RRB-JE 2024

Railway Recruitment Board

Junior Engineer Examination

Civil Engineering

Building Construction

Well Illustrated **Theory** *with*
Solved Examples and **Practice Questions**

MADE EASY PUBLICATIONS

Building Construction

Contents

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CHAPTER 01

Introduction

1.1 Introduction

The term building in Civil Engineering parlance is used to mean a structure having various components like foundations, walls, columns, floors, roofs, doors, windows ventilators, stairs, lifts, various type of surface finishes etc. As a Civil Engineer is mainly concerned with the construction of buildings, it is essential for him to acquire good knowledge of construction of various components of a building.

1.2 Type of Building

National building code of India (SP : 7-1970) defines the building as any structure for whatsoever purpose and of whatsoever materials constructed and every part there of whether used as human habitation or not and includes foundations, plinth, walls, floors, roofs, chimneys, plumbing and building services, fixed platforms, verandah, balcony cornice or projection, part of a building or any thing affixed there to or any wall enclosing or intended to enclose any land or space and signs and outdoor display structures tents, shamianas and tarpaulin, shelters are not considered as a building.

As per national building code of India, buildings are classified into nine groups based on occupancy as follows:

Group A : Residential buildings
Group B : Educational buildings
Group C : Institutional buildings
Group D : Assembly buildings
Group E : Business buildings
Group F : Mercantile buildings
Group G : Industrial buildings
Group H : Storage buildings
Group I : Hazardous buildings

1.3 Structural System of Building

Building is an assemblage of two or more components which are interrelated and compatible. Each component is essential for the required performance of a building. Building components like walls, floors, roofs, windows and doors are interrelated and compatible with each other. The required performance of the building as a whole imposes restrictions on the components.

The simplest building system consists of only two components, floor and an enclosure. Floor is a flat horizontal surface, on which human- activities take place. An enclosure extends over and around the floor giving shelter to living being from weather.

A load bearing wall is one which rests on the foundation taken deep into the subsoil. It takes superimposed load. i.e. the load transmitted from slabs and beams. It transmits the load of the superstructure on the subsoil on which it rests. The entire wall should be taken deep into the ground where the enlarged footings provide enough stability for it. Also stress transmitted is considerably reduced because of increase in width of footings.

A partition wall is an internal screen wall which rests above the floor level; to create a room or enclosure. It may not be anchored deep into the soil and may; not take any load of superstructure.

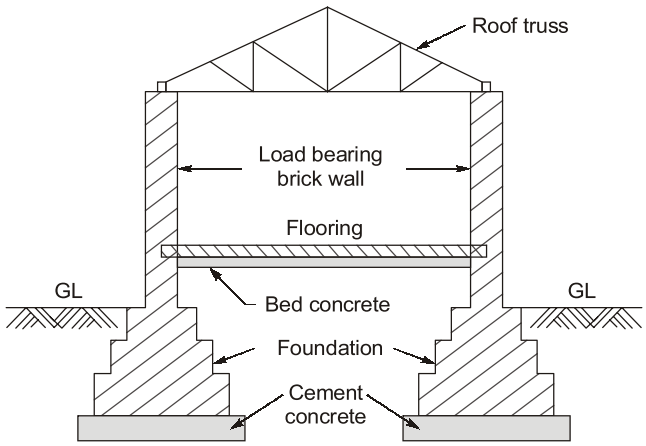
According to structural system there are three types of buildings:

(1) Load bearing structure (2) Framed structure (3) Composite structure

1.3.1 Load bearing structure

The system of building comprising of slabs, beams and load bearing walls is known as a load bearing structure. Most of the residential buildings are small in size and are up to three storey are generally constructed as load bearing structures.

As shown in figure below loads from the slab roof or trusses and floors are transmitted through walls to the firm soil below the ground. In load bearing structures walls of the upper floors have less thickness than the walls of lower floors, so compared to upper floors, the carpet area at lower floors will be less. Such type of structures are most suited for buildings up to three storey and where hard strata of soil is available. Generally for individual residential bungalow, tenement, low rise flats, temples and rural buildings load bearing structure system is adopted.



Load Bearing Structure

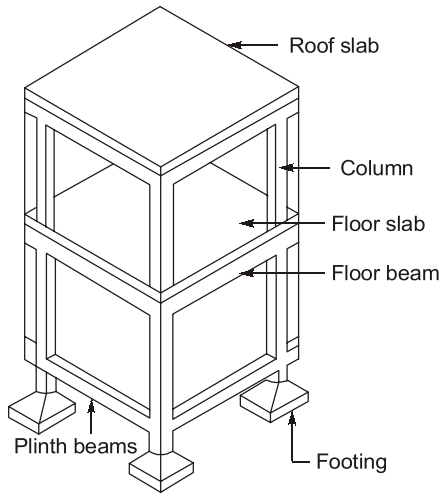
1.3.2 Framed Structure

It is a structure comprising of slabs resting on beams which are supported by a network of columns. As shown in figure below the live load from the slab is transferred to the cross beams, which in turn transfer it to main beams through rigid joints. Main beams rest over I columns and load from the beam is transferred I to the soil through columns and their footings.

All the walls may or may not be a partition walls as none of them bear any load. All the walls rest on plinth beams and not provided with any footing or foundations. Generally all multistoried buildings or high-rise buildings are constructed as framed structure. As partition walls can be shifted easily anywhere on the floor, higher degree of flexibility is available while planning a framed structure.

All the above elements of the frame are constructed monolithically. Framed structure is subjected to a variety of external loads like compressive, tensile, torsion and shear along with moment. R.C.C. is the most suitable material to withstand all these loads. Bricks can withstand only compressive loads, so all framed structures are constructed with R.C.C.

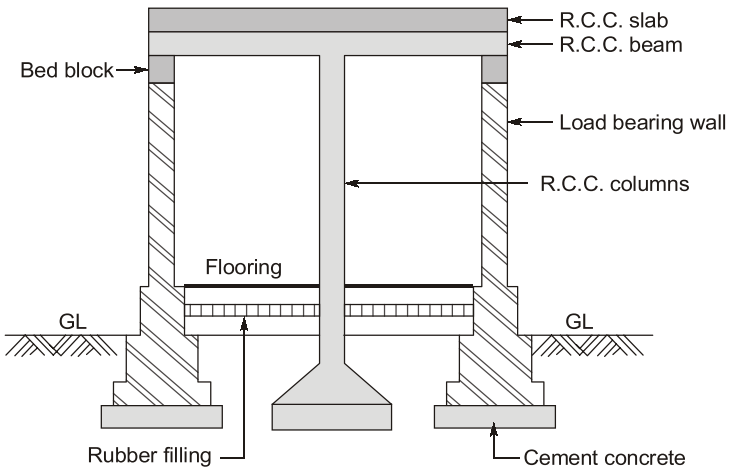
In comparison with load bearing structures, more carpet area is available and lit is almost same for all the floors.



Framed Structure

1.1.3 Composite Structure

As shown in figure below some of the buildings are constructed with combination of both load bearing as well as framed structure. Such structure is (called composite structure. In this type of structure external walls are treated as load 'bearing walls and all intermediate supports are in the form of R.C.C. columns. Composite structures have advantages of both load bearing as well as framed structure. Composite structures are preferred for the buildings having large spans such as warehouses, workshops, halls, large factory sheds, etc.

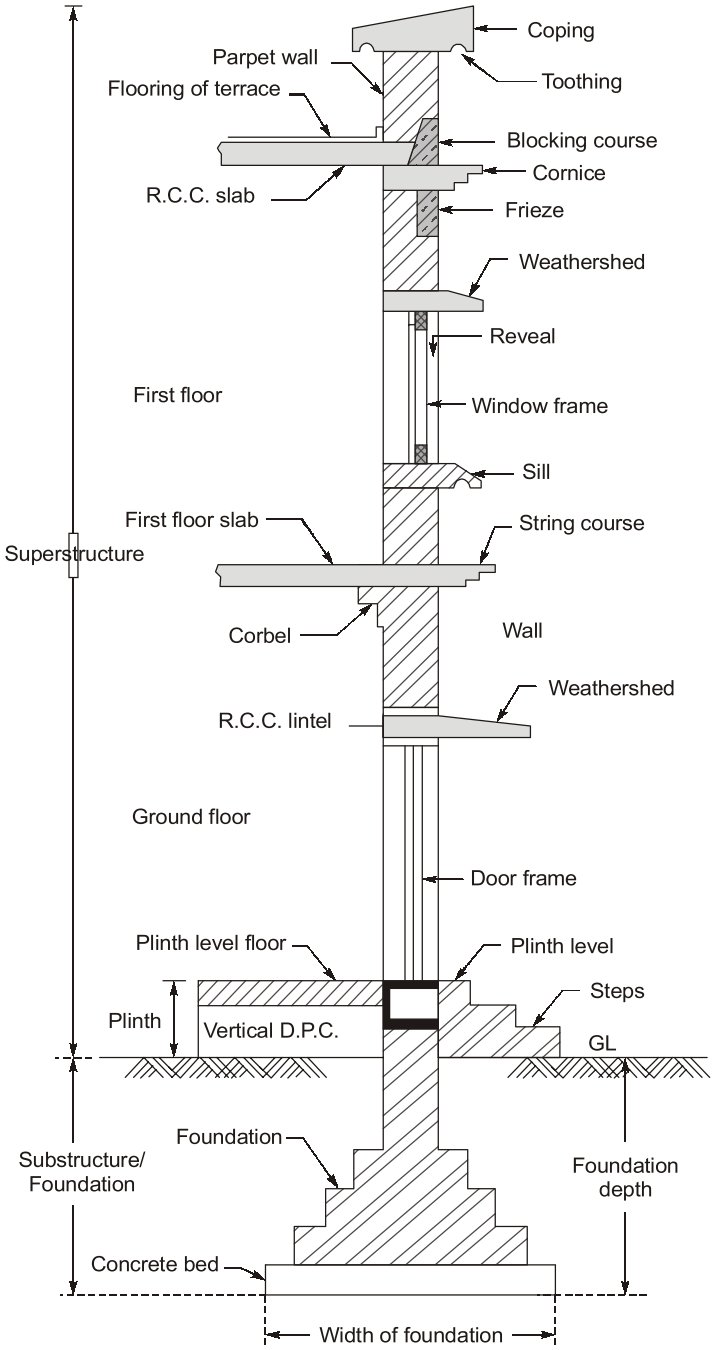


Composite Structure

1.3 Components of Buildings

A building has two basic parts: (i) Sub-structure or foundations (ii) Super structure

- Sub structure or foundation is the lower portion of the building, usually located below the ground level, which transmits the load of the superstructure to the supporting soil.
- A foundation is therefore that part of the structure which is in direct contact with the ground to which the loads are transmitted.
- Superstructure is that part of the structure which is above ground level and which serves the purpose of its intended use. A part of the superstructure, located between the ground and the floor level is known as plinth.
- Plinth is therefore defined as the portion of the structure between the surface of the surrounding ground and surface of the floor, immediately above the ground. The level of the floor is usually known as plinth level. The built up covered area measured at the floor level is known as plinth area.



Components of a Building

A building has the following components:

1. Foundations
2. Masonry units: Walls and columns.
3. Floor structures
4. Roof structures
5. Doors, windows and other openings
6. Vertical transportation structures such as stairs, lifts, ramps etc.
7. Building finishes.

1.5 Principles of Site Selection

For good planning and designing of buildings, the site selection of the building is the most important. The following general principles should be kept in mind while selecting a site for a building:

(i) The purpose of the. building and extent of privacy is desired.

(ii) The site should be located in fully developed or fast developing locality.

(iii) The site should be located in such a way that community services like police and fire protection, clearing of waste .and street cleaning, utility services like water-supply, electricity, drainage, etc., amenities like school, hospital, market, cinema, bank, etc., shopping facilities and means of transport are also available within short distance.

(iv) Before selecting a site, one should study the bye-laws of the local authority, which before restrictions regarding proportions of plots to be built up, open spaces and margins to be left in front and sides, heights of buildings etc.

(v) Area of plot should be such that the building constructed on it meets the requirement of the owner, after following certain restrictions of local authority.

(vi) Shape of the plot should be irregular or not having any sharp corners.

(vii) The site -should be situated on an elevated place and also levelled with uniform slopes from one end to the other to provide good and quick drainage of rain water.

(viii) The soil of the site should be good enough with high safe bearing capacity to provide economical foundations.

1.6 Planning Regulations and Bye-Laws

A bye-law is a local law framed by a subordinate authority. The building codes or bye-laws are defined as the standards and specifications designed to great minimum-safeguards to the workers during construction; to the health and comfort of users; and to provide enough safety to the public is general.

Every locality has peculiarities of its own and with respect to its weather conditions, availability of materials and labour, other factors etc., it becomes economical to construct residential buildings and other structures in a definite planned way. Hence, every locality prepares or frames certain rules and regulations controlling the development of area under its command.

An order prescribed is known as the regulation, while the law of a local authority-is known as bye-law. Bye-law is supplementary law or regulation.

Following are the three main objects of framing bye-laws:

(i) It becomes easier to pre-plan the building activities and provisions of bye-laws give <guide lines to the designing architect or engineer.

(ii) The building bye-laws prevent haphazard development without any resemblance to the development of the area as a whole.

(iii) The provisions of the building bye-laws usually afford safety to the human beings who work and live in them against fire,noise, health hazard and structural failure.

The bye-laws and regulations govern the following building aspects:

1. Set-back or building line.
2. Floor space index or built-up area.
3. Open space requirements around the building.
4. Size of rooms.
5. Height of rooms and buildings.

6. Lighting and ventilation of rooms.
7. Water supply and sanitary provisions.
8. Structural design or sizes and sections.

1. **Set-back or building line:** A set back may be defined as frontage margin or open space in front of the abutting street or road. The land contained in set-back belongs to the owner of the property. It is also referred to as a building line and is laid down in each case parallel to the plot boundaries by the local authority, beyond which nothing can be constructed towards the plot boundaries. Certain buildings like cinema, business centres, factories, etc. which attract large number of vehicles, should be set-back a further distance apart from the building line. This line after this extra margin is called control line.

   The fixation of building line depends upon the site of the proposed building, keeping in view' the present width and future widening requirements.

   Following are. the advantages of the building line or set-backs are as follows:

   (i) If absolutely necessary, part of the set-backs may be acquired for the purpose of widening the road.

   (ii) If the set-back is uniform, the buildings are constructed in one line parallel to the axis of road, resulting in improvement of road.

   (iii) The-provisions of the set-backs results into better conditions of air, light and ventilation of the buildings.

   (iv) The set-backs at street corners improve visibility and impart safety to the traffic.

   (v) The space of set-backs can be conveniently used as a parking place or for developing as garden.

   (vi) They are necessary for the protection of the buildings from street nuisance.

   (vii) They reduce the danger of fire by increasing the distance between opposite buildings.

2. **Floor space index or built-up area:** The built up area or covered area equals to the plot area minus the area due for open spaces. The ratio of the total floor area inclusive of all the floors to the area of the plot on which building stands is known as the floor space index (F.S.I.) or floor area ratio (F.A.R.). The value (of F.S.I. or F.A.R. is determined by local authority and it may be different for different areas and for different buildings of the town. Floor area means built up area excluding area of walls.

   The F.S.I, controls the development activity on the plot of land and consequently. It can be used as a measure to check density of population. For instance, if the plot area is 600 m^2 and if permissible F.S.I, is 0.80, the maximum built-up area' which can be put up on the plot is 480 m^2.

   Following are the limitations of built-up area mentioned in National Building Code:

No.	Plot Area	Maximum permissible built-up area
1.	Less than 200 m^2	60% with two-storeyed structure
2.	From 200 m^2 to 500 m^2	50% of the plot area
3.	From 500 m^2 to 1000 m^2	40% of the plot area
4.	More 1000 m^2	33.33% of the plot area

3. **Open space requirements around the buildings:** The sufficient open a spaces, inside and around the building should be left to meet with the requirements of lighting and ventilation. In case of buildings abutting streets, in front, the open! spaces to the rear or sides of the building should be provided to serve the purpose! of future widening of such streets. All such open spaces weather

interior or exterior;] should be kept free from any erection thereon and shall be kept open to the sky and no cornice, roof, or weather shed more than 0.75 m in width shall project over such open space.

Following are the requirements of open space for varying heights of building as per National Building Code:

No.	Height of building	Open space requirement
1.	Less than 10 m	(a) Front open space width: (i) For building with front street - minimum 3 m (ii) For building with streets on two or more sides – average 3 m and in no case less than 1.8 m (b) Rear margin: – average 3 m and in no case less than 1.8 m (c) Side margin: – minimum 3 m for every detached and semi-attached building (d) Distance from centre line of any street: – In no case less than 7.5 m or as determined by local authority
2.	From 10 m to 25 m	Requirements as per above item no. 1 is increased at the rate of 1 m for every 3 m or fraction thereof.
3.	From 25 m to 30 m	Minimum 10 m.
4.	Above 30 m	Minimum 10 m increased by at the rate of 1 m for every 5 m or fraction thereof subject to maximum 16 m.

If any human-habitation is not receiving air and light from front or rear, shall abut on interior open space having width not less than 3 m.

4. **Size of rooms:** Considering the point of health and ventilation, National Building Code has fixed certain minimum areas or sizes for individual rooms and apartments which are tabulated below:

No.	Type of room	Minimum Area
1.	One habitable room	9.5 m^2, minimum width 2.4 m
2.	Two habitable rooms	Minimum area of one room 9.5 m^2 and of other 7.5 m^2 with minimum width 2.4 m.
3.	Kitchen only	4.5 m^2, minimum width 1.8 m
4.	Kitchen with store room	5.5 m^2 minimum width of kitchen 1.8 m
5.	Kitchen cum dining room	9.5 m^2, minimum width 2.4 m
6.	Bath room	1.8 m^2 or minimum size 1.5 m x 1.2 m
7.	Water closet (w.c)	1.1 m^2 (Floor area)
8.	Bath - W.C. combined	2.8 m^2 (Floor area) minimum width 1.2 m
9.	Mezzanine floor (living room)	9.5 m^2 (Not more than 1/3rd of the plinth area of the building.)

5. **Height of rooms and buildings:** General criteria to decide the height of the building as per N.B.C. is 1.5 times the width of the street to which the building abuts on its front side. If street width is above 8 m or equal to 12 m, the height of the building should not be more than 12 m and in case of more than 12 m wide street, the height of the building should not be more than street width and in no case more than 24 m.

6. **Lighting and ventilation of rooms:** For sufficient lighting and ventilation in the rooms of building, openings like windows, ventilators or direct opening to external air should be provided.

The area of such openings excluding area of doors should be minimum 1/10th of the floor area for dry and hot climate and minimum 1/6th of the area for wet hot climate. The aggregate area of doors and windows shall not be less than 1/7th of the floor area of room.

7. **Water supply and sanitary positions:** Certain minimum requirements for water supply and sanitary conveniences like water tap, sink, nahni trap, water closets, urinals, wash basins, etc. shall be provided as per N.B.C. for different types of buildings.

8. **Structural design or sizes and sections:** Each structure should be designed for safe loads, earthquake resistance, bearing capacities, etc. as per the; latest relevant I.S. codes and N.B.C. Each component of the building should be designed with its specific requirements. Some general thumb-rules for structural design are as follows:
   (i) Depth of foundation: 0.75 m to 1.0 m - for single storeyed building below ground level. 1.0 m to 1.3 m below G.L. for two storeyed building.
   (ii) Width of foundation of wall: Double the thickness of wall just above the plinth and then add 30 cm to it will give the width of the foundation.
   (iii) Concrete in foundation of wall: It should be nearly equal to 5/6th of the thickness of wall above the plinth. The design of all other structural components is out of the scope of this book.

1.7 Orientation

The setting of plan of the building on its site with reference to the directions is known as orientation and it plays a great role in increasing its utility from the l view point of climate considerations. However, an orientation of the building may either be dictated by the prevailing circumstances or it may be decided by choice. In the former case, the plan is provided with elements which would make the orientation as comfortable as possible. In the latter case, maximum advantage is taken of the choice granted in the orientation of the building.

Following are some of the suggestions for good orientation of the buildings in a tropical climate:

1. **Cross ventilation:** Sufficient number of windows and ventilators at suitable level from the floor should be provided to cause movement of air for developing comfortable conditions inside the building. If this is not possible as in the case of the public buildings, resort should be taken to artificial ventilation.

2. **Damp-proof course:** It is desirable to provide damp-proof course at suitable level to keep away walls from damp. In a similar way, the overhanging of roofs on south and west sides will help in protecting the walls from the rain.

3. **Placing of walls:** The long walls of the building should be placed towards north and south. The short walls on the other hand should be placed towards east and west. Such a placing of walls would result in exposing less area of wall to the sun rays and it will assist in maintaining comfortable temperature inside the building.'

4. **Projections:** If projections in the form of balconies, verandahs weather-sheds, etc. are provided on east and west sides, the adjoining rooms remain comparatively cool.

5. **Roof:** It is evident that roof of a building is exposed to the maximum amount for sun and rain. Hence, it is necessary to exercise great care in deciding the type of roof and its method of construction. R.C.C. flat roofs should be provided [with water-proofing treatment and pitched roofs should contain valley gutters, overhang' eaves, etc. for draining rain water.

6. **Treatment of ground:** It the ground surrounding the building is provided with grass or trees of vegetation, it will considerably assist in reducing the temperature inside the building.

7. **Wind direction:** The orientation of the building should be such that advantage is available for enjoying the natural breeze. In Gujarat, the buildings usually face south-west to catch the breeze which blows in summer in that direction. However, such orientation implies danger of rain. But as rain is occasional, there is no serious difficulty; experienced by the people.

1.8 Essential Factors of Planning

There are certain general essential factors which an architect should bear in mind while planning a structure. These principles are not rigid like the laws of mathematics or physics. But they are of very general nature and they have to be applied on individual merits only. Following are such essential factors of planning:

1. Aspect
2. Circulation
3. Economy
4. Elegance
5. Flexibility
6. Furniture requirements
7. Grouping
8. Privacy
9. Prospect
10. Roominess
11. Sanitation.

Each of the above principle of planning will now be briefly described.

1. **Aspect:** The term aspect was formerly used to mean the regulation of admitting more or less sunshine in the room. But its meaning has now been given wider scope and it includes the arrangement of doors and windows in the external walls of buildings, particularly of residential buildings, so as to fully enjoy the natural gifts of sunshine, breeze, scenery, etc. However, the term aspect should not be confused with elevation-or external appearance of the building. Generally the aspect to be given to a building should be such that rays of sun reach all the rooms during some period of the day. The sunshine develops hygienic conditions and it imparts a cheerful air to the room,

2. **Circulation:** The term circulation or access or internal thoroughfare is used to mean the link between the various rooms and floors of building. The proper provision of circulation makes the building comfortable and convenient. The circulation in a building is of two types:
   (i) Horizontal circulation: If the circulation is on the same floor, it is known as horizontal circulation and it includes passages, corridors, halls and lobbies. All such means of horizontal circulation should be sufficiently lighted, well ventilated, straight, definite, independent and short to grant comfort and convenience to the users. They should not intrude upon the privacy of individual rooms and cause any obstruction. However, these spaces can be fruitfully utilized for providing shelves, closets, etc., if the situation so permits.
   (ii) Vertical circulation: For achieving access to the upper floors, stairs or staircases or lifts are provided. Even in case of multi-storeyed buildings accommodating electrically operated lifts, stairs or staircases are provided for use in an emergency such as power failure or fire occurrence. Thus stairs or staircases still remain as the only unfailing means of vertical circulation. All stairs and staircases should be well-designed and they should satisfy the minimum requirements regarding layout, treads, risers, width, pitch, headroom, light, landings, handrail and ventilation.

3. **Economy:** As a matter of fact, the economic factor is not one of the principle of planning. But in actual practice, if the architect is unable to control his scheme within the financial limit of the client, the project miserably fails. It is, therefore, of utmost importance for an architect to know well in advance the amount the client intends to spend for the project and advance the amount the client intends to spend for the project and accordingly, he should proceed to finalize his scheme. For this purpose, the detailed accurate estimate for the total investment in the project should be carefully worked out and if the occasion demands, necessary additions and omissions should be suggested to bring down the total investment within permissible adjustments.

The factor of economy definitely affects the planning of the architect and as such, no definite rules can be framed to attain economy. But the practical knowledge and experience of the architect plays an important role in preparing an economical project under given conditions and circumstances.

4. **Elegance:** The term elegance is used to indicate the architectural effect produced by elevation in relation to width, height position of doors and windows, materials employed in construction of exterior walls, etc. The result of elegance is aesthetics and without the aesthetic sense, the elevation will be devoid of elegance.

   For creating elegant structures, it is necessary to understand clearly the principles of architectural design and composition. In general, the elevation of a structure should be an external statement of the internal facts and design aspects of the building.

5. **Flexibility:** The plan of the building should be prepared by keeping in mind the future requirements. In fact, the design should be such that with minor adjustments, it becomes possible to satisfy future needs when the occasion arises.

   It is desirable for an architect to prepare a master plan of the project and the progress can be achieved stage by stage. Such a practice will smoothen the process of flexibility without any serious difficulty.

6. **Furniture requirements:** The architect should bear in mind the furniture requirements of a room or space in a structure. For instance, the plans of library buildings, schools, hotels, etc. should also show the layout of furniture so that the number of persons to be accommodated can be easily worked out. In the same way, every room of a residential unit has to perform certain function for which necessary furniture pieces are required. It should be seen that placing, type, size and extent of such furniture pieces do not obstruct doors, windows and the circulation space.

7. **Grouping:** The placing of various rooms or units of a structure in proper correlation of their functions and in due proximity with each other is known as grouping and the correct grouping grants the status of a balanced design. The grouping varies according to the type of building. For instance, in a residential building, kitchen and dining room should be grouped close to each other. In a similar way, the κ departments of an industrial unit should be arranged as per flow chart of the manufacturing process. It is observed that grouping leads to saving in unnecessary movements, proper correlation, easy control and overall economy.

8. **Privacy:** One of the important requirements of good planning is the privacy offered to the occupants. It should not be confused with seclusion which indicated ! total isolation and is desirable only in certain cases such as study rooms, libraries, etc.

   The privacy is of the following two types:

   (i) External privacy: It indicates the privacy of all parts of the building as a whole from neighbouring buildings, public streets and byways. The external privacy can be achieved by screening entrance, planting of trees, etc.

   (ii) Internal privacy: It indicates privacy of different rooms in a structure and it I can be achieved by correctly positioning the openings. The correct grouping of rooms usually lead to proper privacy and it attains supreme importance in case of residential units. It is desirable to adopt single shutters in preference to double shutters for achieving maximum privacy. The frosted glass for windows also help considerably for providing more privacy as compared to the plain glass.

9. **Prospect:** The term prospect is used to mean the external views as seen from certain rooms of the building and it is thus dictated by the surrounding peculiarities of the site of the project. In its wide sense, it also includes the concealment of some undesirable views in a given outlook.

It is sometimes observed that the considerations of aspect and prospect are conflicting with each other. Under such circumstances, the architect should exercise his skill and knowledge to bring an acceptable solution with regard to aspect and prospect of the proposed building. It is an accepted principle that desired vista, vision or concealment of undesired views play a great role for human beings to enjoy the property.

10. **Roominess:** The term roominess is used to refer the effect derived from space of a room i.e. its length, width and height.

    The planning of room should be such that maximum benefit is obtained from the minimum dimensions of the room. For instance, in case of residential buildings, a square room is found to be inconvenient as compared to the rectangular room of the same area from the view point of utility, furniture layout, etc.

    The height also plays a significant role in developing the desired effect of roominess. A small room with more height looks awkward. For a club where the atmosphere of fellowship is prevailing, the ceiling height may be kept low. On the other hand, for public buildings like monumental buildings, temples, high courts, etc., the excess height will help in granting a grand appearance to such buildings.

11. **Sanitation:** As a principle of planning, the term sanitation is used to mean architectural hygiene and it includes broadly the following four components:

    (i) **Cleanliness:** The accumulation of dust is injurious to health and it allows the growth of bacteria and spread of disease. It is therefore necessary to have a very plain treatment for the interiors of rooms and provision of ornamental mouldings. Skirtings, cornices, etc. should be made in such a way that they can be easily cleaned.

    (ii) **Lighting:** The provision of ample light is of primary significance as it serves two purposes, namely, for illumination and for granting hygienic conditions.

    The lighting in the interiors of buildings may be provided by the following three types:

    (a) Natural lighting (b) Assisted natural lighting (c) Artificial lighting:

    There should be sufficient and uniform distribution of light and direct glare should be avoided. The glare not only distracts but it also disables -the -vision. The provision of vertical windows is preferred to-horizontal — windows of the same area.

    The artificial lighting may be sub-divided into two categories:

    (a) General lighting: The light is diffused as much as possible over the room and it is for general movement or for rest and conversation.

    (b) Localized or concentrated lighting: The light is provided with greater degree of illumination over a limited area for the purpose of writing, reading, dressing, etc.

    It should however be noted that the requirement of the lighting are different for different types of buildings.

    (iii) **Sanitary units:** These include sanitary conveniences such as water closets, bath rooms, urinals, toilets, etc. They should be provided with suitable flooring and dado materials so that they can be easily maintained clean.

    (iv) **Ventilation:** Sufficient number of windows and ventilations should be accommodated to facilitate renewal of fresh air. It is desirable to provide cross ventilation for structures like schools, hospitals, factories, etc.

    The concept of ventilation indicates sensation of comfort, reduction in humidity and proper supply of oxygen. If ventilation is bad, it leads to nausea, headache, sleepiness, etc.

The ventilation may either be achieved by natural means or artificial means. The natural ventilation is achieved due to forces set in motion by the heat of sun. The artificial ventilation is made available through air conditioning.

1.9 Basic Functional Requirements of a Building

The design and performance of a good building should satisfy, the following basic functional requirements.

(i) The structure of the building should be strong and sound to resist its normal bonding.

(ii) It should have sufficient stiffness so that its detonation does hot reduce the efficiency of the structure to its intended purpose.

(iii) From the performance point of view, the building should be well planned to give maximum comfort and convenience to the occupants of the building.

To achieve the above three basic fundamental requirements, a building should satisfy the following requirements in its design and construction:"

1. Comfort and convenience
2. Dimensional stability
3. Durability
4. Economy
5. Fire protection
6. Heat or thermal insulation
7. Light and ventilation
8. Moisture or damp prevention
9. Security against burglary
10. Sound insulation
11. Strength and stability
12. Termite control.

We will discuss above points in detail.

1. **Comfort and convenience:** This is one of the basic requirements of functional planning of a building. Following points should be kept in mind to achieve this requirement.
   (i) A building should be provided with enough light during day or night **f** without any effect of glare.
   (ii) A building should be oriented in such a manner to get maximum benefit f of natural air and light.
   (iii) Due weightage should be given be to living, working and health conditions l of the occupants of the building.
   (iv) Grouping of the rooms should be so planned as to ensure better circulation optimum utilization of space and maximum efficiency in a building.

2. **Dimensional stability:** The changes in the dimensions of materials structures are caused due to the following:
   (i) Elastic and plastic deformation or creep due to applied loads.
   (ii) Expansion and contraction due to temperature variation or moisture content in the atmosphere, which results into cracking of the buildings.
   (iii) Chemical reactions between building materials and moist air.

   Following are the measures to prevent dimensional changes:
   (i) The effect of elastic deformation is taken care by considering effective modulus of elasticity in design.
   (ii) The effect of plastic deformation is taken into account by considering proper load factor against failure in design.
   (iii) Avoid using the materials which are deformed due to-moisture or temperature changes.
   (iv) Provide unnecessary restraint to shrinkage or expansion of the material.
   (v) Try to use the materials which have a large extensibility, means less tensile stress than its tensile strength to avoid cracking.

3. **Durability:** Period of time upto which the building remains habitable is called its durability. Durability of a building depends upon following factors.
   (i) Degree of maintenance;
   (ii) Method of construction adopted;
   (iii) Types of materials used in a building;
   (iv) Exposure conditions to weathering which is determined by the climate, i environment, site, aspect and height of the building;
   (v) Effect of frost action on exposed building materials;
   (vi) Crystallization of salts by groundwater movements;
   (vii) Surface erosion by rain water;
   (viii) Effect of sunlight on paints, plastics, glass, asphalt, rubber, etc

   To increase and maintain durability, of a building following steps should be taken:
   (i) Proper features like projecting eaves, copings, sunshades, cornices, parapets, sills, etc. should be provided in the building to prevent from rainfall, sunlight, moisture and other exposures of weather.
   (ii) Proper care is to be taken in designing a building in maintenance of a building, in choice of materials and in the protection of a building against weathering effects.

4. **Economy:** At every stage of functional planning, designing, construction, maintenance and operation of a building economics aspect should be considered simultaneously. The building should be functionally and structurally sound. As well as should not cost much higher than usual.

5. **Fire Protection:** To protect the building against fire, composite and non-combustible materials should be used in the construction of walls, columns, beams, etc. Also standards of fire safety or fire extinguishers as specified in the building code should be provided with sufficient and quick fire exit. The chances of a fire can be reduced through adequate planning of buildings in horizontal and vertical directions.

6. **Heat or thermal insulation:** Properly insulated building cuts down the cost of electric burring in summer as well as in winter. To achieve heat insulation requirements for different types of buildings, one or more of the following means should be adopted:
   (i) Exterior walls should be thicker which imparts strength to the building and ‘ also provide insulation against heat and cold.
   (ii) Construction of cavity walls as external walls to protect the building from outside heat or cold as the follow space between two walls acts as an insulating material.
   (iii) In the construction of walls, roofs, floors etc. to fill air spaces in construction materials, heat insulating materials like slag wool, light weight concrete, rock wool, quilts, mats, foamed slag aggregates should be used.
   (iv) The building should be provided with chhajjas, canopy, weather sheds, verandah, courtyards, tress, garden etc. to achieve heat insulation.
   (v) Top terrace of the building should be insulated against heat economically by using special flooring method.

7. **Light and ventilation:** In every building position, number and sizes of doors and windows should be in such a way that sufficient day light free from glare comes from the right direction. Sufficient daylight should reach in each and every room of the building, to crate pleasing environment to work and to live. The designer should also keep in mind the lighting requirements with heat insulation of the building.