requirements of the railway necessitates arrivals and departures of users at random timings. To ensure this condition, it is necessary to locate the sleeping area away from the entrance, dining hall, kitchen etc. The floor immediately above the sleeping area should not permeate any sound.

6) it is always better to provide privacy to sleeping people. It helps in not affecting others from the peculiar habits like smoking, snoring, reading while lying, using ointments which give off smell, coughs, etc. Cubicles to accommodate two persons at a time can reduce such incidences. Use of sound absorbing materials can also help in this matter. Cubicles should be well ventilated. Some cubicles should be earmarked for smokers because of the lingering smell.

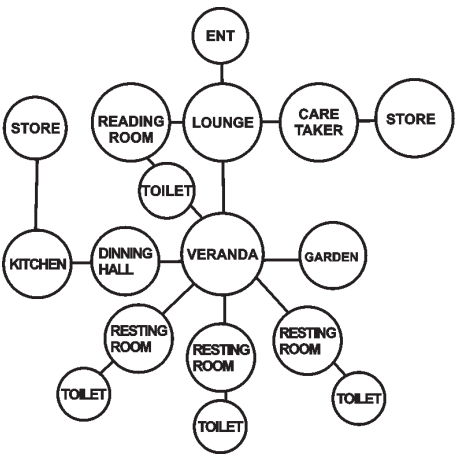


Fig. 2.6 Bubble Diagram for Running Room

7) Smoking should not be permitted in common areas.

8) The illumination in the sleeping areas should be such that neither is too bright nor too dim. The colours for the walls and drapery should be soft and cool. Use of wall posters depicting greenery helps in relaxing the stresses. Separate reading lamp for each cot should be provided. By the use of thick curtains, light intensity can be reduced even in day time so that the resting staff can comfortably sleep.

9) The kitchen, dining hall, store, bathrooms, toilet, dressing room can be clustered together in one or two different places in the case of large running rooms, so as to avoid noise infiltration to the resting area.

10) The sound making gadgets should be avoided near resting area, such as Television, grinders/ mixers, etc. Even telephone should be placed at appropriate location.

11) The occupancy of the running room is scattered throughout the 24 hr. duration. Hence the size of kitchen, dining hall, bathroom and toilets can be optimized to keep the initial running costs low. Bathrooms and toilets should receive natural light. Exhaust fans should be provided. For the workers of running rooms, separate toilet should be provided.

12) Kitchen should have adequate arrangements for storing the cooked food, including fridge, warmers. Microwave ovens will be very useful.

13) Bathroom should have arrangement for continuous hot water supply.

14) 24 hr. water and electrical supply is to be ensured for the running room.

15) A notice board should be placed at a central place to display information relevant for the users.

2.5.4 Railway Office :

The offices of railways can be broadly classified into three categories, namely, booking/reservation/parcel/ goods, depot offices and administrative offices. The planning for each type will differ. The important features to be incorporated while designing an administrative office are highlighted as follows :

Each office is an activity center. There will be main activity and sub activities. These sub activities are inter-related. A link diagram is to be prepared depending upon the interaction level. To explain the planning, the example of a Divisional Office is taken. The principles can be extended to any administrative office.

Here the main activity is to coordinate the various organs of a divisional railway set up. The nodal officer i.e. Divisional Railway Manager has to interact with team of branch officers. The branch officers in turn look after the routine works. Hence, the sub activity center of such an office are the branch officers. These branch offices can be classified into three types :

- User departments i.e. Operating and Commercial Branches.
- Service departments like Engineering, Mechanical, Electrical, Signal & Telecommunication, Electrical Traction, etc.
- Supporting departments like Personnel, Accounts, Stores, Security, Medical, etc.

If we define the level of interaction between various departments as intensity of inter-movements, then to reduce

the cross currents it is possible to arrange the locations of different departments in a designed matrix form. The Operating Department's interaction is maximum with Mechanical, Traction, Engineering and Signal departments. The Commercial department will have to interact with Accounts, Security and Engineering departments.

Hence the location of Engineering Branch should be nearer to Operating and Commercial Branches. Mechanical, Electrical and Signal & Telecommunication can be located nearer to Operating but not necessarily close to Commercial and Engineering. The Accounts Branch will have to be closer to Commercial, Personnel and Engineering. Stores Branch should be closer to Electrical, Mechanical branches.

The location of General Branch which includes PRO and the chambers of Commercial and Operating Officers should be in the foremost part of the office complex. All other departments can be either in upper floors or in rear blocks. Conference Hall should be nearer to DRMs chamber. The main entrance to the building should have a Reception with a Visitor's lobby. In addition to these branch offices, many common facilities should be preferably at such a location so that the staff from all the branches can easily make use of them. Toilets should receive plenty of natural light and should be provided with exhaust fans.

The location of branch officers room should be such that they have effective control over the staff working under their control. Glazed partitions should be liberally provided. Officers should walk through the working areas, rather than through exclusive corridors.

2.5.5 Canteens :

Canteens are again a part and parcel of institution or public campus, and is a combination of semi-public and public use (Refer Fig. 2.7).

1. Location : Location of a canteen can be secondary, i.e. not central, as only a small portion of a crowd will be visiting it

any given time. It can be at a distance from the main activity area. However, a service access (vehicular) is desirable for smooth movement of material to and from the canteen.

2. Features : Large comfortable passages should be provided between seating arrangements. The seating arrangements can consist of groups 4 to 6 or can be continuous.

Service areas, counters, etc., should be properly located, so as to ensure minimum travel distance from the kitchen to seating arrangement. Service counters should have a large empty space in the front, in order to cater to a group of people at once.

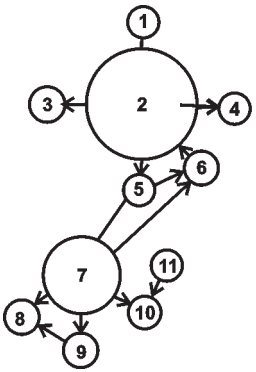
Toilets should be concealed and properly ventilated, with separate facilities for gents and ladies. Wash basins should be provided in adequate numbers. Bathing facilities can be deleted.

Location of cash/coupon counter should be at vantage points and should be located near entrances. Supervision of the entire dining and service areas should be possible from this location.

The planning of kitchens is very critical. The cooking space, the preparation area and wet areas are to be clearly demarcated. Proper ventilation is essential.

Storage of raw material and the stocks should be a separate facility, which can be under lock and key. It should have an external service access.

A separate scullery (wet area) with storage of crockery and good garbage collection system is required.



1 - ENTRANCE
2 – SEATING
3 – TOILETS
4 – COUNTER
5 – PANTRY
6 – SERVICE
7 – KITCHEN
8 – UTENSIL STORE
9 – SCULLERY
10- RAW MATERIAL STORE
11- SERVICE ACCESS

Fig. 2.7 Bubble Diagram for Canteen

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CHAPTER 3

PUBLIC BUILDINGS

3.1 TYPES OF PUBLIC BUILDINGS:

Public buildings are structures which are open to one and all, the crowds throng to these places for varied reasons. The activity carried out inside these buildings directly concerns the masses, and all buildings standards undergo a change. The types of public building are as under :

a) Assembly buildings : Theatres, Museums, Religious buildings, Exhibitions, Pavilions.

b) Public buildings : Stations, Airports, Governments offices, Commercial complexes.

c) Institutional buildings : Schools, Colleges, Universities.

The difference between the three is very subtle. Assembly buildings are operational through out the day and lie vacant during the nights, and the flow of vehicles and people in numbers is at specific hours : for e.g. in a theatre, the crowds enter and leave before or after a show.

In case of public buildings, they can operate round the clock without a break, all throughout a year, and movement of people to and fro is almost continuous.

Institutional buildings have a different motive, and a specific crowd utilizes them at fixed hours. However, the creation of a good environment or a pleasant campus is very important.

The planning and circulation along with design requirements, are very complex and vary from type to type in case of public buildings. Major deviations from the optimized solutions can lead to lot of drawbacks. A very few of these can be studied as examples.:

3.1.1 Primary Health Centres :

1. Location and general : Such centres are found in the mufosil areas or in large establishments like industrial campuses, and render medical services to limited extent. The number of out patients who come everyday exceeds the in patients by far. The staff and other facilities are limited.

2. Features : Large courtyards in front of the centres are very useful, and open verandahs with a roof reduce the load in the waiting areas. It should have good and central access to its premises, with sufficient light and ventilation. Garbage/waste disposal should be very effective and full proof. A thick tree cover along the periphery can enhance the courtyard and can double as parking space.

The bubble diagram shown in fig. 3.1 indicates the most appropriate circulation.

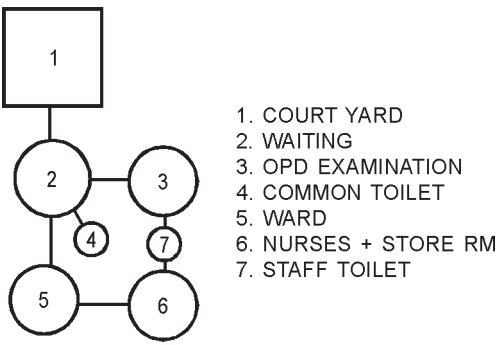

Fig. 3.1 Bubble Diagram for Primary Health Centre

3.1.2 Hospitals :

A hospital is a building type which has a very complex set of requirements with a lot of technical specifications. The circulation patterns recommended are also extremely technical and the anthropometric requirements are not as per standard norms. The structure comprises simple and complicated

components and building services like power supply, fire fighting etc., get priority of the highest order. Each component has a time scale/life span after which alterations, replacement and repairs form a very major area.

Designing essentially is based on grouping together activities which have similar characteristics/nature or are inter-related. This is done so as to avoid duplication of services.

The departments in a medium/large hospital are :

1) Patient accommodation
2) Medical/Technical facilities
3) Engineering services
4) Laboratories
5) Pharmacies
6) Catering and laundry (cleaning)
7) Library
8) Supply, services and disposal
9) Lecture halls/hostels/canteens/parking
10) Research and development facility
11) Expansion facility
12) Good landscape.

There are separate in patient and out patient departments. The inter-relationship can be illustrated in Fig. 3.2.

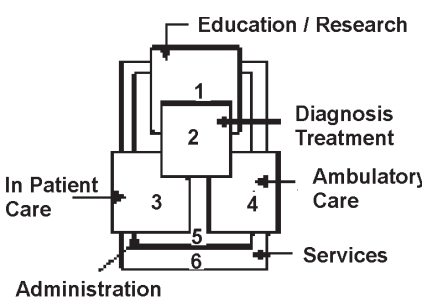

Fig. 3.2 Bubble Diagram for Hospital (Sector Relationship)

Case studies and data collection for public buildings has multiple functions and complex inter-relationships.

3.2 LANDSCAPING

Landscape architecture is a fully developed super specialization in architecture, which has more or less supplementary function, it essentially deals with the surrounds of a building except in cases of aforestation 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 non living materials. In the olden days, it was considered more as an art form which was used to enhance and enrich the main structure (e.g. The Taj Mahal).

Different styles of landscape architecture are practiced all over the world. The scales also differ from a small balcony garden to large parks and gardens. A few of the prominent landscape styles are :

1. English Landscape : it is essentially symmetrical with a strong central axis. These are extremely formal gardens, with geometrically laid out lawns and flower beds.

2. French/Italian Landscape : This is extremely ornate and profuse with a lot of features like cascades, statues, cabanas etc. It is almost crowded and does not have geometry, making it very informal.

3. Japanese Landscape : It is a special art in itself, which is closely linked with Japanese culture and religion. Entire stores are depicted in constricted areas in the form of miniature gardens leading to ornate and miniature landscapes. Use of bonsai and ikebana is very popular.

4. Islamic : Landscaping in most of the Islamic countries even today is extremely formal and strongly axial. The use of large lawns, is restricted and paved surfaces are large. Trees are used as features. Use of shallow and still pools of water and fountains are extensive.

Landscape comprises hard and soft materials. Trees, shrubs and lawns are soft materials while paving, statues, pools, street furniture, lampposts, low walls etc., are the hard materials. The two have to be combined effectively to achieve a good design.

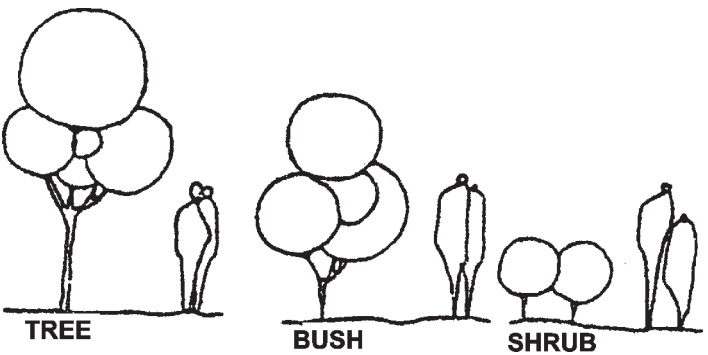

Fig. 3.3 Plant Materials

Plant materials are classified into (see fig. 3.3) :

1) Trees : above 8 – 10 feet height
2) Bushes : below 8 – 10 feet height
3) Shrubs : below 2 feet height

The factors which affect landscaping are :

1) Soil type
2) Rainfall
3) Sunlight/heat
4) Manures/fertilizers

Soil types include :

1. **Clay :** It is adhesive and homogenous, where plants rot due to an excess of water. A surface and storm water drainage has to be provided for successful landscaping.

2. **Sandy :** This soil is very loose and the grip of the roots suffers. Minerals and manure get washed away. Water and watering retention is poor and the only solution for this is regular watering & manuring.

3. **Loam :** It is a combination of (1) and (2) and is ideal for trees and shrubs.

4. **Alluvial :** It is soil, which is humus from river beds, and is ideal for cultivation.

5. **Peat :** it is usually found in marshlands and swamps. It comprises decayed organic material. Growth of landscape here is almost impossible.

Selection of plant material is based on the function. For example as illustrated in Fig. 3.4, trees can be used

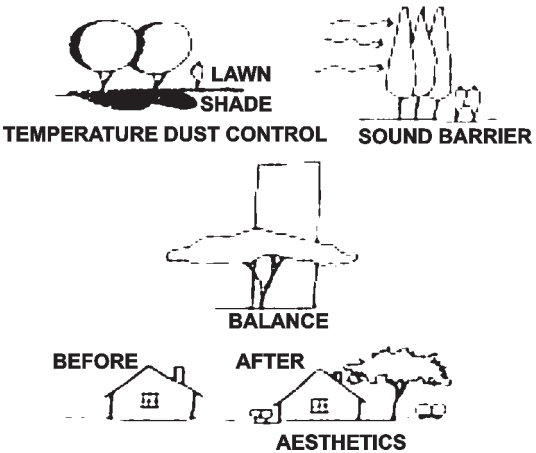

Fig. 3.4 Functions of Plant Material

- for shade
- barriers to sound/ pollution
- for mass greening effect
- for reducing temperature and
- increasing rainfall
- colours of flowers
- balance and
- aesthetic.

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CHAPTER 4

GREEN BUILDINGS

4.1 INTRODUCTION :

Earth is home to more than 7 billion people, and populations continue to grow. Many experts fear that we are using natural resources too rapidly to be sustained. Supplies of energy resources and water are specially threatened. Moreover, we are using these resources in ways that pollute and otherwise harm earth.

A green building, built on principles of ecological sustainability, is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. It focuses on:

(a) Efficient utilization of resources – energy, water, and building materials;

(b) Protection of occupant health (improved air quality) and enhancement of employee productivity

(Better use of day light and natural ventilation);

(c) Reducing waste, pollution and environmental degradation as compared to conventional building. Emphasis is on energy efficiency and water conservation techniques (storm water harvesting, and sullage recycle, reduction in green house gas emissions, use of recycled waste products (Fly ash based building elements) by adopting an integrated design approach for reducing the operation and maintenance costs over the building life cycle.

4.1.1 Sustainable Development: Bruntland Commission on Environment and Development set up by U.N. defined in its report in 1987 ecological sustainability as a pattern of resource use that aims to meet the needs of the present without

compromising the ability of future generations to meet their needs. It implies that we are borrowing the planet, its resources, and its environmental function and quality from future generations.

4.1.2 Non Renewable Resources: For the past century or more, much of the world has run on the energy in petroleum, coal and natural gas – the fuels known as fossil fuels. Fossil fuels come from underground deposits that were formed millions of years ago from the remains of the plants and animals. Today, we know that supplies of fossil fuels are dwindling and will eventually run out. Thus they are called non-renewable resources.

4.1.3 Renewable Resource: A natural resource is termed as renewable resource if it is replaced by natural processes at a rate comparable or faster than its rate of consumption by humans. Solar radiation, tides, winds and hydroelectricity are perpetual resources that are in no danger of a lack of long-term availability. Renewable resources may also mean commodities such as wood, paper, and leather, if harvesting is performed in a sustainable manner.

4.1.4 Green House Gases (GHG) : Fossil fuels must be burned to use their energy, which releases the gas carbon dioxide (Co_2). Carbon dioxide is a key part of Earth's atmosphere because it helps regulate (control) the temperature by returning some of the sun's heat. This process is called greenhouse effect. Co_2 and other gases (methane, nitrous oxide, halogenated fluorocarbons, ozone, per fluorinated carbons, and hydro fluorocarbons) that trap the sun's heat are called greenhouse gases. Without these gases, heat would escape back into space and Earth's average temperature would be about 20^0 colder. It is this greenhouse effect that makes life on the planet possible.

As we burn fossil fuels and put more Co_2 into the atmosphere, more and more heat is trapped. The irony of the situation is that excess production of these GHGs caused by human activity (auto emissions, burning of coal in power plants,

etc.) is now threatening our very existence by leading to global warming.

4.1.5 Global Warming: Scientists have shown that the air temperature of Earth has been rising for decades due to growing levels of Co_2 and other GHGs. Nearly all scientists believe that rising temperatures are caused by human activity, which in turn causes changes in climate in unpredictable ways.

4.2 GREEN BUILDINGS: GLOBAL AND LOCAL PERSPECTIVE

The construction sector poses a major challenge to the environment. Globally, buildings are responsible for at least 40% of energy use. An estimated 42% of the global water consumption and 50% of the global consumption of raw materials is consumed by buildings when taking into account the manufacture, construction, and operational period of buildings. In addition, building activities contribute an estimated 50% of the world's air pollution, 42% of its greenhouse gases, 50% of all water pollution, 48% of all solid wastes and 50% of all CFCs (Chlorofluorocarbons) to the environment.

4.3 GREEN BUILDING

Buildings have major environmental impacts during their life. Resources such as ground cover, forests, water, and energy are dwindling to give way to buildings. Resource-intensive materials provide structure to a building and landscaping adds beauty to it, in turn using up water and pesticides to maintain it. Energy-consuming systems for lighting, air conditioning, and water heating provide comfort to its occupants. Hi-tech controls add intelligence to 'inanimate' buildings so that they can respond to varying conditions, and intelligently monitor and control resource use, security, and usage of fire fighting systems and other such systems in the building. Water, another vital resource for the occupants, gets consumed continuously during building construction and operation. Several building processes and occupant functions generate large amounts of waste, which can be recycled for use or can be reused directly. Buildings are thus

one of the major pollutants that affect urban air quality and contribute to climate change. Hence, the need to design a green building, the essence of which is to address all these issues in an integrated and scientific manner. It is a known fact that it costs more to design and construct a green building compared to other buildings. However, it is also a proven fact that it costs less to maintain a green building that has tremendous environmental benefits and provides a better place for the occupants to live and work in. Thus, the challenge of a green building is to achieve all its benefits at an affordable cost.

A green building depletes the natural resources to a minimum during its construction and operation. The aim of a green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources when in use, and maximize the reuse, recycling, and utilization of renewable resources. It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bioclimatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions. It is evolved through a design process that requires input from all concerned - the architect; landscape designer; and the air conditioning, electrical, plumbing, and energy consultants - to work as a team to address all aspects of building and system planning, designing, construction, and operation. They critically evaluate the impacts of each design decision and arrive at viable design solutions to minimize the negative impacts and enhance the positive impacts on the environment. In sum, the following aspects of a green building design are looked into in an integrated way.

- Site Planning
- Building envelope design
- Building system design (HAC{heating ventilation and air conditioning}, lighting electrical and water heating)

- Integration of renewable energy sources to generate energy on-site
- Water and waste management
- Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, and so on)
- Indoor environmental quality (maintain indoor thermal and visual comfort and air quality)

4.4 BENEFITS OF GREEN BUILDINGS

A green building has lower resource consumption as compared to conventional buildings. The following is the percentage reduction of various resources in a building and their respective reasons.

- Green buildings consume 40% to 60% (depending on the range of measures adopted) lesser electricity as compared to conventional buildings. This is primarily because they rely on passive architectural interventions in the building design, and high efficiency materials and technologies in the engineering design of the building.

- Green Buildings also attempt to work towards on-site energy generation through renewable energy utilization to cater to its energy needs. For instance, solar thermal systems can help generate hot-water and replace the conventional electrical geyser in buildings. Solar PV panels can help generate electricity which can reduce the buildings dependence on grid power.

- Green buildings consume 40% to 80% (depending on the range of measures adopted) lesser water as compared to conventional buildings. By utilizing ultra low-flow fixtures, dual plumbing systems, waste-water recycling systems and rain-water harvesting, green buildings not only reduce their demand for water use but also look at on-site supply options to cater to its internal and external (landscape) water demands.

- Green buildings generate lesser waste by employing waste management strategies on site.They may also employ waste to energy or waste to resource (like manure, or compost) strategies on site, to minimize their burden on municipal waste management facilities and landfills.

- Green buildings generate lesser pollution both during construction as well as while in use. Through best-practices such as proper storage of construction materials, barricading of the site to prevent air and noise pollution during construction, proper storage and disposal of waste during construction and operation, ensures reduced impact on the surrounding environment.

- Green buildings ensure proper safety, health and sanitation facilities for the labourers (during construction) and the occupants (while in use).

- Green buildings restrict the use of high ODP (ozone depleting potential) substances in their systems as well as in finishes.

- Green buildings offer higher image and marketability.

All of these can be achieved at a minimal incremental cost with an estimated payback period of about 3-5 years (excepting renewable energy for power generation).

4.5 COST OF GOING 'GREEN'

The green buildings cost more than the conventional buildings, the difference of cost being dependent on green features being incorporated in the design and construction. A green building may cost 20% to 50% more but annual energy costs would go down by 30% to 65%. However, over a certain period, depending on the energy requirement of the building, the additional expenditure will be compensated by the reduction in annual energy bill. This pay back period would vary from building to building. However, over the life cycle the green

buildings would turn out to be more economical as compared to conventional buildings.

4.6 STRATEGIES FOR GREEN BUILDINGS

A large pool of green features and techniques are available for adoption in design and construction of buildings. Appropriate ones have to be selected depending on function and type of the building, climatic conditions etc. Some such feature which aim at fulfilling the criteria for green buildings are as follows:

(i) Sustainable site development

The site planning should ensure minimal damage to site and surroundings.

a) Land should be disturbed only to the extent it is unavoidable.
b) Preserve land in the surrounding area.
c) Avoid disturbance to water courses.
d) Minimise cutting of trees. Undertake compensatory plantation.
e) Replant the grown up trees.
f) Preserve the excavated top soil and use it in landscaping.
g) Adopt erosion control measures to prevent erosion of exposed soil.

(ii) Social responsibility

The following aspects must be taken care of during planning and construction.

a) Ensure safety provisions at construction site.
b) Provide sanitary facilities for workers.
c) Raise screens to minimize air pollution in the area around the construction site.

(iii) Appropriate landscape design

The following aspects must be taken care of during planning and construction.

a) Landscape to be designed to avoid ‘heat island effect’.
b) Hard surface to be minimised. If hard surface is provided it should be porous and shaded by vegetation to the extent feasible.
c) Species of plants requiring less water for survival and growth to be preferred.
d) Native species of plants to be preferred.

(iv) Construction material and practices

The following aspects must be taken care of during selection of material and construction.

a) The design of the building should be resource efficient. Requirement of material should be less than that for a conventional building.
b) Low energy intensive materials to be preferred. These include regionally available material and material which require less energy during manufacturer e.g. local stones, composite woods, farm wood etc.
c) Materials derived from waste of other industrial processes such as fly ash and other eco-friendly material to be used in construction.
d) Utilisation of construction waste at the same site or at other construction sites.

(v) Water management

It consists of reduction in water demand, avoiding wastage of water and conservation strategies like rain water

harvesting and waste water utilization.

a) These include planting of native species (shrubs / trees) and other species requiring less water.
b) Use of sprinklers for lawns and drip irrigation for shrubs and trees.
c) Waste water treatment and use of treated water for irrigation of landscape.
d) Rain water harvesting and use of stored water for irrigation.
e) Use of low discharge fixtures such as double discharge flush in the building to bring down water demand.
f) Intelligent feature such as urinals having sensors in public places and mass use locations.

(vi) Energy efficiency

Energy efficiency is one benefit from green buildings which appeals to all. The green buildings incorporate energy efficiency primarily through reduced requirement of power for lighting and air conditioning. Several traditional Indian designs provide for efficient natural lighting, ventilation and thermal insulation. For example the Indian circular courtyard design enhances air and light. The jali work used in several medieval building including Taj Mahal cools the air.

There are a number of features which contribute to energy efficiency of buildings. Some of these are discussed below :

a) Architectural design should aim at creating optimum thermal and visual conditions in the building thus reducing the need for artificial lighting, forced ventilation and air-conditioning.
b) Bio-climatic architectural principles for optimum use of nature for lighting and space conditioning should be applied. These include orientation; positioning;

coating and shading of windows; selection of suitable materials for wall, roof and windows; and thermal insulation of roof and walls. If the building is designed taking the bio-climatic principles into consideration, the energy load can be easily reduced by about 20%.

c) There are several solar passive features such as courtyard pattern, solar chimney, wind tower and earth tunnel which can be incorporated in the design. With the use of courtyard pattern and solar chimney the hot air is made to move upwards so that cooler air from vegetated areas can move in. The wind tower and earth tunnel facilitate cooling of air before it is supplied to the air-conditioning system.

d) Use of efficient air conditioning and water cooling systems having intelligent features.

e) Use of efficient light fittings such as CFLs, T-5, LED lamps etc. and use of sensors (illumination meters) to avoid wastage.

f) Another important component of Green Building concept is harnessing non-conventional sources of energy such as solar energy for heating and electricity generation or gasifier system to utilize bio-waste. Solar water heaters and solar photo-voltaic cells are obvious options for harnessing solar energy. Similarly bio-gas plants are to be used to generate energy from bio-waste.

(vii) Health and well being

The following suggestions can be considered for improving health and well being of occupants :

a) Indoor air quality should be improved by using non-toxic (low VOC) paints, adhesives and other materials.

b) CFC free HVAC and refrigeration system should be used.

c) Halogen-free fire suppression systems should be used.

4.7 THE INDIAN SCENE

In recent years some major buildings constructed in the country have adopted green features. These includes the CII- Godrej Green Business Centre, Hyderabad; TERI's Retreat Building, Gul Pahari, Gurgaon; Laboratory Building IIT Kanpur; ITC Green Centre, Gurgaon; Wipro House, Gurgaon; and Transport Corporation of India Ltd, Gurgaon .

Some of these building have succeeded in getting prestigious LEED (Leadership in Energy and Environmental Design) Rating. The Godrej Green Business Centre, Hyderabad was the first building in the world to get Platinum Version 2 Rating. ITC Green Centre and Wipro House have also got Platinum rating.

It is a matter of great pride for Indians that the CII Sohrabji Godrej Green Business Centre at Hyderabad was adjudged as world's 'Greenest' building in the year 2003 (Fig. 4.1). In that year the CII – Sohrabji Godrej Green Buisiness Centre in Hyderabad (Fig. 4.1), a 20000 sq. feet building designed by Vadodara based architect Karan Grover was awarded 'Version 2 Platinum' rating by United States Green Building Council (USGBC), Pittsburg. The Council recognises structures for environment friendly materials and techniques; and energy efficient architecture.

The 'Version 2 Platinum' was the highest rating achieved by any building, under the Leadership in Energy and Environment Design (LEED) Systems for rating for environmentally conscious buildings. The Hyderabad building was credited with 57 of 62 parameters it had competed in. Three buildings in U. S. A. had won the next lower rating i.e. 'Version 1 platinum' till then.

Fig. 4.1 CII - Godrej Green Business Centre, Hyderabad

The green features of The CII – Sohrabji Godrej Green Business Centre building include the following :

(1) Ninety percent of the building doesn't require any artificial lighting during the day.

(2) Two forty feet wind towers and screen walls provide air pre-cooled by 10^0C to the air conditioning systems.

(3) Photovoltaic panels are built in to generate solar energy which fulfill 20% of building's energy requirement.

(4) Thermal insulation of walls, glazings and roof.

(5) Electric fixtures have been automated to save power.

(6) Material used were recycled and eco-friendly broken mosaic tiles, steel, wood, glass, fly ash brick, locally available stones and non-toxic paints.

(7) Water is treated on-site and used for gardens.

(8) Rain water Harvesting.

4.8 GREEN RATING SYSTEM:

The green buildings in India is not a new phenomena. Earlier buildings were used to be made on Green building concepts due to constraint of resources. Over the years due to availability of resources at door steps & at subsidised cost, the resources have been over utilised particularly energy & water. This had led to crunch of resources & adverse impact on environment. People started realising that if we keep on over utilising the resources, nothing will be left for future generations. Therefore Green Building movement had again started and some voluntary rating system came into existence. Out of this two rating system Leadership in Energy and Environmental Design (LEED) & Green Rating for Integrated Habitat Assessment (GRIHA) are popular in India.

LEED rating system was developed & piloted in USA by United State Green Building Council (USGBC) in 1998. Later in 2006 LEED-INDIA version based on LEED rating system developed by Indian Green Building Council (IGBC) based at Hyderabad. The rating system is divided into **Five Key Area and maximum 69 points.** The rating system was revised in **2011 with 110 points.** The distribution of points in five key areas are as under.

Key Areas	No of points (2006) Max. 69	No of points (2011) Max. 110
Sustainable site development	13	26
Water savings	06	10
Energy efficiency	17	35
Materials selection	13	14
Indoor environmental quality	15	15
Bonus points	05	10

The buildings are Rated as certified Level to platinum Level depending on the points achieved by it as under

Rating	No of points (2006) Max. 69	No of points (2011) Max. 110
LEED Certified	26-32	40-49
LEED Certified Silver level	33-38	50-59
LEED Certified Gold Level	39-51	60-79
LEED Certified Platinum Level	52-69	Above 80

GRIHA rating system was developed in 2005 by The Energy & Resources Institute (TERI) based at Gurgaon. The rating system is divided into **3 Key Areas, 33 Criteria & 100 points.**

Key Areas	No of Criteria Total 33	No of points Max. 100
Site selection & Planning	**09**	**24**
a) Conservation & efficient utilisation of resources	07	20

b) Health & well beings during construction	02	04
Building Planning & construction a) Conservation & efficient utilisation of resources	**22** 16	**74** 64
b) Health & well beings during post construction	02	10
Building operation & maintenance Bonus points	**02** **01**	**02** **04**

The building is rated from one star to five star depending on points recieved by it as under:

Rating	**No of points Max. 100**
One star	50-60
Two star	61-70
Three star	71-80
Four star	81-90
Five star	91-100

4.9 ADOPTING GREEN FEATURES IN BUILDINGS

The green buildings involve additional initial costs but over the life cycle these buildings turn out to be more economical. Besides, from the environmental and social consideration, it is desirable to go for green buildings. It is not necessary to incorporate all green features in each building. Even if some of the green features are incorporated in individual buildings considerable benefit would accrue for the occupant and the environment.

4.10 GREEN BUILDING: A CASE STUDY OF NEW IRICEN ADMINISTRATIVE BUILDING

A state of art New Administrative Building near the existing Hostel at Koregaon Park is constructed to reduce travel time from hostel to Institute. Being a Premier Institute imparting training to all Civil Engineers of Indian Railways, the building was planned as a Green Building to impress upon all the trainee officers the importance of Green Environment. In building construction many environmental friendly measures such as reuse of material like released wooden sleepers, released wooden beams & purlins from existing rest house etc, use of recyclable material like Gypsum Board, Zyproc partitions, fly ash in bricks & cement were planned. Building saves 44% of energy by use of energy efficient fittings, day light integration & use of solar energy. The building also saves 59% of water by use of low flow fixtures & sewerage treatment plant. The building has been awarded LEED-INDIA Platinum rating by Indian Green Building Council (IGBC) with 61 credits, out of maximum possible 69 credits. The building has also been awarded Five Star rating under GRIHA rating system by The Energy & Resource Institute (TERI).

Over the years the demand for buildings are increasing due to increase in population. Due to change in technology and life style the demand for energy & water has increased many fold in construction & operation of buildings. Buildings consume almost 50% of energy globally. Therefore there is a need to reduce energy & water demand as well as other resource in construction & operation of building to reduce negative impact on environment.

4.10.1 Green Building:

It conserves nature & natural resources, increase energy efficiency & reduce negative impact on occupants. For this nature shall be optimally used for lighting & space conditioning by way of proper orientation of building, proper positioning & size of windows including shading & coatings, proper selection of material for roof, wall & windows including

insulation and other features like landscape & water bodies etc. Energy efficient light fittings, intelligent control like daylight sensor, occupancy sensor etc & renewable energy shall be used to reduce energy demand. Use of low flow fixtures, rain water harvesting & recycling of water are planned to reduce water demand.

The Green Building saves 30 to 60% energy demand as well as 20 to 50% water demand. It also saves requirement of virgin material due to extensive reuse of material as well as use of high recyclable content in new material.

4.10.2 Planning of New Administrative Building:

The institute was initially started in a heritage building near Pune Railway Station. Due to increased demand of training & to improve quality of training, few more wings like Library wing, Auditorium, model room, Laboratory wing & Annex wing etc. were added. Over the years it was felt to have proper campus with hostel, Institute and other facilities in one place to optimise the use of all facilities even after office hours particularly the Library & computer center with the establishment of permanent hostel at Koregaon park. Initially it was tried to get extra land from Defence at Koregaon park, however that proposal did not materialise. It was even tried to have full campus at a different location but finally it was decided in 2004 to construct new administrative building in Koregaon park adjacent to hostel by shifting the Officers Rest House. This has also reduced time & energy which was being wasted in travel to & fro from hostel to institute.

The building was planned as a state of art Building having stilt plus four floors. At planning stage itself, it was decided to construct the building as energy efficient building.

Subsequently during 2nd Works Standard Committee meeting at Shillong in 2005, which was attended by all Chief Planning & Design Engineers of Zonal Railways along with representative from Railway Board, IRICEN and Research Development & Standardisation Organisation (RDSO), it was decided that Indian Railways shall adopt Green Building technology. IRICEN being Premier Institute imparting training to all Civil Engineers of Indian Railways, its new building shall be planned as Green Building to impress upon all the trainee officers the importance of Green Environment and shall be rated by reputed certifying agency.

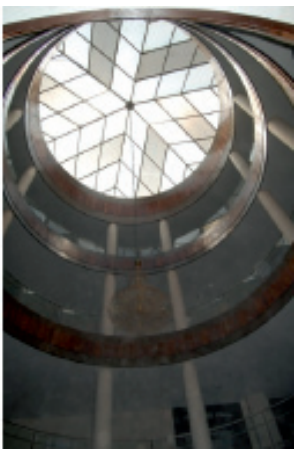
4.10.3 Intelligent Design Features:

This building has been constructed in RCC framed structure of stilt + 4 floors with a total plinth area of 8700 sqm. The facilities at each floor have been provided keeping functionality and access required by various users and outsiders. On level I Museum cum model room, which is also visited by many engineering college students as a part of their curriculum; Laboratory and Auditorium are provided. On 2nd level Library, reading room which shall be accessed by Trainees during extended hours in evening and office are provided. On 3rd level 5 class rooms with two having capacity of 70 & three having

capacity of 40 including one computer class room have been provided. On this floor conference room and computer center have also been provided. On 4th level all faculty rooms along with a committee hall for internal meetings have been provided.

(i) The building has been provided with 2 skylights, one atrium cut on all floor & other big cut out on top two floor to utilize day light to maximum extent. The skylight above atrium is covered with polycarbonate dome whereas the other skylight has been provided with BIPV (Built in Photo Voltaic) panels which generate 10 KW of electricity.

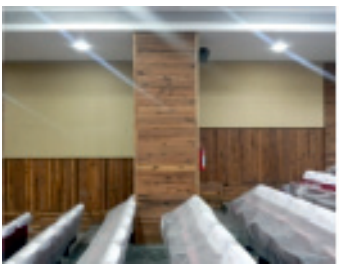
(ii) Energy saving to the tune of 44% has been achieved which is rare for such type of buildings. This feat has been accomplished by providing insulation to walls on south & west side (double wall of fly ash bricks with 25mm insulation filler in cavity), double glazed windows on south, west & east side of buildings with high performance glass, and terrace insulation by providing 40mm EPS boards and high SRI value (>90%)



(iii) The water usage has been reduced by 59% by use of sensor based low flow fixtures in toilets. 20 KLD capacity sewage treatment plant is provided which treats all the water generated from this building as well as from adjacent hostel to tertiary

level and this treated water is used for watering of landscape bringing down the fresh water requirement for landscape to NIL.

(iv) Released wooden track sleepers have been extensively used for cladding in auditorium and atrium. Released teakwood from dismantled Officer's Rest House has also been used for door frames and false ceiling of porch. Released Maple wood flooring of Badminton Court is used for stage floor of the Auditorium.



4.10.4 Green Features Provided:

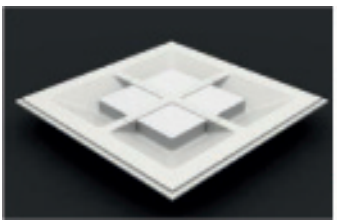
4.10.4.1 Consruction Waste Management and Resousrce Reuse:

The building has been constructed on a previously developed plot which housed officers' Rest House (ORH). During demolition of ORH, due care was taken to salvage wooden beams and posts, granite flooring and other materials that could be reused in the new building. The project has diverted 97.63% of onsite construction waste generated for landfill & other uses. Air & water Pollution Prevention during construction was achieved by provision of proper barricading & regular spraying of water. Resource Reuse achieved up to 10.79% by using materials like released sleeper wood, released teakwood from ORH, Badminton Court, maple wood flooring and use of old furniture in new Building.

Materials having Recycled Contents like Gypsum false ceiling, zyproc partition, fly ash bricks, PPC, RMC with fly ash etc. were used up to 11.67% of total material usage. 57.22% of the total value of the construction materials used in the project was manufactured with local material within 800 km of the project site.


4.10.4.2 Energy Conservation:

Energy Efficient LED lighting fixtures with Occupancy and Daylight Sensors have been used including provision of Task lighting & dimmers. Most Efficient VRV (Variable Refrigent Volume) AC Units with COP (Coefficient of Performance) up to 4.85 have been provided. The total estimated energy generation from on site PV is 51982 kWh including BIPV which is 11.24 % of the total energy required building 461,877 kWh. Measurement and Verification of Energy and Water Consumption with BMS (Building Management System). Timer Based Exterior Lighting Fixtures have also been provided. With this project was able to save 44% energy which is rare for such types of buildings.




4.10.4.3 Indoor Air Quality Management:

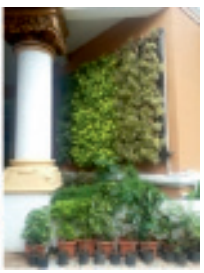
Fresh Air Design was made in all parts to meet International Ventilation Codes of ASHRAE. The entire campus site is declared as “No Smoking Zone”. CO_2 monitoring in all densely populated spaces such as Auditorium & classrooms is provided. Low VOC Adhesives, Sealants, Paints were used. Urea-Formaldehyde resins were not allowed in all composite

wood and agri fibre products were used in the building. Operable windows & Thermostats provided for Thermal Comfort & fresh air control.

4.10.4.4 Other Green Features:

Top soil was preserved and re-used. Full-grown trees that existed on the site were transplanted. 54.35% (3,061 sq.m.) of the site area (excluding the building footprint) was restored with native/adaptive vegetation. 100% Parking has been provided under cover. Separate area has been nominated for pooled cars and electric charging points provided to encourage people to reduce dependence on fossil fuel.





4.10.4.5 Other Important Measures:

Fire fighting measures have been provided as per NBC (National Building Code) norms. Smoke sensors are provided in each room. Whole building campus has been declared as no smoking zone. Fire hydrant has been provided on each floor. Two way fire brigade entry has been provided at ground floor.

The location is such that it is easily accessible by fire brigade vehicle. One separate overhead RCC tank is provided on the terrace for the firefighting purpose. Licensed authorized vendor was engaged for providing the fire fighting system.

The building has been designed as earth quake resistant structure, by following the IS code. IS 456 and IS 875 (part I to V), IS 1893, IS 13920 and IS 3370 part I to IV. The building has been designed as a framed structure. Light weight aerated concrete block (siphorex) and Gypsum board (Zyproc) have been used for partition walls to reduce loads. No overlap was permitted in the reinforcement of foundation. No overlap was permitted in bottom and top 1/3rd length of columns. Staggering of splices of reinforcement bars has been done columns and beams. Extra reinforcement bars have been provided at the junction of column and beam. Expansion joint has been provided.

The various architect effects such as Bust of Sir M Visvesaryya in atrium, Monogram of IRICEN & other beautification works in atrium & porch were provided with the help of Sir J.J.School of Arts, Mumbai.

4.10.5 Contribution of Participants:

Integrated Design and Construction process had enabled project team members to work closely from the project outset till its completion thus helping the project team to achieve appropriate solutions that have produced multiple benefits. The building was built by the Construction Organization of Central

Railway. It was a team work comprising of General Manager, Chief Administrative Officer & Construction Engineers of Central Railways, Faculty from IRICEN and various construction agencies & consultants.

4.10.6 Agencies Associated with Project & their Work :

- M/s KCPL, Miraj (Civil Construction)
- Shri Ravi Jante, Latur (Balance Works Civil Construction)
- Shree Electricals, Pune (HVAC)
- Omega Enterprises, Ahmedabad (Lift)
- Shalakha Infraprojects Ltd., Pune (Sub-station, DG)
- Data Com, Mumbai (Communication, PA system, networking
- Consultants :
- CII Godrej, Hyderabad : Feasibility Study for LEED Certification.
- M/s Shashi Prabhu & Associates, Mumbai : Architectural & Structural Consultant
- M/s Conserve, Chennai : Energy Simulator
- M/s Inertia, Hyderabad : LEED Facilitator
- Sir J.J.School of Arts, Mumbai – Bust of Sir M Visvesaryya, Monogram of IRICEN & Other beautification works.
- Sub Consultants :
- M/s V.N. Purandare & Associates, Pune : Auditorium & Acoustics
- M/s NECON Engineers, Pune : General Electrical
- M/s REFRISYNTH Engineers, Pune : HVAC
- Green One, Pune : Landscape
- SGS India Pvt. Ltd., Gurgaon : Building Commissioning Agent

4.10.7 Energy Efficiency in New IRICEN Green Building at Koregaon Park-Pune

The New IRICEN Building is designed and constructed as Green Building. It has achieved the highest LEED 'Platinum' and GRIHA 'Five Star' ratings. One of the most important features of any green building is Energy efficiency. It is calculated by comparing proposed energy utilization of the

building with energy saving measures by as against base case, i.e. an ordinary building with same built up area and usage.

The base case parameters for energy efficiency are different for GRIHA and LEED rating. But IRICEN Green building has performed exceedingly well in both the rating systems. In LEED Rating, IRICEN green building has achieved 44.25% energy saving as against base case and scored all 10 points for optimizing energy performance. Whereas, the savings projected 74.9 % energy was as against GRIHA's benchmark EPI and achieved all 16 points for optimizing energy performance.

The energy audit of IRICEN Building after one year of occupation revealed that the actual energy efficiency performance is far better than the proposed case. The energy consumption from MSEB is only half of the estimated electricity consumption. In addition 22,000 units generated from solar PV cells.

This spectacular energy performance could be achieved by taking following additional measures.

1. Efficient wall construction – Double wall of fly-ash brick masonry with sandwiched insulation.
2. Efficient roof construction:- Heat reflective tiles with high SRI value and over deck insulation.
3. Efficient Lighting: LED lights & T5 tube lights.
4. Efficient double glazing: Provision of high performance glass on all windows and double glazing on South, East and West side windows.
5. Efficient VRV COP- The A/C provided have high COP and of variable refrigerant volume (VRV)
6. Occupancy & Day light sensors.
7. Demand control ventilation.

4.10.8 Summary:

Our country is witnessing a boom in the construction sector which leads to environmental pollution, global warming etc. Green Buildings can reduce the energy demand and optimize the use of other resources. The best part of this building is that it will be part of curriculum of trainee officers at IRICEN which will help them in propagating the green concept throughout the country. New Administrative Building for IRICEN at Koregaon Park, Pune is one step taken by Railways in the Direction of Greener Environment of future.

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CHAPTER 5

BASICS OF ARCHITECTURE

5.1 PRINCIPLES OF AESTHETICS AND ITS COMPONENTS :

Aesthetics can be defined as sensitivity to aspects like colour, texture, form, balance, rhythm, composition relief, etc. This sensitivity varies from individual to individual, and because of this variation, we find that not every person can draw or paint well. Certain theories and principles, do however, govern aesthetics. Some of them are listed as below:

5.1.1 Colour

In 1931 A.D., J.E. Le Blon, laid down a theory of colours, which states that all colours are derived from 3 basic colours – Red, Yellow and Blue. These were called primary colours. A mixture of these primary colours leads to the secondary colours – orange, green and purple. It later leads to the tertiary colours – olive, and citron and quarternary colours – buff, sage and slate.

As is common knowledge, white light is composed of seven colours namely VIBGYOR. The colour that is reflected by a particular object after absorbing the other six colours is perceived by humans as the colour of that particular object e.g. when a ray of light falls on a red rose, all the other colours except red are absorbed by the flower, and red is reflected by it. That it why it is perceived to be red in colour.

A combination of various colours leads to colour schemes. Different types of colour schemes are as follows :

1.	Achromatic :	Use of black and white
2.	Monochoromatic :	Different values of the same colour

3.	High Key	: Use of dark colours
4.	Low Key	: Use of light colours
5.	Polychromatic	: Use of various colours
6.	Analogous	: Yellow-Red-Orange
7.	Complimentary	: Red-Green, Purple-Green-Yellow, (Complimentary)
8.	Adjacent	: Red-Green-Blue,Red-Green-Yellow (Complimentary) Blue-Orange-Yellow Blue- Orange-Red.

Colours have a distinct psychological impact on the viewer and directly affects his state of mind, level of calmness and enthusiasm. A few examples are listed down for reference:

i)	Red	:	Danger, excitement, War, revolution, upsurge
ii)	Yellow	:	Warmth, cheer, a beginning
iii)	Blue	:	Calm, coolness, royalty, seniority
iv)	Orange	:	Fire, stimulus, autumn
v)	Green	:	Life, growth, freshness
vi)	Pink	:	Love, health
vii)	Grey	:	Dullness, indecisiveness
viii)	Black	:	Fear, end, termination, sorrow
ix)	White	:	Purity
x)	Brown	:	Earthiness.

A combination of these colours lad to two simple categories of colours, namely the warm and the cool colours (Warm – Red, Orange, Yellow, etc) (Cool – Blue, green, etc.)

5.1.2 Balance

Balance is a quality, which though hard to define comes across very strongly in every composition. it can be categorised as shown in Fig. 5.1.

i) Formal Balance ii) Informal Balance

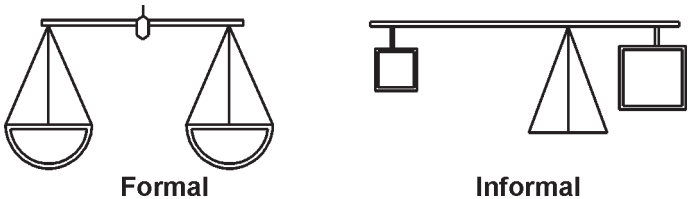

Fig. 5.1 Balance

Formal balance usually symbolizes symmetry, dignity, unity while informal balance conveys as sense of excitement and unpredictability. For example, a court building is usually symmetrical in plan and elevation, i.e. is formal and thus conveys honesty and fairness. However, an exhibition pavilion is the opposite whereby, by virtue of informal layout and appearance leads to feeling of excitement and enthusiasm amongst the viewers.

5.1.3 Textures :

Textures i.e. the relief of a particular surface, helps highlight, downplay or identify particular elements. This is a quality of the material itself, which can create interesting results when used in composition with other materials e.g.

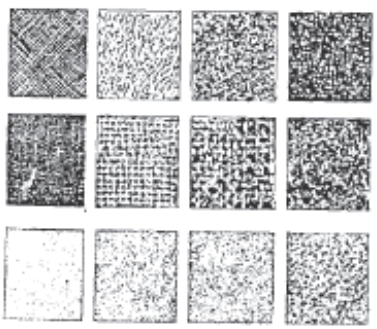

Fig. 5.2 Different Types of Textures

the soft texture of a carpet laid on the floor helps an interior of a room by giving it a soft and comfortable look. Different types of textures such as rough, smooth, grainy, undulating, pitted, rubbery, mottled are shown in Fig. 5.2.

5.1.4 Rhythm

Visual flow governing the movement of the eye from one part of a design to another in a particular pattern creates rhythm. Rhythm is a movement created by a regular succession of strong and weak elements in design. Examples are shown in Fig. 5.3 A to C.

i) Repetitive rhythm :
e.g. laid out on a grid IRON pattern.

Fig. 5.3 A

ii) Flowing rhythm :
e.g. pathways in garden.

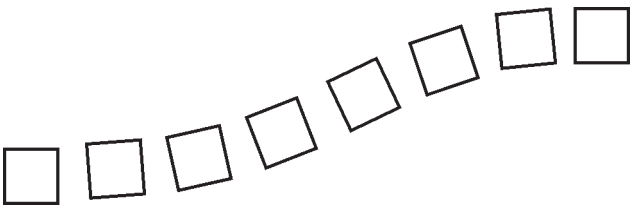

Fig. 5.3 B

iii) Progressive rhythm:
e.g. small patterns leading to large ones.

Fig. 5.3 C

5.1.5 Proportions

Proportions can be defined as a comparison of various elements between two or more objects. These elements include physical dimensions, colour, texture and the relationship between the background, middle ground and foreground (i.e. the third dimension). If proportions in a composition are not proper, it is enough to render it useless, irrespective of the other qualities of the composition. ‘‘Vitruvian Man’’ is a fine example of proper proportion (Fig. 5.4).

Objects with different elements of aesthetics, when, organized and grouped together form a “composition.” All the objects which we see in our day to day life, are thus, three dimensional compositions of different objects.

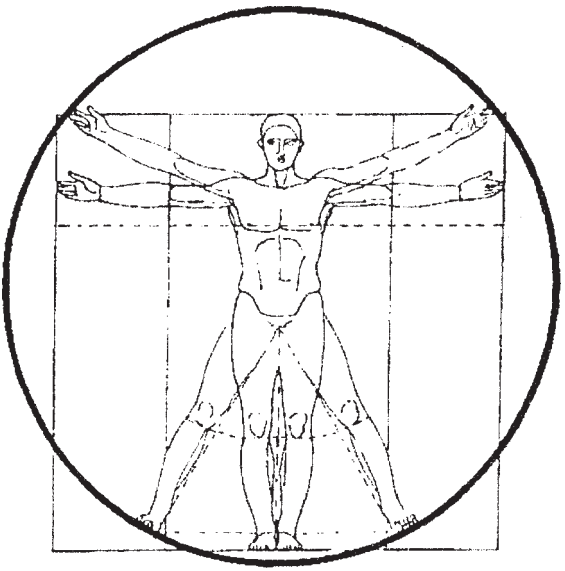

Fig. 5.4 Vitruvian Man

5.2 FORM AND FUNCTION RELATIONSHIP

This is the guiding principle of design, be it architectural, structural or product design. The function of a particular element or object leads to its basic form and a deviation in this can lead to failure of design.

5.2.1 “Form” in architecture can be defined as the coming together of similar elements in a symmetrical or asymmetrical manner. Some of the form used frequently are :

5.2.1.1 Grid form : Whenever modules are arranged at a specific regular interval, they lead to grid form, e.g. a large factory building laid out on a grid (Refer Fig. 5.5).

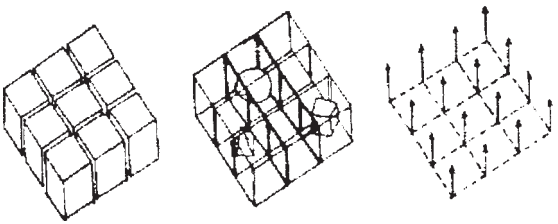

Fig. 5.5 Different Grid Forms

5.2.1.2 Centralised forms : Grouping of several forms with a central focal point usually lead to centralized forms as shown in Fig. 5.6. Due to their strong central focus, they tend to dominate a composition e.g. a circular dining table with chairs around it.

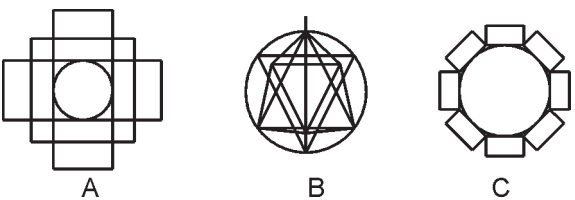

Fig. 5.6 Different Centralized Forms

5.2.1.3 Linear Forms : When elements are aligned along a central spine and grow or get added only along this spine, a linear form gets evolved e.g. growth of a town along a river, platforms along a railway track (Fig. 5.7).

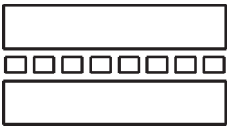

Fig. 5.7 Linear Form

5.2.1.4 Radial Form : Any composition which has elements extending away from a central local point lead to a radiant form, e.g. New Delhi (Fig. 5.8).

Fig. 5.8 Radial Form

5.2.1.5 Clustered Form : The grouping of elements asymmetrically, but at the same time, having an inter relationship, lead to cluster, e.g. a cluster of houses in a small village (Fig. 5.9).

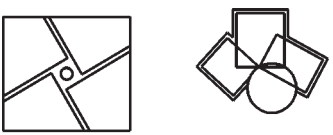

Fig. 5.9 Different Clustered Form

5.2.2 The importance of the “form and function” relationship can be clearly understood by studying some examples.

If we consider a sports stadium, the form of the stadium building, which, in principle, is a centralized form, has seats and tiers arranged around the main ground, spectators and viewers who sit on these tiers, can concentrate on the activity in the center. Also, hundreds of people witness the activity simultaneously. If a deviation was made from this basic form, the function of a stadium would not be achieved and would lead to the failure of the design.

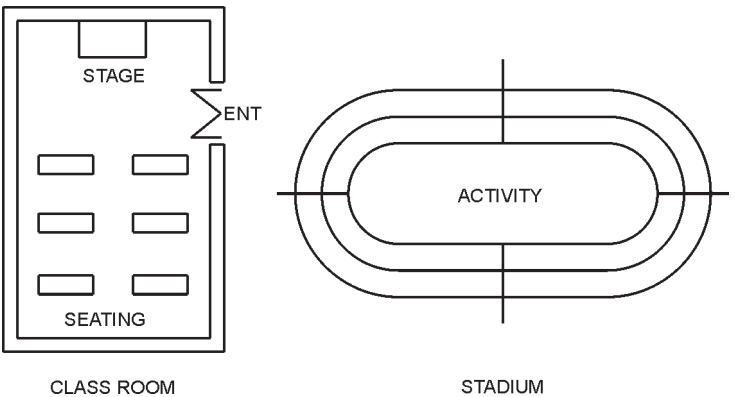

Fig. 5.10 Differences in Form

However, if the same form was to be used for classroom, it would fail as the blackboard would be visible to only those who are directly in front of it. These differences are shown in Fig. 5.10.

Railway platforms have to be aligned parallel to the tracks to enable travellers to access any bogie along the entire length of the train. An attempt to change this form would defeat the purpose as it would not function properly.

This principle guides the designing of all objects, ranging from a hair pin to a large airport (Fig. 5.11)

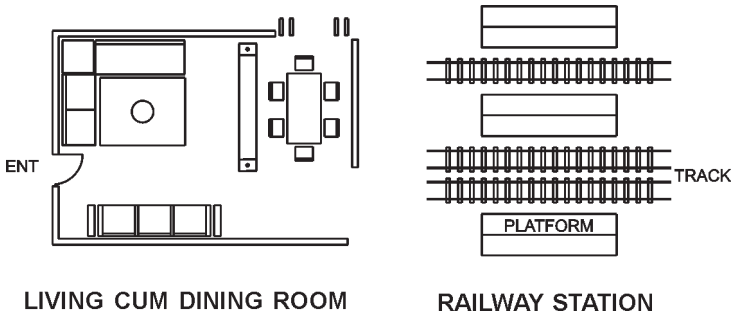

Fig. 5.11 Differences in Form

5.3 ANTHROPOMETRY

This can be defined as the relationship between the human body and movement of the body with things and spaces that it comes in contact with in day to day life. This science is extremely important to all designers, as it is an unchangeable component of any design data.

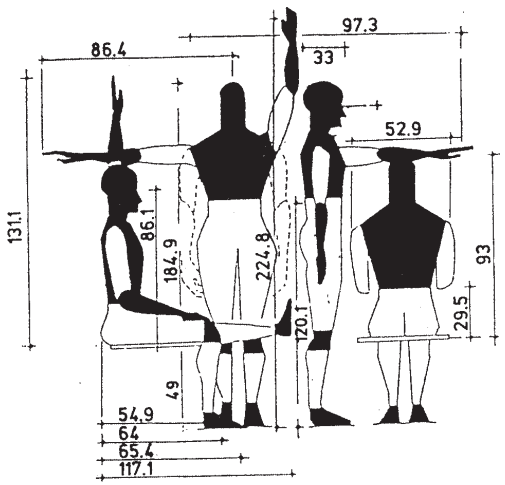

Fig. 5.12 Structural Body Dimensions

The proportions of a human body are also a part of this study, i.e. the ratio of the height of the torso to the legs.

Dimensions of the static human body and the human body in motion can be classified as :

i) Structural dimensions (Refer Fig. 5.12)
ii) Functional dimensions (Refer Fig. 5.13).

Structural dimensions are static i.e. measurements of the head, torso, limbs, arm length, etc. These are essentially fixed, and based on a large case studies, an average set of measurements is worked out.

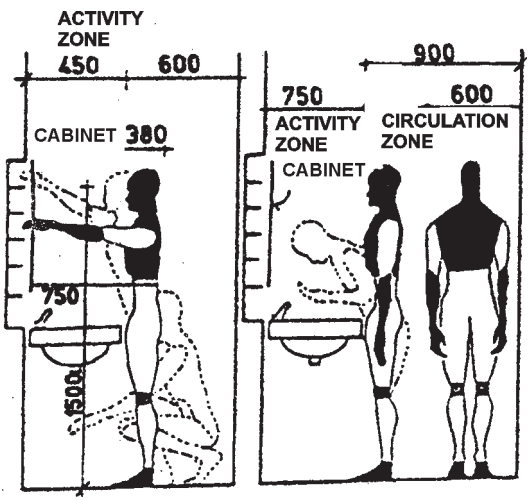

Fig. 5.13 Functional Body Dimensions

Functional dimensions are dynamic are related to the positions and movements of the human body associated with tasks e.g. sitting, climbing, walking, sleeping etc. These become extremely critical in architectural designing, as they determine the standards of comfort while implementing the task.

A variation in any of these can lead to design mistake. If a kitchen platform gets too tall, cooking on it would become extremely difficult. Some important standard functional dimensions are listed in Annexure, at the end of this book for ready reference.

5.4 BUILDING COMPONENTS

Any structure is a composition of various building components. The components by themselves, are non-functional. However, when composed together, they acquire a value of their own. Each component has to fulfill two aspects, namely functional and aesthetical. A window, for example, is useless unless it is set into a wall of a room. Once placed in a position, it carries out the function of providing light and ventilation to the interior. Along with this, a proportionate and elegant window opening can add to the aesthetical value of that particular elevation.

Basic components include the structural members, walls, ceilings, floors, roofs, etc. while secondary components include windows, doors, weather sheds, porches, pergolas, etc.

5.4.1 Analysis of Building Components

The analysis of building components forms a very important part in the process of designing and detailing. It can be carried out as follows :

1. Type
2. Function
3. Location
4. Material
5. Aesthetical impact.

This can be properly explained by studying an example.

1. The type of component would include the physical attributes like thickness, size etc., i.e. 4 1/2 “, 6”, 9” thick brick masonry or in case of windows, whether it is sliding, pivoted or

top hung determines its type.

2. The function of the component determines all the other factors. A 4 ½" thick brick wall is used on external faces as an infill panel whereas 14" thick brick masonry acts as a load bearing wall.

3. The location of the component depends on the function. For example, if windows are placed on the windward sides then the quality of ventilation is satisfactory. Careful attention is required while finalizing their locations.

4. Each component can be cast or fabricated in different materials and the aesthetical value of the structure is determined largely by the material used. Brickwork, stonework, cement blocks, special block, etc. can perform the function of a wall but by virtue of the material used, the external appearance can change.

5. All the above factors help to enhance or lower the visual impact of the component. As seen in Fig. 5.14 below, the offset in the dining room spoils the appearance to a certain extent.

5.4.1.1 Structural Members

Columns of a structure can protrude out to the

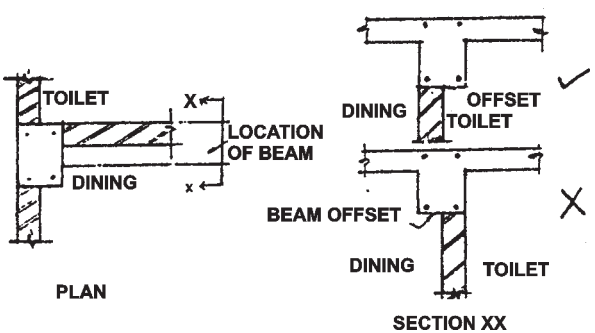

Fig. 5.14 Visual Impact of the Component

elevation and can appear highly unsightly. However, these can be highlighted instead and can be used as features, e.g. in factories a rhythm can be established using the same. Structural members create ugly offsets and can spoil the entire interior of a room. Beam offsets result in breaking the continuity of walls. Lintels can create ugly patches on elevations. An effective method to avoid this is by co-relating the structural drawings with architectural drawings prior to construction.

5.4.1.2 Roofs

Various roof forms can be used and different shapes can be explored, like flat slabs, sloping roofs, vaults, domes, pyramids. Flat slabs are generally used in offices, apartment blocks, institutional buildings, etc. Bungalows, cottages, holiday resorts with sloping roofs have their own charm. Entrance foyers of large public building and hotels look impressive if they have high roofs. This just goes to show the different effects which are created by the skillful use of components.

5.4.2 Secondary Building Components

Some of these components are doors, windows, weather sheds, planters and flower boxes, grooves/ mouldings, window grills, entrance steps, porches, patios, sitouts, awnings, terraces, cornices and arches. These are being continuously upgraded and new inventions and building materials lead to an overall change in the elevational values of a building. However, care has to be taken while selection of components and materials as wrong choices can lead to shocking disparity. For example if aluminium sliding windows are used in a structure with Gothic facades, the effects would not be harmonious.

Combination of various building components leads to various elevations and thus to the overall effect. This has lead to different architectural styles being evolved. For example in Gothic structures, ornate facades, moulding in plaster, stained glass windows, false fronts, false columns etc., contributed towards the evolution of surface decoration skills to perfection.

The real skill of a designer lies in the combination of these components in order to create a volume which is interesting in appearance, without compromising on the function.

■ ■ ■

CHAPTER 6

THE PROFESSIONAL ARCHITECT

6.1 SERVICES RENDERED BY AN ARCHITECT

As in all professions, even architecture has its ethics and norms of practice. A qualified architect can practice in the country provided he is a member of the Council of Architecture, which is the central governing body. On completion of his professional studies he is awarded the membership of this Council which enables him to practice anywhere in the country provided he follows the norms laid down by the Council. The duties and functions of an architect are listed below, and the fulfillment of each of these is required for a good design solution. The services rendered by an architecture are as under:

1) Visit to the proposed site to get a feel of the layoff, the land, surroundings, roads, electrical cables, drainage & water lines, existing vegetation, etc. which are likely to affect the site and design.

2) Preparation of conceptual sketch designs based on the requirements given by the client.

3) Preparation of detailed sketches before finalisation.

4) Finalisation of sketch design.

5) Preparation of the submission drawings, etc., to be sent for sanctioning to the various government bodies.

6) Assisting the client in the approval of plans

7) Preparation of initial estimates based on standard cost guidelines and material specifications.

8) Preparation of detailed working drawings and working details pertaining to civil work.

9) Assisting the client in the appointment of various consulting agencies, if required.

10) Preparation of final estimates based on the final architectural and structural drawings.

11) Explaining the available option regarding the various types of civil contracts and assisting the client in finalisation of the type of contract.

12) Assisting the client in the scrutiny and analysis of tenders.

13) Assisting the client in negotiating the finalisation of the civil contractor.

14) Drafting of agreements between clients and contractors (optional).

15) Supervision on site to ensure quality, speed and trueness of the work and to prevent any deviation from the approved plans.

16) Submission of site visit reports to the client.

17) Checking of bills raised by the civil contractor and certification of the same on behalf of the client.

18) Issuing stage completion certification to the client for submission to financial institution, if required.

19) Preparation of landscape scheme on the completion of the civil work to enhance the working environment and to minimize pollution (optional).

20) Assisting the client in getting the completion certificate for the work from the authorities.

6.2 ADDITIONAL AND OPTIONAL SERVICES

1) Obtaining the contour survey of the site from an associate agency.
2) Making a model of the structure/campus.
3) Assisting the client in appointment of structural, landscape, water and sewerage consultants.

6.3 IRICEN BUILDING - CONSULTANCY CONTRACTS

1. General :

A new administrative building for the Indian Railways Institute of Civil Engineering (IRICEN) was to be constructed in Koregaon Park at Pune. In view of the specialized nature of the job, Railways decided to go in for Architectural and Structural Design Consultancy for the said work. The tender documents, schedule and other details in connection with fixing up the agency for the above work are given below.

2. System of Tendering :

The tender was in two packet system – Technical & Financial. Two separate envelopes, one for each bid were prepared and both the bids were submitted together after putting both the envelopes in one single envelope. The details of each packet are mentioned below :

(a) Packet-I (Technical Bid) : For packet-I, the tenderers will be required to submit following documents :

(i) Architectural Drawing & Design with plan, elevation and perspective view.

(ii) Brief report giving important features of drawing, design and other important aspects.

(iii) The estimated cost of the project based on the design and drawing submitted by the Consultants. (The consultants are required to develop the design/ scheme keeping in view the total cost of the project.)

Bidders were shortlisted on the basis of details furnished by them. Bidders were asked to make presentations also.

(b) Packet-II (Financial Bid) : Packet-II was the financial bid based on detailed design and drawing, conceptual plan etc. furnished by the consultants. Packet-II of only the selected bidders, which comprises of detailed offer for Architectural and Structural design as per Railways schedule, were opened in their presence about which they were informed in writing.

3. Submission of Bids : Following condition was incorporated

The tenderers shall be responsible for the proper submission of the bid to the proper authority in time. The tenderers are required to sign each and every page of tender document before submission. It may please be noted that Railways will not be responsible for any postal delay.

4. Eligibility Criteria for Tenderers : Criteria was incorporated

Only those firms, which in their individual capacity satisfy the following criteria need to quote for this tender.

(a) Total contract amount received during the last three financial years and in the current financial year should be minimum of 150% of advertised tender value.

(b) Should have completed in the last three financial years (i.e. current year and three previous financial years) at least one similar single work, for a minimum value of 35% of advertised tender value.

Note:- (1) Criterion (a) :Following documents will be relied upon for working out the total contractual amount received by the tenderer to evaluate credientials against criterion (a) above :

(i) Attested copies of Annual Income Tax returns field with Income Tax Department.

(ii) Attested certificate of the tax deducted at source (TDS certificate).

(iii) Audited balance sheet duly certified by Chartered Accountant.

(iv) Attested certificate from Employer/Clients about the contractual payment received for the work done.

(2) Criterion (b) : The word completed would mean having satisfactorily executed the single work of requisite value in the qualifying period specified in criterion (b) above.

Tenderers should submit documentary proof in regard to fulfilling these eligibility criteria along with their offer. The offers of tenderers who do not meet the eligibility criteria as mentioned vide (a) to (b) above shall not be considered. The tenderers who fail to submit documentary proof along with their offer will, normally, not be considered.

5. Scope of Consultancy Services :

Consultancy was required to be carried out for the following:

(I) New administrative building complex including its surroundings.

(II) New 10 suite Officers' Rest House.

(III) Conversion of part of the existing IRICEN Building to 20 room Officers' Rest House.

With respect to all of the above, the Consultants were directed to carry out the following:

1) Preliminary Concept Design :

The Consultant shall

a) Furnish a preliminary report bringing out Consultant's visualization of the project, the design proposal highlighting how it addresses the various issues discussed in the prelude/ introduction section of this document and also site evaluation and analysis with basic approach to circulation, activity, distribution and interaction and external linkage.

Note : The report should not be in more than 10 pages.

b) Prepare site plan (layout plan) showing contours, features and services and facilities available, general layout of buildings and services, preliminary sketch and design with drawing, giving details of useful areas, services areas, circulation area and total plinth area to provide information in respect of magnitude of work and its component and service. The Consultant should submit the design and modify it if considered necessary by the Railways. Site inspections for finalisation of above details shall be conducted by the Consultant at their own cost.

c) Obtain the approval of the Employer to (b) above and supply 6 copies of approved site plan (Layout Plan). Note : The layout plan shall be a dimensioned plan.

2) Master Plan :

a) Furnish a detailed report bringing out Consultant's visualization of the project, the design proposal highlighting how it addresses the various issues discussed in the prelude/ introduction section of this document and also site evaluation and analysis with basic approach to circulation, activity, distribution and interaction and external linkage.

The narrative report will specifically mention if the proposal would need approval from Municipality or any other authority.

b) Furnish preliminary report on environmental impact of the project if required and finalize it after discussion with the Railways clearly outlining the measures required for mitigating the adverse impact.

c) Prepare Master Plan showing planning for all internal and external utility services like water supply, sewerage, storm water drainage, electrical, HVAC (Heating, Ventilation and Air-conditioning) Fire Alarm & Fire-fighting appliances, accoustics, telephone conduit, street/compound lighting, landscaping, development plans showing roads, paths, parks, paved areas, drains, culverts, compound walls, external lighting, interior design and graphic signage, security system, telecommunication system etc. indicating scope, specifications and costs separately of such sub-head. The scope of work shall be as defined above, however, the employer reserves the right to exclude any of the above services from the scope of the Consultant's work.

Proposed structures in appearance should be aesthetically appealing and matching with the cultural heritage of local area. The elevations will normally show the treatment given to the Exterior surfaces all round as well as other details viz. Doors, Windows, Openings, Balconies, Arches, Canopys, Projections, etc. along with the colour schemes. The plan will also show type of Floor, Wall Treatment, Staircase including & railings, provision for Water supply, Sanitary, drainage including type and location of fittings and fixtures; the type and locations of Electrical wiring, Fittings and Fixtures. The specifications of material proposed to be used, will be given, if not covered by standard specifications of Central Railway. The complete inventory of all fittings and fixtures will be given.

Architectural features should not be unduly complicated to cause any problem in execution.

d) Obtain approval of the Railways to (c) above.

e) Architect will submit abstract or preliminary estimate on plinth area rates basis of the works proposed in the Master plan. The estimate will be supported with details of area/size

and rates adopted. The approximate cost of the work is Rs.3.84 Crores. The architect is expected to submit the proposals, execution of which will cost around Rs.3.84 Crores.

f) Obtain the approval of the Railways to (e) above.

g) Submit the proposal to local body complete as per requirement of local bodies including preparation of Model/ Presentation of Model etc. if any.

h) Obtain the approval of layout plan & drawing from the competent authority and statutory body, if necessary, according to the local Acts, Laws, Regulations etc. and make any changes desired by such authorities. The approved/modified layout plan and drawings are to be submitted to Railways.

i) Submit program of work assigned to them, up to the stage of tender document.

j) Submission requirement:

(i) Detailed report in bound booklet of A-4 size.

(ii) A diagram of the general functional arrangements as designed, showing the distribution of activities at different levels.

(iii) Summary schedule of usable and gross areas expressed in the metric system.

(iv) Drawings:

1. Lay-out drawing on a 1:5000 scale shall indicate the lay-out of propose building with the extg. Buildings, urban form and necessary infrastructure and area details as per Railways requirements along with corresponding sections. It should also indicate the landscaping, types of plantations etc. in and around the proposed building. It should also indicate the parking arrangements.

2. Detail drawing on a scale of 1:400 of the administrative building.
3. The conceptual details and sketches of various modules.
4. The plans for circulating area showing the dimensions and layout of circulating area with arrangements for Drainage; Entry, Exit and Parking for Vehicles; Garden, Flower beds, Trees; External Lighting; Footpaths, etc. and Landscaping in general.

5. Three dimensional Illustrations : As may be felt necessary by the Architect.
6. CD of proposal : The entire proposal should also be submitted on CD should be in “dwg” format, readable in AutoCad release 14.

7. MODEL: A building model including the campus at a scale l:500. The architects are free to give perspective drawings etc. explaining their proposal in detail in addition to building model. It will show the proposed building and the surrounding area including circulating area, parking and approaches. It should be sturdy enough to withstand shifting for display purposes.

k) Number of copies of drawings:

The Consultant shall supply to the Railway a minimum of 6 (Six) copies of plans at each stage along with original tracings with cross sections, front and side elevation to explain in details and soft copy on CD.

l) Alterations in drawings :

The Consultant shall not make any deviations, alterations, additions or omissions from the approved drawing without the knowledge and prior written consent of the Railways. In case of any change required due to site conditions, Consultant will supply modified plans to the extent necessitated without any additional charges.

3) Detailed estimate, working drawings and schedule of rates and quantities stage :

The preparation of detailed working drawings incorporating services and schedule of quantities.

a) Preparation of working and detailed architectural and structural drawings and detailed estimate as per Railways norms for civil, electrical and telecom works, for all items of the above work, including internal and external utility services, along with details of quantities (Bill of quantities), supporting calculations and details of structural design for whole of the work to facilitate call of tender.

For items not covered by the schedule of rates the Consultant would provide detailed specifications, description of the item and market rates. Railways will work out the analysis of rates and modify the cost of individual items, if required in consultation with the Consultant.

b) Obtaining approval of Railway to the above and modify them if considered necessary by the Railways and/ or if the cost exceeds the approved preliminary cost by over 5%.

c) Obtain the approval of the Railways to (a) & (b) above and to all computations of all structural designs and all services designs which shall be in accordance with the latest IRS/IS codes of practice. Such detailed computations of all designs shall be made available to the Railways for any check and approval the employer may like to exercise, before sanction detailed estimates and call of tenders. The Consultant shall indicate the names of his Associates, if any, for various services and structural designs, their organizational affiliation, qualifications and experience and shall be fully responsible for the correctness and accuracy of structural and service designs and the responsibility for safety of the structure shall be entirely that of the Consultant, notwithstanding the approval by the Railways of these designs. The Consultant and their associates, if any, shall certify in writing that the designs are in accordance with the up to date and relevant codes of practice.

d) Obtaining approval of local authorities, if any, and make changes required by them.

e) All the structural designs and drawings shall be got proof checked by IIT Mumbai/VJTI Mumbai/Govt. College of Engg. Pune at consultant's cost for which nothing extra will be payable.

f) Supply to the Railways eight copies of the detailed working drawings, specifications (Bill of quantities) and detailed estimates etc. free of charge for use during execution of work.

g) While designing the structures, relevant IS codes and supporting specifications of Central Railway, wherever applicable will be considered. All the working drawings should show the dimensions of beams, columns, slabs as well as reinforcements, etc. in metric units.

Detailed estimate will be prepared taking into account prevailing market rate of labour and material and overhead expenses. This will also include the price list of all the fittings and fixtures as well as of any special material or workmanship proposed by the architect.

4) Construction Stage:

a) Supply to the Employer such further drawings, specifications or details which may be required for proper execution of work.

b) Obtain Employer's approval for any material deviation in design, cost, working drawings, schedule and specifications from the approved scheme.

c) SITE VISITS : The architect will be required to visit the site of work during execution(construction) which may start within 6 months of approval of detailed drawings and may continue for one and half year or so. During this period, services of architect may be required to visit the site of work to clarify any decision or interpretation of the drawings and specifications that may be necessary and attend conferences and meetings

as and when required, After each site visit the architect should confirm that the work is being executed as per drawings & specifications and deviations if any shall be brought to the notice of Employer. The architect may also offer suggestions, to improve appearances and workmanship or/and offer necessary guidance in executing the work as per approved architectural drawings. The payment shall be made on pro-rata basis per visit.

5) Completion Stage:

a) Obtain completion and occupations certificates, wherever necessary from the local bodies, after, completion of work and inspection by Municipal/Fire/Electrical Inspectors and supply the same to the Employer. For this purpose any assistance required from the employer will be extended to Consultant. Any fee payable to local bodiesfor issue of completion certificate shall be borne by the employer.

b) Prepare completion drawings, including 1:100 scale plans, elevations and cross sections etc. indicating the details of the building and all internal and external services as completed and supply 4 sets of completion drawings to the Employer and also hand over the original of the completion drawings to the Employer. The changes, if any, during the execution of work will be intimated by the employer to the Consultant for preparation of above drawings.

c) Assist the employer in Arbitration/Litigation case that may arise out of the contract entered into, in respect of above work, regarding clarifications/interpretations, supply of drawings, designs, specifications as and when required. The Consultant's role will be limited to these clarifications only and unless specifically required by Arbitrator/Court, he shall not be required to participate in actual Arbitration/ Litigation.

6. Payment Schedule :

The estimated cost of the work as mentioned above

was Rs.384 lakhs. The consultant was asked to quote his offer on lumpsum basis taking into account the items of work/ consultancy required as listed in the tender documents viz. para 1 to 5 above and other terms and conditions. However, after acceptance of offer, the payment for individual item/activity shall be released as a percentage of accepted offer value according to following schedule :

	Description of item/activity	Payment as a percentage of accepted offer
1	On submission of conceptual drawings thereof and reports and the approval by the Railways.	10%
2	On submission of Master plans, all architectural drawings and detailed drawings (excluding those related to structural design) with abstract Estimate and approval thereof.	20%
3	On submission of model.	10%
4	On obtaining necessary clearance from local bodies, if required.	10%
5	On submission of detailed designs duly proof checked by IIT, Mumbai/VJTI, Mumbai/Govt. Engg. College, Pune, working drawings.	7.5%
6	On approval of detailed designs duly proof checked by IIT, Mumbai/VJTI, Mumbai/Govt. Engg., College, Pune, working drawings.	7.5%
7	On submission and sanction thereof by the Competent authority of the detailed estimate.	10%
8	On submission and approval thereof by the Railways, of the Schedule of Rates and quantities and Rate analyses.	15%
9	For conducting site visits	10%

The fees for the Architectural consultancy for the above project will remain unchanged even if the total cost of the project increases subsequently. The fee includes the cost of providing local representative for day to day liaisoning during the designing and executing the project and travel expenses towards periodical supervision by the Architects, Engineers and other technical persons. All taxes are to be borne by the architect.

7. Completion Period :

The entire work was to be completed within 6 months. The time schedule for submission of various plans by the Architect was as under :

	Activity	**Date**
(i)	Date of issue of acceptance letter.	D
(ii)	Submission of conceptual plans after issue of acceptance letter	D+15
(iii)	Approval of conceptual plan after receipt of the same	D+30
(iv)	Submission of master plan and abstract estimate after approval of conceptual drawings.	D+45
(v)	Approval of master plan	D+60
(vi)	Submission of detailed architectural plan after approval of master plan.	D+75
(vii)	Submission of detailed plans for circulating area after approval of master plan.	D+75
(viii)	Obtaining clearance from the local bodies, (If required) after approval of master plan	D+75
(ix)	Approval of detailed architectural plan.	D+90
(x)	Approval of detailed plans for circulating area.	D+90
(xi)	Submission of Model after approval of Master plan	D+90
(xii)	Submission of detailed estimate after approval of Master Plan.	D+90
(xiii)	Submission of schedule of rates and	

	quantities and rate analyses in Railways format, after approval of Master Plan.	D+90
(xiv)	Approval of model.	D+105
(xv)	Submission of designs and detailed structural drawings duly proof checked by IIT, Mumbai/VJTI,Mumbai/Govt.College of Engg., Pune after approval of detailed architectural plan for the building.	D+120
(xvi)	Sanction of detailed estimate	D+120
(xvii)	Approval of structural designs and drawings	D+150
(xviii)	Miscellaneous activities.	D+180

8. Assessment Criteria for Technical Bids :

The Technical bid of the Architect will generally be assessed on the basis of its ability to meet the requirements outlined in the 'Nature and Scope' section of this document. The assessment will be made on the basis of following broad parameters. Marks allotted against each is also indicated :

(i) Functionality : 10

This includes ability of the proposed building to meet the functional requirements as outlined in the introduction section of this document, optimum use of available space, ability to meet emergencies, reduce noise pollution from adjacent tracks and roads etc. and innovative solutions for various services required, etc.

(ii) External linkages : 10

This includes its ability to integrate with the existing IRICEN Hostel and the proposed Sports Complex, facilitate quick and organized movement from one to the other and conservation and enhancement of onsite landscape elements, etc.

(iii) Energy saving features : 10

This includes maximum use of natural daylight, features such as window sizing and shading, insulation and use of efficient light fittings, use of sensors for lights and air conditioning and maximum use of renewable energy sources, intelligent features for energy conservation etc.

(iv) Cost of construction : 10

This includes ability to meet out all the requirements at least construction cost.

(v) Environment friendliness : 10

This includes ability of the design to conserve and improve the environment, conservation of scarce natural resources such as water and energy, efficient methods for rain water harvesting, effluent treatment and water recycling and sufficient green spaces, etc.

(vi) Aesthetics : 10

This includes the visual appeal of the building and the surroundings and its ability to integrate with the other structures in the vicinity, etc.

(vii) Communication efficiency : 10

This includes the efficiency of communication amongst faculty, between Trainee Officers and faculty, between IRICEN and other departments of the Railways etc. primarily pertaining to telecom and internet facilities by incorporating latest technology in terms of electronic connectivity and convergence of data – voice – video in one single network, etc.

(viii) Maintenance free features, provision for future expansion, overall perception etc. : 10

This includes incorporation of such construction/ finishing material which will require least maintenance during

its life time, flexibility of addition, expansion and alternative uses required to accommodate growth and wider institutional horizons in the decades ahead, etc. and the ability of the building to qualify as a landmark structure and also its ability to reflect the vision and the values of the Indian Railways.

9. Procedure for Selection of Architect :

A five member Tender Committee covering all functions i.e. Civil, Electrical, S&T and Finance evaluated the Technical bids. Conceptual plans, drawings, layout plans and design submitted by Architect and further evaluated by the Tender Committee by allotting marks independently by each member to the details submitted by the tenderer and as outlined above. The evaluation was done independently. The marks so obtained, as allotted by all the members independently, were added to obtain the total marks for the tenderer. Based on the total marks obtained, the tenderers were ranked and financial bids of six firms ranking from first to sixth based on total marks obtained were opened.

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Annexure

(Para 5.3)

STANDARD HEIGHTS/DIMENSION/CLEARANCES FOR FIXTURES/FITTINGS/ELEMENTS

Architectural Element/Fitting/Fixture	**Height/Dimension/ Clearance (cm)**
Top of Kitchen platform	80
Minimum clear opening below slab of kitchen platform to accommodate a cooking gas cylinder	68
Top edge of kitchen sink	74
Height of 30 cm wide shelf (to provide full reach upto back of shelf) (Maximum)	150
Lowest shelf in kitchen	50
Front top edge of wash hand basin	85
Top of partitions for urinals	130
Lip of urinal for gentlemen	70
Bottom edge of reflecting surface of mirror fixed behind wash basin	130
Height of Rod of towel rail	90
Bottom of shower rose	200
Height of Stop cock for shower rose	100
Height of Tap in water closet	22
Height of Tap in kitchen ground sink	40
Height of Tap in bathroom	70
Height of Tap in bathroom-if used for taking bath sitting on floor, below the tap	110
Bottom of ceiling fan	260
Top of railing in balcony	90
Top of stair case railing (measured from edge of nosing of steps)	85
Clearance between ceiling fan and ceiling (minimum)	30
Projection of tap in bathroom	20
Projection of shower	50
Distance between centre of W. C. and adjacent wall	45
Min. space in front of W. C.	60

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For suggestions, please write to:
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