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LECTURE NOTE

ON

BASIC OF CIVIL ENGINEERING

COURSE CODE: BCE02001: 3.0.0 (CR 03)

Second Semester, B Tech, Civil Engineering

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VSSUT BURLA

Syllabus for First Semester, B Tech, Civil Engineering
BASIC OF CIVIL ENGINEERING (BCE02001)

Module-I

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Introduction to Civil Engineering: Various disciplines of Civil engineering, Importance of Civil engineering in infrastructure development of the country, Interdisciplinary nature of construction projects

Residential Buildings: NBC Classification, Basic Components of a building: Basic requirement, Planning and Design of buildings: fundamental requirements, selection of sites, introduction to building design: functional and structural design

Foundations: Classification, Bearing Capacity of Soil and related terms (definition only).

Module-II

Fundamental Properties of Construction Materials: Physical, mechanical and durability properties

Construction materials: stone bricks, cement, aggregate, mortar, concrete, timber, steel, non-ferrous metals, paint, plastic, glass, adhesive, tiles, composites (Definition, classification and application).

Module-IV

Importance of Transportation, Transportation modes i.e. Highway, railways, airways, water pipe and conveyor- Basic Characteristics, advantages and disadvantages, Indian road transport system, Types of roads, classification of highway, urban roads: basic requirements and classification: Basic Components of a Road, Rigid and Flexible pavement (comparison only)

Module IV

Quantity of water: Sources of water, Per capita demand, drinking water standards, Public Water Supply System: Necessity and Basic lay out, Conventional water treatment process: Screening, Plain Sedimentation, Sedimentation aided with Coagulation, Filtration and Disinfection (working principles only)

Module V

Irrigation: Importance of Irrigation, Classification of irrigation projects, Irrigation system: Types, Field water distribution, Multipurpose river valley projects, Dams: Purpose, types Layout of canal irrigation system: components and definitions.

Text Books:

- Basic Civil engineering, Gopi, S., Pearson Publication
- Basic Civil Engineering, Bhavikatti, S. S., New Age.

BASIC OF CIVIL ENGINEERING (BCE02001)

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Module-I

Module I Syllabus

Introduction to Civil Engineering: Various disciplines of Civil engineering, Importance of Civil engineering in infrastructure development of the country, Interdisciplinary nature of construction projects

Residential Buildings: NBC Classification, Basic Components of a building: Basic requirement, Planning and Design of buildings: fundamental requirements, selection of sites, introduction to building design: functional and structural design

Foundations: Classification, Bearing Capacity of Soil and related terms (definition only).

Subject to Revision

1. <u>INTRODUCTION TO CIVIL ENGINEERING</u> :-

Civil engineering is a professional engineering discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including

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public works such as roads, bridges, canals, dams, airports, sewage systems, pipelines, structural components of buildings, and railways.

Civil engineering is traditionally broken into a number of sub-disciplines. Civil engineering is the application of physical and scientific principles for solving the problems of society, and its history is intricately linked to advances in the understanding of physics and mathematics throughout history. Because civil engineering is a broad profession, including several specialized sub-disciplines, its history is linked to knowledge of **structures**, **materials science**, **geography**, **geology**, **soils**, **hydrology**, **environmental** science, **mechanics**, **project management**, and other fields.

1.1 DISCIPLINES OF CIVIL ENGINEERING-

Civil engineering is a broad field of engineering that encompasses the planning, design, construction, and maintenance of physical infrastructure and publicly built environment, including works like roads, bridges, canals, dams, and buildings. It is one of the oldest engineering disciplines, and it has played a vital role in the development of human civilization.

There are many different disciplines of civil engineering, each with its own focus and specialties. The various disciplines of civil engineering are-

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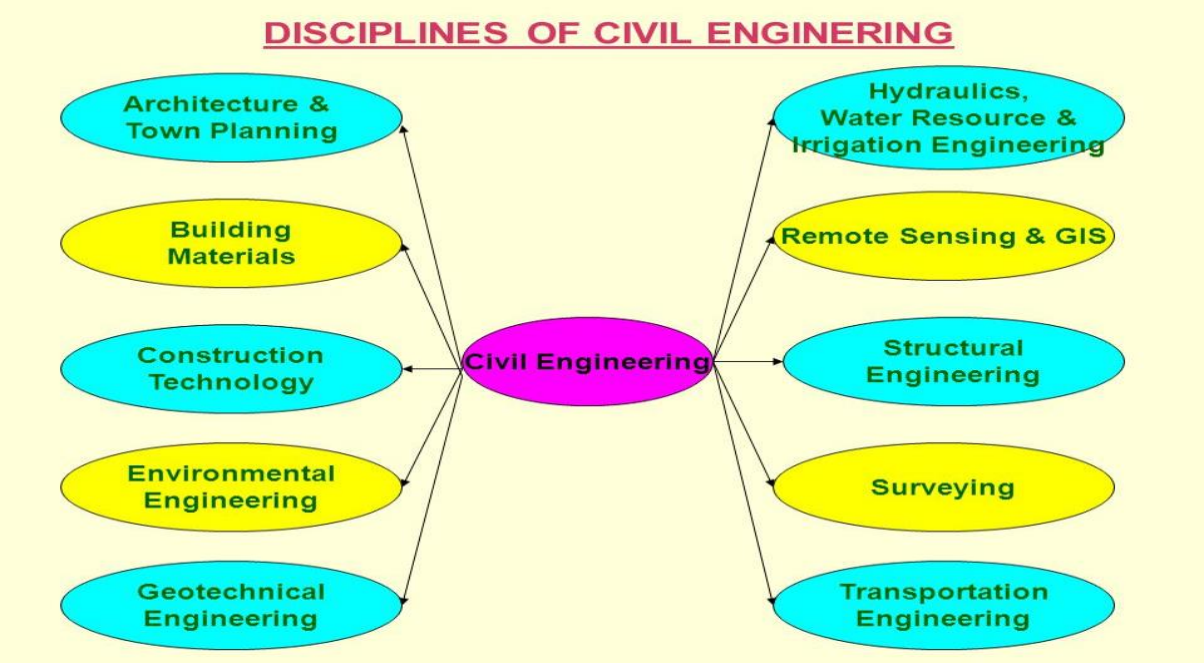

I. ARCHITECTURE AND TOWN PLANNING

An art of **shaping** and **guiding** the **physical growth** of the town creating buildings and environments to meet the various needs such as social, cultural, economic and recreational etc. and to provide healthy conditions for both rich and poor to live, to work, and to play or relax, thus bringing about the social and economic well-being for the majority of mankind is known as town planning.

OBJECTIVES OF TOWN PLANNING-

- To create and promote **healthy conditions and environments** for all the people.
    - To make **right use of the land** for the right purpose by zoning
    - To ensure **orderly development**
    - To **avoid encroachment** of one zone over the other.

II. BUILDING MATERIALS TECHNOLOGY

All the building structures are composed of various types of materials. These materials are either referred to as building materials or materials of construction.

A builder, perhaps an architect or engineer, or a contractor needs to become familiar totally with these building materials.These are some of the most commonly used building materials -

1. Stones	4.Sand	7.Timber	10.Ceramics
2. Bricks	5.Mortar	8.Metals	11. Miscellaneous Building Material
3. Cement	6.Concrete	9.Glass	

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Fig.Some Building Materilas

III. CONSTRUCTION TECHNOLOGY AND MANAGEMENT

It focuses on the knowledge and skills required for the **planning**, **coordination** and successful **implementation of large Projects** such as design and construction of structures and buildings, ship structures, aircraft, dams, roads, and bridges etc. It is a fusion of **engineering** and **management**.

IV. ENVIRONMENTAL ENGINEERING:-

- This field is concerned with the study of the necessary methods and techniques of **environment protection** as well as the availability of the basic life elements such as water and air with a specific level of quality to protect the mankind health and environment.
- This includes design and construction of **water distribution networks, wastewater and storm water collection systems**, **water treatment plants and wastewater treatment** for reuse in industrial and agricultural fields.
- Environmental engineering involves also the study of the different techniques of **controlling air, water and soil pollution** as well as the **proper disposal or recycle of solid and hazardous wastes**.

V. GEOTECHNICAL ENGINEERING:-

- This field is concerned with the study of the **soil properties** of the construction site and its **bearing capacity**.

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- Geotechnical engineering is concerned also with the **suitable solutions for any problem in the soil** as well as the choice of the best and secured methods of design and construction of the foundation of engineering structures.

VI. HYDRAULICS AND WATER RESOURCES ENGINEERING-

- This field covers the basic concepts of **water science** and its related theorems and applications. This includes the methods of **transporting water from sources to distribution sites** through channels and pipelines, water sources and storage system, types of dams and their design methods.
- It involves also the study of **seawater movements and shore protection**.
- Hydraulic engineering consists of the application of fluid mechanics to water flowing in an isolated environment (pipe, pump) or in an open channel (river, lake, ocean).

VII. REMOTE SENSING ENGINEERING-

Remote sensing is the process of **detecting and monitoring the physical characteristics** of an area by measuring its **reflected and emitted radiation** at a distance (typically from satellite or aircraft).

Some specific uses of remotely sensed images of the Earth include:

- **Large forest fires** can be mapped from space, allowing rangers to see a much larger area than from the ground.
- **Tracking clouds** to help predict the weather or watching erupting volcanoes, and help watching for dust storms.
- **Tracking the growth of a city and changes in farmland or forests** over several years or decades.
- Discovery and mapping of the rugged topography of the ocean floor (e.g., huge mountain ranges, deep canyons, and the "magnetic striping" on the ocean floor).

VIII. STRUCTURAL ENGINEERING:-

- This discipline deals with the **analysis and design of concrete and steel structures**, such as multi-story buildings, bridges, towers....etc. It deals also with the study of the **durability** and **resistibility** of such structures for live loads, wind and earthquake.
- The study involves also the study of the properties of building materials according to the international specifications.

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IX. SURVEYING:-

Surveying typically involves measurements of **horizontal and vertical distances** between points. It also includes descriptions of the **exact characteristics of the land structure and surface**.

A **surveying engineer** also works to:

- provide the proper design and development of infrastructure
- protect the surrounding natural environment
- maximize the efficiency of the proposed structures

X. TRANSPORTATION ENGINEERING:-

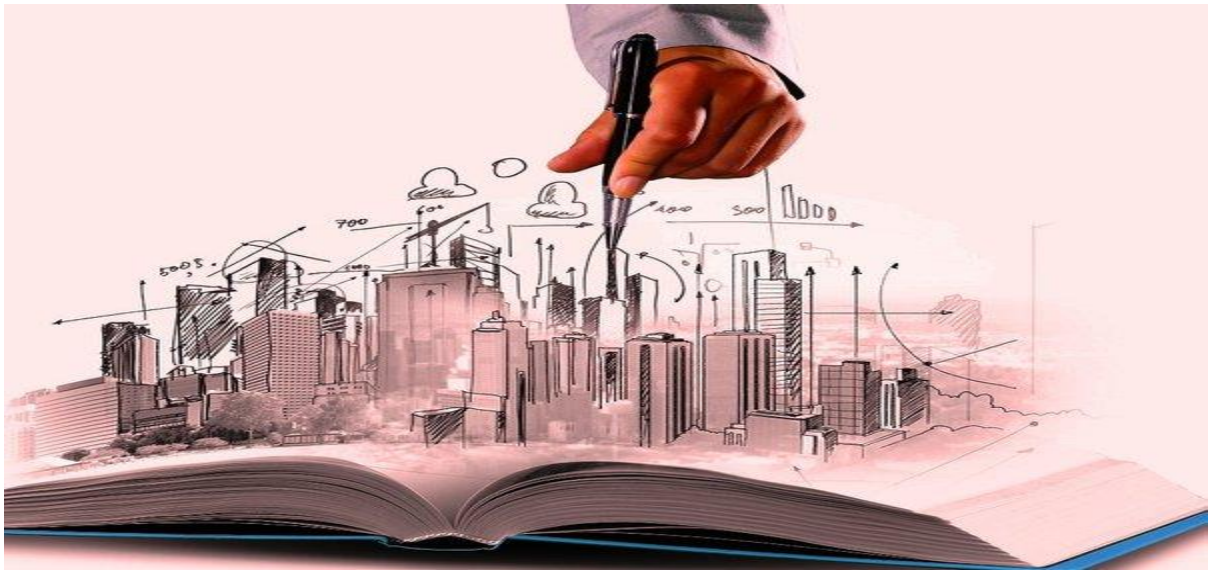
Transportation engineering is a branch of civil engineering that involves the **planning, design, operation, and maintenance of transportation systems** to help build smart, safe, and liveable communities.

Any system that moves people and goods from one place to another falls under the scope of transportation engineering, which includes:

i. Highways and roadways
ii. Automated transport systems
iii. Space transport systems
iv. Railways
v. Traffic control systems
vi. Public transport systems
vii. Oil pipelines

1.2Importance of Civil Engineering in Infrastructure Development of the Country:-

Civil Engineers play a major role in the **infrastructure development** of a country. All structures constructed in the past exhibit the path of civilization and current infrastructures development express the practices followed by civil engineers.



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Infrastructure can be defined as activities that provide society with services necessary to conduct daily life and to engage in productive activity and development in a country's economy.

In a country like India, the major infrastructural. Factors that are most significant in accelerating the pace of economic development are energy, transport, irrigation, finance, communications, education, and health.

The knowledge of basic areas of civil engineering can be of great use in providing the infrastructural facilities where constructional aspects are involved for development of regions.

- Good surface communication links such as tar or concrete rods.
- Provision of water supply distribution system i.e., construction of water storage reservation or sumps, laying of underground pipes etc.
- Provision of a drainage system which may include construction of surface drains as subsurface drains for the disposal of wastewater.
- Supply of electrical power for which construction of transmission line towers, construction of electrical substations.
- Providing inland communications lines, i.e., telephone lines etc.
- Construction of recreational places e.g., gardens, parks etc.

1.3 Interdisciplinary nature of construction projects

Construction projects are inherently interdisciplinary in nature, involving a wide range of knowledge, skills, and expertise from various fields to successfully plan, design, execute, and manage them. Here are some key aspects that highlight the interdisciplinary nature of construction projects:

I. Architecture and Design: Architects play a crucial role in creating the initial design and layout of a building or structure. They consider aesthetics, functionality, and safety while working closely with clients and other stakeholders.

II. Civil Engineering: Civil engineers are responsible for the structural integrity of the project, ensuring that it can withstand various loads and environmental conditions. They also deal with infrastructure elements like roads, bridges, and utilities.

III. Structural Engineering: Structural engineers specialize in designing and analyzing the structural systems of buildings and other structures, ensuring they are stable and safe.

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IV. Mechanical and Electrical Engineering: These engineers design systems for heating, ventilation, air conditioning, lighting, plumbing, and electrical services within a construction project.

V. Environmental Engineering: Environmental engineers may be involved in projects that require adherence to environmental regulations and sustainable practices, such as managing stormwater runoff, waste disposal, and energy efficiency.

VI. Geotechnical Engineering: Geotechnical engineers assess the soil and rock conditions at a construction site and determine the appropriate foundation and earthwork design.

VII. Project Management: Project managers oversee the entire construction process, ensuring that tasks are completed on time and within budget. They must have a strong understanding of construction methods, materials, and contracts.

VIII. Surveying: Surveyors gather data on the project site, which is essential for proper planning, design, and construction. They provide accurate measurements and land information.

IX. Construction Management: Construction managers work closely with contractors and subcontractors to coordinate construction activities, monitor progress, and address any issues that arise during the project.

X. Legal and Regulatory Compliance: Legal experts help navigate the complex legal and regulatory landscape of construction, including permits, zoning laws, contracts, and liability issues.

XI. Health and Safety: Safety professionals ensure that construction sites comply with safety regulations and implement measures to protect workers and the public.

XII. Urban Planning: In the case of large-scale projects, urban planners may be involved to ensure that construction aligns with the long-term development goals of a city or region.

XIII. Sustainability and Green Building: Specialists in sustainability and green building practices can integrate environmentally friendly features and technologies into construction projects.

XIV. Interior Design: Interior designers focus on the aesthetics and functionality of interior spaces, creating a pleasant and functional environment for building occupants.

XV. Public Relations and Communication: Communication experts help manage public relations and community engagement during construction projects, addressing concerns and keeping stakeholders informed.

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2. Residental Buildings

According to the National Building Code of India, a residential building includes any building that comes with sleeping accommodation for normal residential purposes, without or with dining and cooking facility

Group A-Residential

A1: Lodging or rooming houses.
A2: One or two-family private dwellings
A3: Dormitories
A4: Apartment houses
A5: Hotels (upto 4 star category)
A6: Hotels (**Starred**- five star and above)

(i) **Lodging and rooming houses**- These are buildings in which separate **sleeping accommodation with or without a dining facility** but **without a cooking facility** is provided. For instance, Inns, Clubs, Motels, and Guesthouses.

(ii) **One or two-family private dwelling**- A private dwelling which is occupied by members of one or two-family. Maximum sleeping accommodation is provided for **20 persons**.

(iii) Dormitories- Any building in which group sleeping accommodation is provided with or without dining facilities. e.g., School and College Dormitories, Hostels, and Military Barracks.

(iv) Apartment Houses- Buildings in which living quarters are provided for **three or more families** having independent cooking facilities and living independently of each other. e.g., apartments, Mansions, and Chowls.

(v) Hotels -Buildings in which sleeping accommodation is provided with or without dining facilities for up to four-star categories (hotels).

(vi) Hotels (**Starred)** Normally five star and above by local authority.

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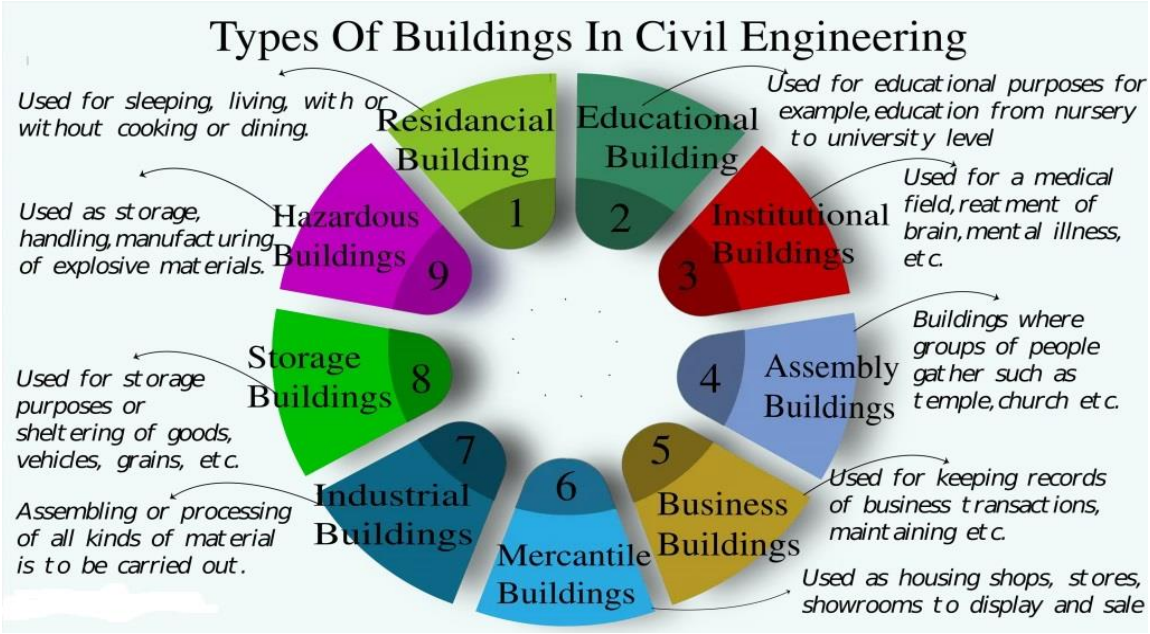
2.1 TYPES OF BUILDING AS PER NBC (NATIONAL BUILDING CODE):-

Any structure made for whatsoever purpose with any material, used for human habitation or not which included foundation, plinth, walls, floor, roofs, chimney, plumbing, and building services, Verandah, Balcony, and cornice, etc. is called a building. Buildings are classified based on **occupance** and **type of construction**:

A. RESIDENTIAL
B. EDUCATIONAL
C. INSTITUTIONAL
D. ASSEMBLY
E. BUSINESS
F. MERCANTILE(included **retail** and **wholeshale** store)
G. INDUSTRIAL (low, moderate and high fire hazards)
H. STORAGE
I .HAZARDOUS



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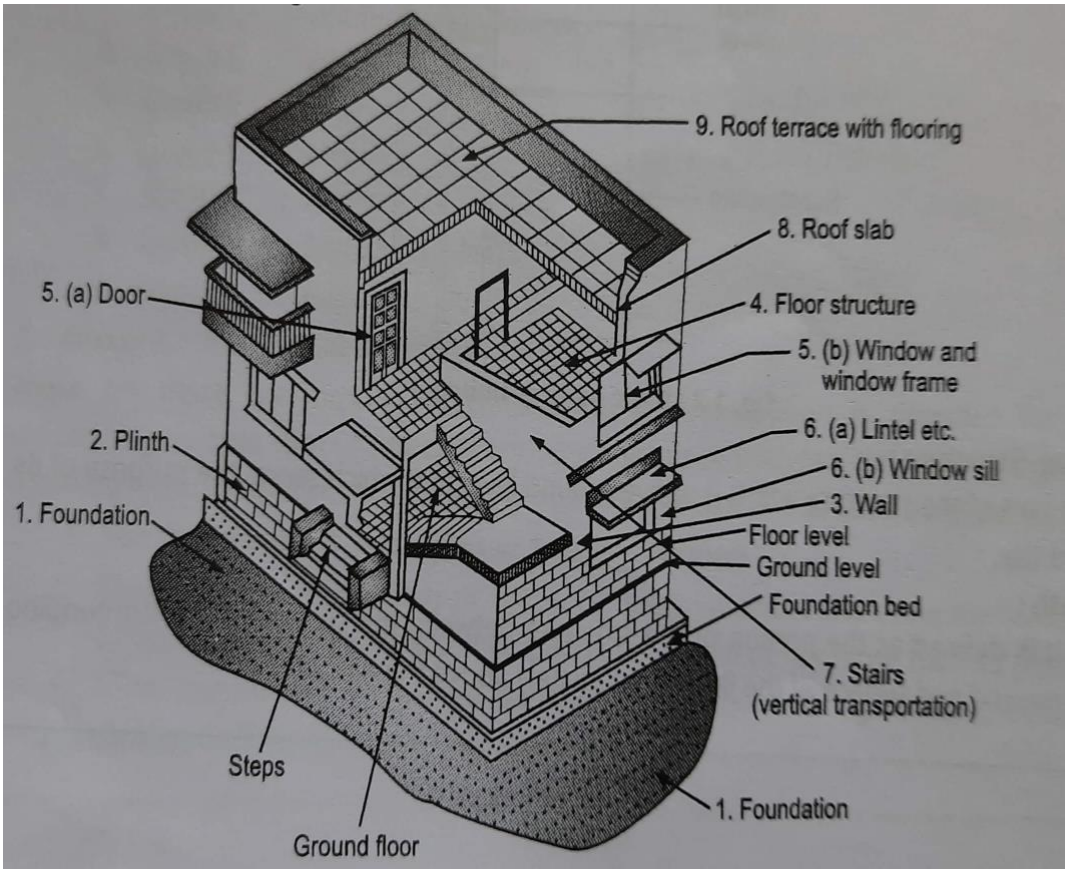
2.2 BASIC COMPONENTS OF A BUILDING

Building component means any subsystem, subassembly, or other system designed for use in, or as part of, a structure, which may include structural, electrical, mechanical, plumbing, and fire protection systems and other systems affecting health and safety.

The basic function of a building is to provide **structurally sound and environmentally controlled spaces** to **house and protect** occupants and contents.A building is combination of various components. A Civil Engineer should have good knowledge of execution of each and every component with respect to design layouts given by Architect.

The following are the basic component parts of a **residential building**:-

1. Foundation
2. Plinth
3. Walls and columns
4. Sills, lintels and chejjas
5. Doors and windows
6. Floors
7. Roofs
8. Steps, stairs and lifts
9. Finishing work
10. Building services.
11. . Parapet



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The functions of these elements and the main requirement of them are discussed below-

1. <u>Foundation</u>:

Foundation is the most important part of the building. Building activity starts with digging the ground for foundation and then building it. It is the lower most part of the building. It transfers the load of the building to the ground. Its main functions and requirements are:

(a) Distribute the load from the structure to soil evenly and safely.

(b) To anchor the building to the ground so that under lateral loads building will not move.

(c) It prevents the building from overturning due to lateral forces.

(d) It gives level surface for the construction of super structure.

2. <u>Plinth:</u>

- The portion of the wall between the **ground level** and the **ground floor level** is called **plinth**. It is usually of stone masonry. If the foundation is on piles, a plinth beam is cast to support wall above floor level. At the top of plinth, a damp proof course is provided. It is usually 75 mm thick plain concrete course.
- The function of the plinth is to keep the **ground floor above ground level**, **free of dampness**. Its height is **not less than 450 mm**. It is required that plinth level is at least **150 mm above the road level**, so that connections to underground drainage system can be made.

3.<u>Walls and Columns</u>:-

The function of walls and columns is to transfer the load of the structure vertically downwards to transfer it to foundation. Apart from this wall performs the following functions also:

(a) It encloses building area into different compartments and provides privacy.

(b) It provides safety from burglary and insects.

(c) It keeps the building warm in winter and cool in summer.

4. <u>Sills, Lintels and Chejjas</u>:-

- A **window frame should not be directly placed** over masonry. It is placed over **<u>50 mm to 75 mm thick plain concrete course</u>** provided over the masonry. This course is called as **<u>sill</u>**.

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- **Lintels** are the **R.C.C. or stone beams** provided **over the door and window openings** to **transfer the load transversely** so as to see that door or window frame is **not stressed unduly**. The width of lintels is equal to the width of wall while thickness to be provided depends upon the opening size.
- **Chejja** is the projection given **outside the wall to protect doors and windows** from the rain. They are usually made with R.C.C. In low cost houses stone slabs are provided as chejjas. The projection of chejja varies from 600 mm to 800 mm. Sometimes drops are also provided to chejjas to improve **aesthetic** look and also to get additional protection from sun and rain.

5. Doors and Windows:-

- The function of a **door** is to give access to different rooms in the building and to deny the access whenever necessary. Number of doors should be minimum possible. The size of the door should be of such dimension as will facilitate the movement of the largest object likely to use the door.
- **Windows** are provided to get light and ventilation in the building. They are located at a height of 0.75 m to 0.9 m from the floor level. In hot and humid regions, the window area should be 15 to 20 per cent of the floor area. Another thumb rule used to determine the size and the number of windows is for every 30 sq. m of inside volume there should be 1 sq. m window opening.

6. Floors:-

- Floors are the important component of a building. They give working/useful area for the occupants. The ground floor is prepared by filling brick bats, waste stones, gravel and well compacted with not less than 100 mm sand layer on its top. A lean concrete of 1 : 4 : 8, 100 mm thick is laid. On this a damp proof course may be provided. Then floor finishing is done as per the requirement of the owner.
- Cheapest floor finish for a moderate house is with 20 to 25 mm rich mortar course finished with red oxide. The costliest floor finish is mosaic or marble finishing. Other floors are usually of R.C.C. finished as per the requirements of the owner.

7. Roof:-

- Roof is the top most portion of the building which provide top cover to the building. It should be leak proof. Sloping roof like tiled and A.C. sheet give leak proof cover easily. But they do not give provision for the construction of additional floor. Tiled

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roof gives good thermal protection. Flat roofs give provision for additional floors. Terrace adds to the comfort of occupants. Water tanks can be easily placed over the flat roofs.

8. <u>Step, Stairs and Lifts</u>:-

- **Steps** give convenient access from ground level to ground floor level. They are required at doors in the outer wall. 250 to 300 mm wide and 150 mm rise is ideal size for steps. In no case the size of two consecutive steps be different. Number of steps required depends upon the difference in the levels of the ground and the floor.
- **Stairs** give access from floor to floor. They should consist of **steps of uniform sizes**. In all public buildings lifts are to be provided for the conveniences of old and disabled persons.
- In hostels **G + 3 floors can be without lifts**. Lift is to be located near the entrance. Size of the lift is decided by the number of users in peak hours. Lifts are available with capacity 4 to 20 persons.

9. <u>Finishing:-</u>

- Bottom portion of slab (ceiling), walls and top of floor need smooth finishing with plaster. Then they are provided with white wash, distemper or paints or tiles. The function of finishing work is:
    - Give protective cover
    - Improve aesthetic view
    - Rectify defective workmanship
    - Finishing work for plinth consists in pointing while for floor it consists in polishing.

10.<u>Building Services:-</u>

- **Water supply, sanitation and drainage works, electric supply work and construction of cupboards and show cases** constitute major building services.
- For storing water from municipal supply or from tanker a **sump** is built in the house property near street. From the sump water is pumped to overhead tanks placed on or above roof level so as to get water all the 24 hours. Plumbing work is made so as to get water in kitchen, bathrooms, water closets, sinks and garden taps. For draining rain water from roofs, down take pipes of at least 100 mm diameters should be used.

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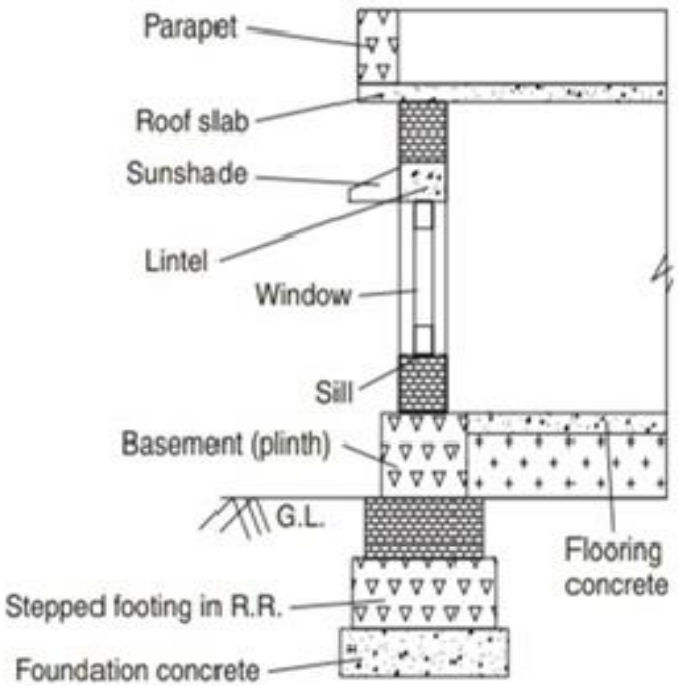
Proper slopes should be given to roof towards down take pipe. These pipes should be fixed at 10 to 15 mm below the roof surface so that rain water is directed to the down take pipe easily.

- The **sanitary fittings** are to be connected to stone ware pipes with suitable traps and chambers. Stone ware pipes are then connected to underground drainage of municipal lines or to the septic tank.
- Many **carpentry works** are required for building service. They are in the form of showcases, cupboards, racks etc.
- **Electric supply** is essential part of building services. The building should be provided with sufficient points for supply of lights, fans and other electric gadgets.

11.<u>Parapet</u>:-The parapet is a minor wall around the edge of a roof, balcony, terrace, or stairway, usually covering the roof's perimeter. It protects the top and pre-built structures from corrosion and degradation.



2.3 Basic requirements of a building

There are many basic requirements of a building, but some of the most important include:

- **Strength and Stability**: A building should be able to withstand all of the loads that it is likely to experience, including its own weight, the weight of its occupants and their

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belongings, and the weight of snow, wind, and other natural forces. The building should also be able to resist collapse in the event of an earthquake or other disaster.

- **Durability:** A building should be able to withstand the effects of weathering and other environmental factors for many years. This means that the building should be made of materials that are resistant to rot, corrosion, and other forms of damage.
- **Fire Resistance**: A building should be able to resist the spread of fire. This means that the building should be made of materials that are non-combustible or that are slow to burn. The building should also have firewalls and other fire protection systems in place.
- **Sound Insulation**: A building should be able to block out noise from the outside and from other parts of the building. This is important for both privacy and for the health and well-being of the occupants.

- **Lighting and Ventilation**: A building should have adequate lighting and ventilation. This is important for both the health and well-being of the occupants and for the preservation of the building's materials.
- **Accessibility**: A building should be accessible to people with disabilities. This means that the building should have ramps, elevators, and other features that make it easy for people with disabilities to get around.
- **Security**: A building should be secure from unauthorized access. This means that the building should have locks, security systems, and other features that make it difficult for people to enter without permission.

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2.4. Planning and Design of buildings:

Planning and design are the crucial phases of any building project, laying the foundation for its functionality, aesthetics, and overall success. The process involves a comprehensive approach that considers various aspects, including the building's purpose, site conditions, user needs, and environmental regulations.

2.4.1 FACTORS AFFECTING THE PLANNING OF THE BUILDING:

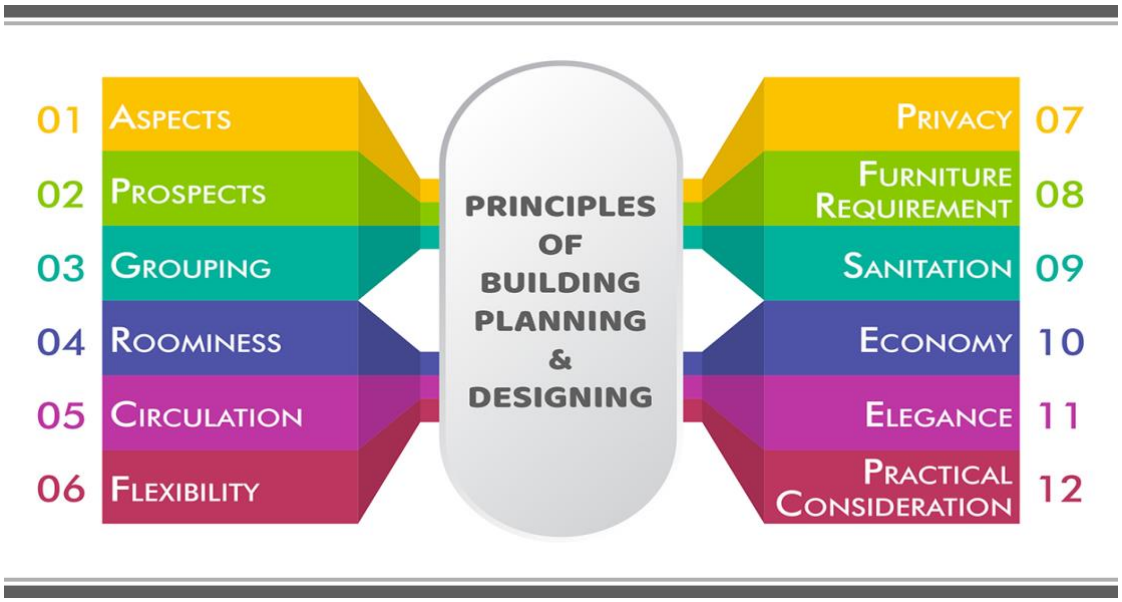
1. The **function** of the building e.g. residential, industrial, public, commercial, etc.
2. **Shape and size of the plot**
3. **Topography**
4. **Climatic** condition
5. Building by-Laws etc.

2.4.2 PRINCIPLES OF BUILDING PLANNING:-

"The concept of positioning all the elements and units of a building in a systematic and practical manner to have the **maximum and best utilization of the available space**, **area** and **facilities** is termed as **Principles of Building Planning**."

There are several principles that affect the planning of a building. This article will give you a brief knowledge of all those principles.

Factors Affecting



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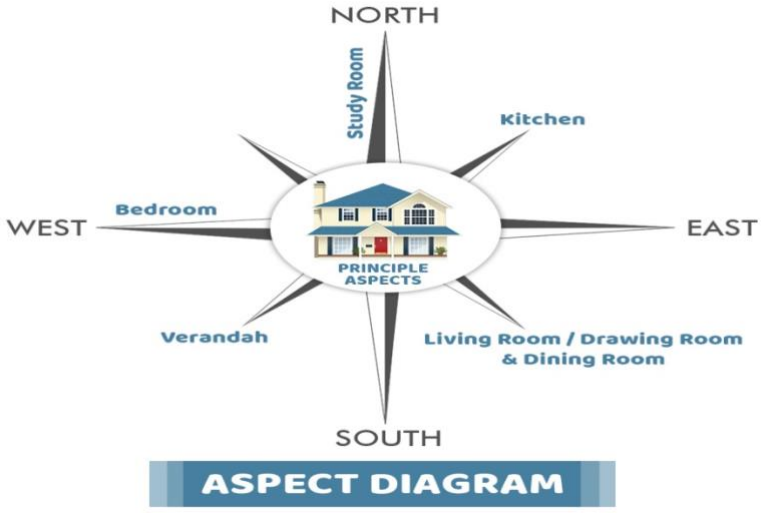
01. What is an ASPECT in building planning?

A building is a complete constitute of different rooms and blocks in it. All the rooms are located according to the standard **use** of components considering the **proper access of natural resources,** i.e., **sunlight** and **wind**. ASPECT is defined as a significant **arrangement of doors and windows** in abuilding, which are enough and efficient to provide **sunlight**, **hygiene**, **wind**, and **eco-friendly environment**. There must be sufficient **light** and **ventilation** in each room and across the house.

The aspect of building can be achieved by **arranging** the rooms, kitchen, veranda, and many other components in **proper directions**. The ways to cover the direction with advisable aspect is given below:



ASPECT DIAGRAM

The above diagram indicates the appropriate directions which should be preferred for the **positioning** of various rooms in a house.

02. What are the PROSPECT principles in building planning?

In these modern times, all the buildings and constructions are aimed to achieve an **aesthetically appealing look** from both **exteriors** and **interior** considerations. The appearance of a house or a building is defined as **PROSPECT.**

The standards are raised to accomplish the building's **pleasant look** by locating doors and windows at an **accurate location** to view nature's beauty and avoid unwanted attributes from getting entry into the house.

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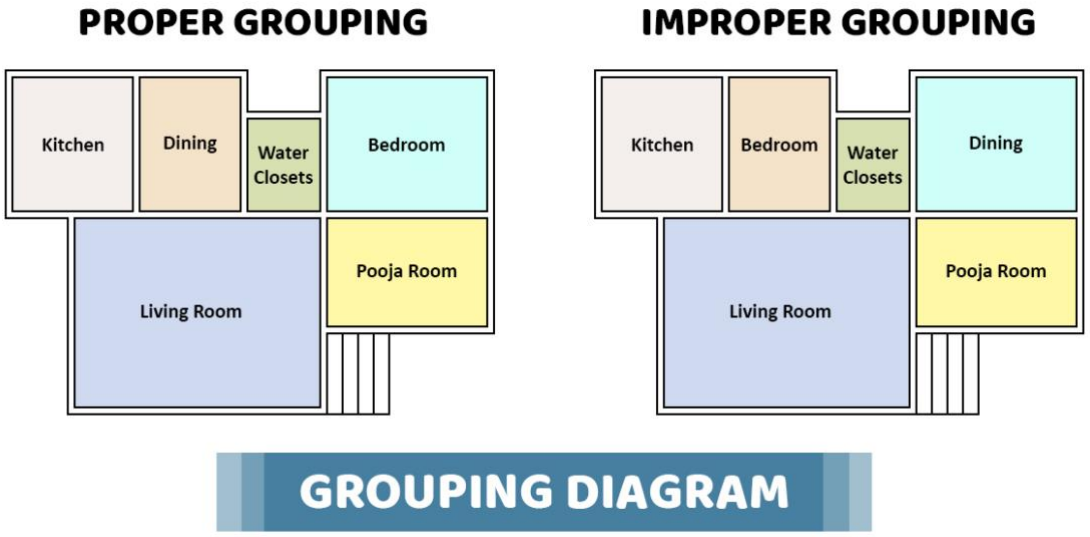
03. What does the GROUPING mean in building planning?

GROUPING: It is to organize the different rooms in such a way that they are adequately **interconnected with each other** to form a functional and practical layout of the house. The **accessibility** of all the rooms is **interlinked** with each other, and this provision can be satisfied by grouping.

To understand the theory of grouping, let us consider an example. In a simple sense, the dining room should be near to the kitchen so that both the units can be easily used for the service. Similarly, water closets should be close to the bedrooms and living room but not close to the kitchen.



GROUPING DIAGRAM

The above figure indicates the common groups of rooms, which should be combined together while planning a residential building.

04. How ROOMINESS can be a principles of building planning?

- The meaning of ROOMINESS is to **<u>maximize the advantage of the available space</u>** from the **minimum dimension** of a room. Both the size and shape of the room play a vital role in providing roominess.

<u>POINTS TO UNDERSTAND THE ROOMINES</u>

- A square room seems small in size when compared to a rectangular room.
- It is always advisable to plan a rectangular room with a proportion of **1.2 to 1.5 times the ratio of the length to the breadth**. The increase in ratio due to length gives the tunnel experience as it looks longer.

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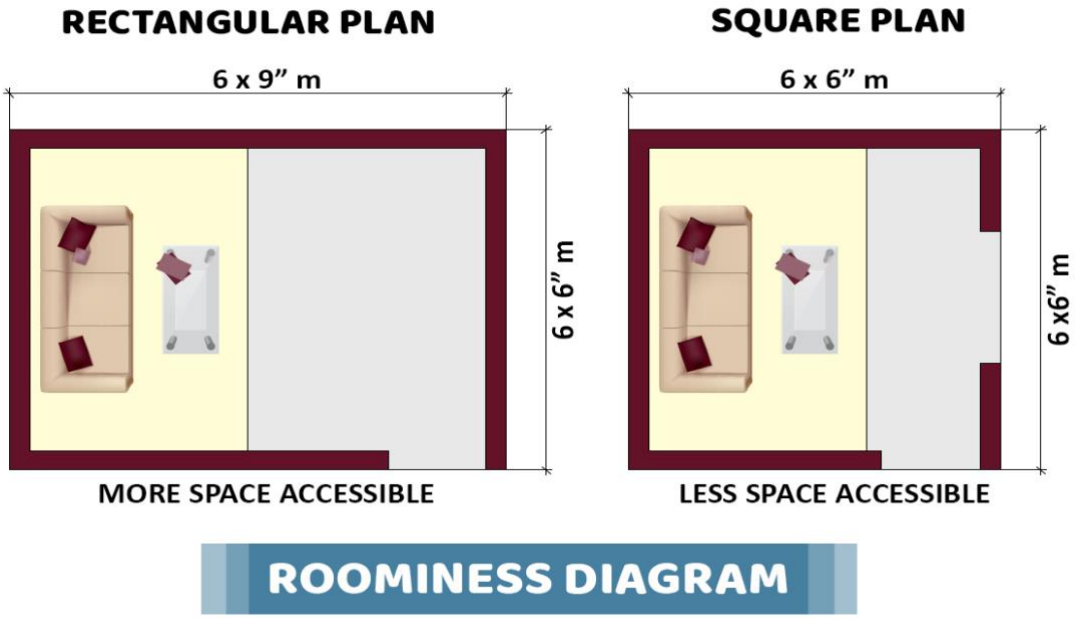
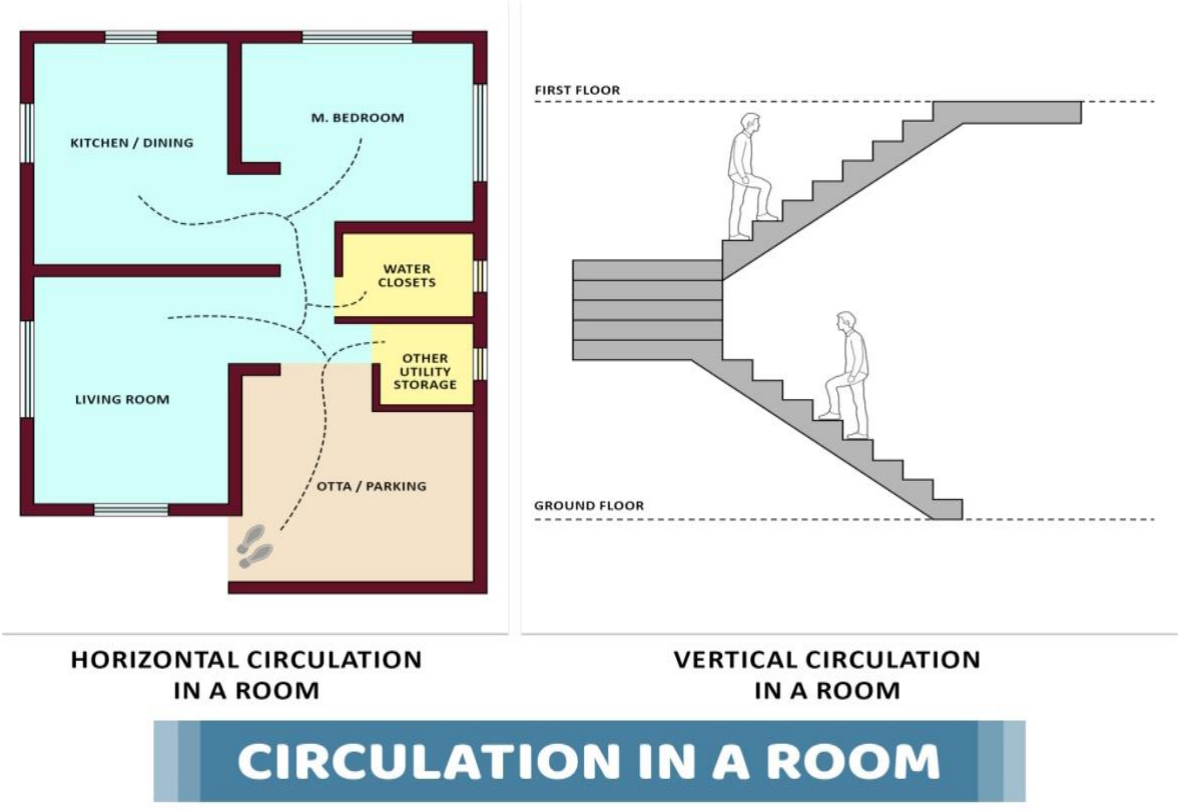
- Also, the **height** should neither be too high nor too less that the ceiling becomes a hindrance.
- Floors, ceilings, walls, ceiling, lifts, furniture, and all such elements should be appropriately placed to offer more space in the rooms.



05. How CIRCULATION act as a principle of building planning?



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06. What is Flexibility in building planning?

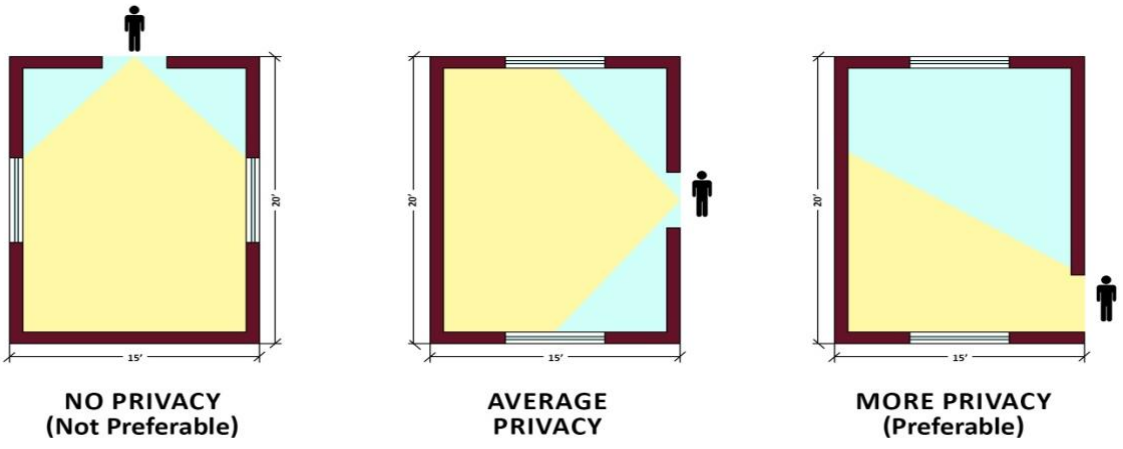
Flexibility means "to **allow use of the particular element in another way possible to fulfil a specific purpose.** An element is initially designed for one **particular reason**, but later the same element is **used differently**."

07. What does Privacy means in building planning?

Privacy is an important factor that needs prior attention. Usually, the privacy can be considered in two ways:

a. **Internal Privacy**: This deals with the privacy inside a house, amongst the rooms. It covers the privacy between rooms and water closets, corridors, passage lobbies etc.

b. **External Privacy:** Privacy of a building with respect to other buildings and the things outside the building- such as streets, roads, etc., is external privacy.



PRIVACY DIAGRAM

08. How FURNITURE influence principles of building planning?

According to rooms' functions, the type of furniture varies. The architects and planner must consider the **furniture's relative positions** to **avoid the congestion** of space. The furniture should match the purpose of the room and justify the **effective use of a room and furniture** as well.

09. What is SANITATION in building planning?

The **hygiene maintenance** in a building is crucial. **Light, ventilation**, and **sanitary conveniences**, are essential factors that provide good sanitation in a building. Adequate

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sanitation can be achieved by placing **doors**, **windows**, and **ventilators** appropriately. Installing **exhaust fans, lighting lamps, suitable absorbent flooring, and improvised plumbing equipment** can lead to better sanitation.

It is studied that for **proper lighting**, the **least area of window** should **not be less** than **1/10th of floor area** in residential building. This ratio can be raised to **1/5th for buildings other than residential** ones.

10.What is the importance of ECONOMY in building planning?

The economy is also one of the major factors to keep in mind while planning a structure. The building should not be too expensive. However, having said that, the cost cutting should not happen by compromising on the safety and the building principles. Often, the cost of the construction at the initial stage is higher as standard designs and materials are used, but it reduces the cost of maintenance and repair in the future.

11. What is ELEGANCE in building planning?

The elegance has a direct connection with the **appearance and layout** of a plan. It has become a trend nowadays to construct **attractive elevations**, which gives a pleasant sense of visibility. Straight, it depends on the **materials used** for construction in the exterior portion and relies on the positions of the door, windows, chhajja, balconies, and many such factors. All these components aim to enhance the look and thus it is necessary to give more footage to it while building planning.

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12. What are the PRACTICAL CONSIDERATIONS in building planning?

While **designing and planning** a building, there are several practical points to be considered for better results. These practical considerations are briefly mentioned as follows:

Life of a Building:

Having considered all the above important attributes a common question that arises is how long a building will survive and sustain and will remain serviceable? It is generally said that, a building has a **100 years life**, but this is not always true. The life of a building does not only deal with the **physical life** but also focuses on **economic** as well as **functional life**.

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2.5. Fundamental requirements of a building

The fundamental requirements of a building are a set of essential criteria and considerations that must be met to ensure the safety, functionality, and usability of the structure. These requirements are typically defined by building codes, regulations, and industry standards. A building is a complex structure that serves a variety of purposes.

The planning and design of a building must meet a number of fundamental requirements, including:

i. **Strength and stability**: The building must be able to withstand all of the loads that it will be subjected to during its service life, including its own weight, the weight of its contents, and environmental loads such as wind, snow, and earthquakes.

ii. **Durability**: The building must be able to withstand the effects of weather and wear and tear over its intended lifespan.

iii. **Fire resistance**: The building must be able to resist the spread of fire and provide safe egress for occupants in the event of a fire.

iv. **Water resistance**: The building must be able to keep out rain and other moisture, and prevent leaks and condensation.

v. **Thermal insulation**: The building must be able to maintain a comfortable temperature for occupants, while also minimizing energy consumption.

vi. **Sound insulation**: The building must be able to reduce noise from the outside and inside, so that occupants can enjoy a quiet and peaceful environment.

vii. **Natural light and ventilation**: The building should be designed to maximize natural light and ventilation, which is beneficial for both the health and well-being of occupants, and energy efficiency.

viii. **Accessibility**: The building should be accessible to all users, including people with disabilities.

ix. **Comfort and convenience**: The building should be designed to provide a comfortable and convenient environment for occupants, with features such as adequate space, functional layouts, and well-designed amenities.

x. **Safety and security**: The building should be designed to be safe and secure for occupants, with features such as fire safety systems, security systems, and well-lit and accessible entrances and exits.

xi. **Sustainability**: The building should be designed to minimize its environmental impact, through features such as energy efficiency, water conservation, and the use of sustainable materials and construction methods.

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2.6 SELECTION OF SITE FOR BUILDINGS :-

The selection of a site for a building is a critical decision that can have a significant impact on the cost, construction, and operation of the building. There are a number of factors that should be considered when selecting a site, including:

i. The soil of site should have good bearing capacity. Hard strata should be available at reasonable depth, around 1.2m to1.5m depth from ground level.
ii. The site should be on elevated ground. It should have slope towards front street to afford good facility of drainage.
iii. Sites nearer to ponds ,pools of water, water logged areas must be avoided as they remain in damp condition .
iv. Sites near to high voltage power transmission lines are avoided.
v. Sites very nearer to big shopping complexes , markets, railway station ,airport are avoided
vi. The surrounding of site should be pleasing and calm.
vii. The orientation of site should be such that it receives natural light and air in plenty.
viii. The location of site is such that the common facilities like school, transportation, medical facilities etc are within reasonable range.
ix. Sites in developed colonies should be preferred.
x. The layout of the colony should be approved by local authorities. This will help in getting essential facilities like water , drainage ,electricity, telephone connection etc easily.

2.7 Introduction to building Design

Building design is a broad discipline that encompasses the planning, design, and construction of buildings. It is a complex process that involves a wide range of considerations, from the functional and aesthetic needs of the occupants to the structural and environmental requirements of the building itself.

The Importance of Building Design

Buildings play a vital role in our lives. They provide us with shelter from the elements, protect us from harm, and give us spaces to live, work, and play. Well-designed buildings can have a positive impact on our health, well-being, and productivity. They can also contribute to a sense of community and identity.

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❖ Functional design of buildings

Functional design of buildings is a fundamental aspect of architecture that emphasizes the practical needs of occupants and the intended functions of the structure. It seeks to create spaces that are efficient, durable, and easy to use, ensuring that the building effectively fulfills its purpose.

➢ Key Elements of Functional Design

1. Space Utilization: Functional design prioritizes efficient space utilization, maximizing the usable area and eliminating wasted space. This involves careful planning of room sizes, circulation patterns, and furniture placement to accommodate the building's activities and occupants.

2. Accessibility: Functional design ensures universal accessibility, allowing all individuals to safely and independently use the building. This involves incorporating ramps, elevators, wider doorways, and other features to accommodate people with disabilities.

3. Safety: Functional design prioritizes safety by implementing measures to protect occupants from hazards. This includes fire safety systems, emergency exits, slip-resistant flooring, and adequate lighting to reduce the risk of accidents and injuries.

4. Environmental Considerations: Functional design integrates environmental sustainability principles to minimize the building's impact on the environment. This includes using energy-efficient materials and systems, maximizing natural light and ventilation, and incorporating renewable energy sources.

➢ Functional Design Process

1. **Needs Assessment**: The functional design process begins with a thorough needs assessment to identify the specific requirements of the building and its occupants. This involves understanding the building's purpose, user groups, and operational needs.

2. **Conceptual Design**: Conceptual design involves generating initial sketches and diagrams to visualize the building's layout, massing, and relationship to the site. This stage focuses on overall spatial organization and functional relationships.

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3. **Space Planning**: Detailed space planning involves refining the layout, determining room sizes, and establishing circulation patterns. This stage ensures that the building's spaces are optimized for their intended functions.

4. **Building Code Compliance**: Functional design must adhere to all applicable building codes and regulations to ensure structural integrity, fire safety, and accessibility standards. This involves collaborating with engineers and code consultants.

5. **Design Development**: Design development involves creating detailed drawings and specifications that provide clear instructions for construction. This stage includes material selections, finishes, and system designs.

6. **Construction Documents**: Construction documents finalize the design intent and provide comprehensive instructions for builders, contractors, and tradespeople. These documents include architectural drawings, structural calculations, and mechanical, electrical, and plumbing (MEP) specifications.

7. **Construction Administration**: Construction administration involves overseeing the construction process to ensure the building is constructed according to the approved design documents. This includes regular site visits, progress inspections, and quality control measures.

- **Benefits of Functional Design**

1. **Enhanced User Experience**: Functional design creates spaces that are easy to use, comfortable, and supportive of occupant activities, leading to a positive user experience.

2. **Improved Productivity**: Functional design can enhance productivity by providing occupants with a well-organized and efficient workspace, minimizing distractions and facilitating collaboration.

3. **Reduced Operational Costs**: Functional design can contribute to lower operational costs by incorporating energy-efficient systems, durable materials, and low-maintenance finishes.

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4. **Increased Building Lifespan**: Functional design emphasizes durability and longevity, ensuring that the building can withstand wear and tear and serve its purpose for an extended period.

5. **Enhanced Environmental Performance**: Functional design promotes sustainability by reducing energy consumption, minimizing waste, and incorporating eco-friendly materials and systems.

❖ Structural Design of a building

Structural design is the process of planning, designing, and analyzing the structural components of a building to ensure its stability, strength, and safety. It involves understanding the loads acting on the building, selecting appropriate materials, and designing the structural elements to withstand these loads without excessive deformation or failure.

Objectives of Structural Design

The primary objectives of structural design are to:

1. Ensure the stability of the building: The structure must be able to resist external forces such as wind, earthquakes, and snow loads without overturning, collapsing, or experiencing excessive movement.
2. Maintain the strength of the building: The structure must be able to support its own weight, the weight of its occupants and contents, and any additional loads such as furniture, equipment, or snow accumulation.
3. Provide adequate stiffness: The structure must be stiff enough to minimize deflections and vibrations under normal loads, ensuring occupant comfort and preventing damage to finishes and materials.
4. Compliance with building codes: The structural design must comply with all applicable building codes and regulations to ensure public safety and protect property.

➢ Structural Design Process

The structural design process typically involves the following steps:

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1. **Conceptual Design**: During the conceptual design phase, the architect and structural engineer collaborate to develop the overall layout and form of the building, considering architectural intent, functional requirements, and structural feasibility.

2. **Load Analysis**: The structural engineer analyzes the various loads that will act on the building, including dead loads (self-weight of the structure), live loads (occupants, furniture, equipment), and environmental loads (wind, snow, earthquakes).

3. **Structural Analysis**: Using mathematical models and computer software, the structural engineer analyzes the behavior of the structure under the applied loads to determine stresses, deflections, and internal forces in the structural members.

4. **Element Design**: Based on the results of the structural analysis, the structural engineer designs the individual structural elements, such as beams, columns, slabs, and walls, to withstand the calculated stresses and deflections.

5. **Detailed Drawings**: The structural engineer prepares detailed drawings and specifications that provide clear instructions for the construction of the structural components, including dimensions, material properties, and reinforcement details.

- **Structural Design Considerations**

Numerous factors influence the structural design of a building, including:

1. Building Type: The type of building, such as residential, commercial, industrial, or institutional, has a significant impact on the structural design due to variations in occupancy loads, floor spans, and functional requirements.
2. Site Conditions: The characteristics of the building site, including soil type, topography, and proximity to seismic faults, influence the foundation design and overall stability of the structure.
3. Architectural Design: The architectural design of the building, including the desired form, openings, and spatial arrangements, must be considered to ensure the structural feasibility and integrity of the design.

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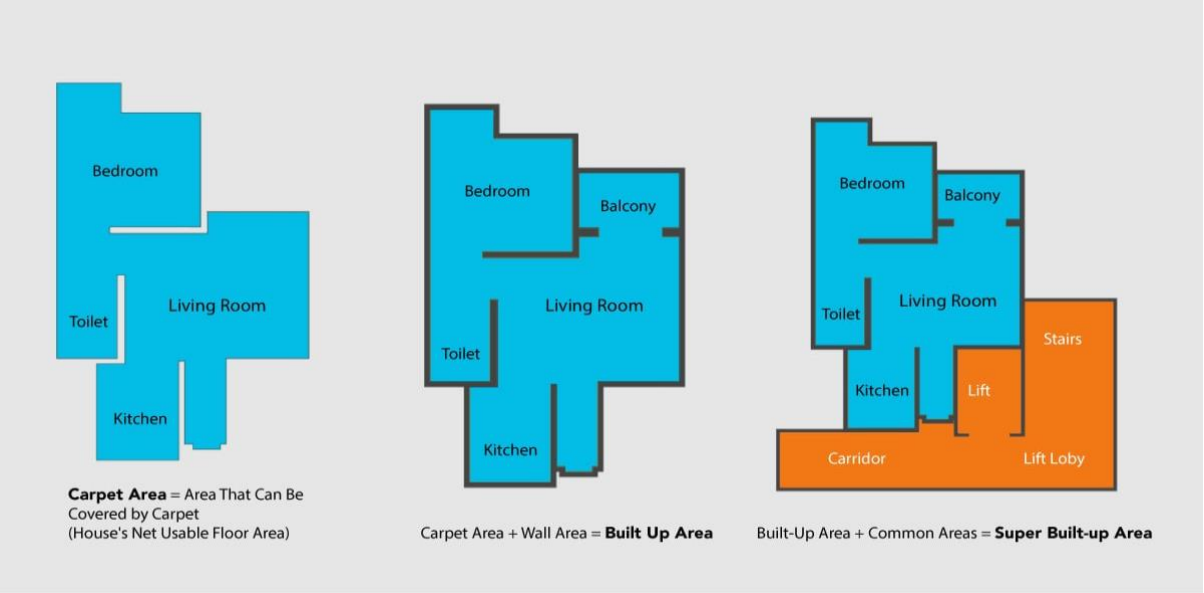
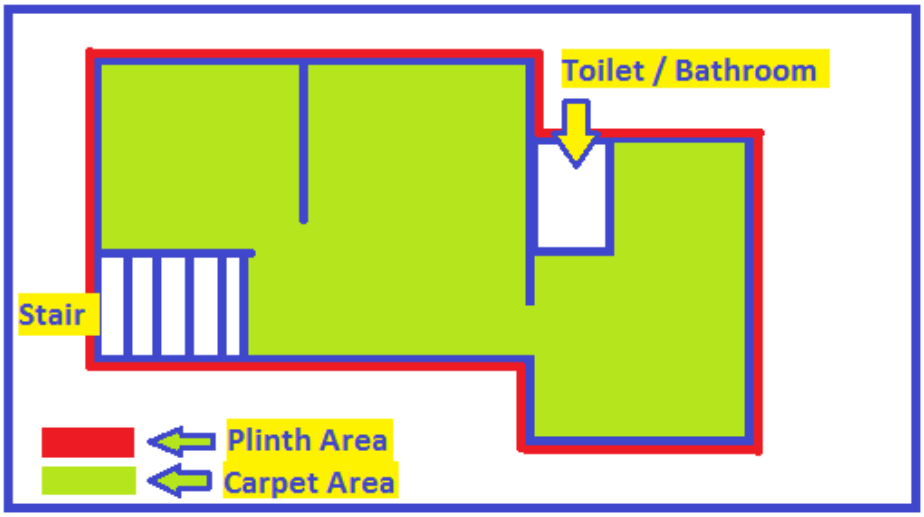
4. Material Selection: The selection of appropriate structural materials, such as concrete, steel, wood, or masonry, is crucial based on factors like strength, stiffness, durability, and cost-effectiveness.

BUILDING AREA TERMS:-





COMPUTATION OF CARPET AREA/LIVABLE AREA-

- Calculated by subtracting the area of the **outer and inner walls** of the building from the **total floor area of the building**. **Carpet Area = Built-up area – Area of walls**.
- For example, if the built area of a property is 2000 sq ft, then its carpet area would be 1400 sq ft.
- The carpet area is the sum of the **actual areas of the rooms that you can carpet**
- The carpet area is smaller than the plinth area by 10 to 20%.

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2.7 Introduction to Building Design: Functional and Structural Design

Building design is the process of creating a safe, functional, and aesthetically pleasing structure. It involves a close collaboration between architects and structural engineers, each with their own unique expertise. Architects focus on the overall appearance and function of the building, while structural engineers ensure that the building is strong enough to withstand all of the loads it will experience during its lifetime.

Functional Design

Functional design is the process of planning and arranging the spaces in a building to meet the needs of the occupants. This includes considering factors such as traffic flow, space utilization, and accessibility. Functional design is important for all types of buildings, from residential homes to office towers to hospitals.

Some of the Important principles of functional design include:

- Efficiency: The building should be designed to use space efficiently and minimize waste. This is especially important in urban areas where land is scarce.
- Flexibility: The building should be designed to be adaptable to changing needs. This may involve using movable partitions or designing spaces that can be used for multiple purposes.
- Accessibility: The building should be accessible to all users, including people with disabilities. This means providing features such as ramps, elevators, and accessible restrooms.

Structural Design

Structural design is the process of designing the supporting elements of a building, such as the foundation, columns, beams, and trusses. The goal of structural design is to create a building that is strong enough to withstand all of the loads it will experience during its lifetime, such as gravity loads, wind loads, and earthquake loads.

Structural engineers use a variety of tools and techniques to design safe and efficient structures. Some of the most common tools include computer-aided design (CAD) software

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and finite element analysis (FEA) software. CAD software allows engineers to create detailed drawings of the building's structure, while FEA software allows them to simulate the behavior of the structure under different load conditions.

The Relationship Between Functional and Structural Design

Functional and structural design are closely interrelated. The functional design of a building can have a significant impact on the structural design, and vice versa. For example, a building with a large open floor plan will require a different structural system than a building with many small rooms.

It is important for architects and structural engineers to work closely together from the early stages of the design process. This ensures that the functional and structural design of the building are compatible and that the building meets all of the necessary safety and performance requirements.

Here are some examples of how functional and structural design work together:

- A large office building with an open floor plan may require a structural system that uses steel columns and beams to create large, column-free spaces.
- A residential home with multiple stories may require a structural system that uses wood or concrete framing to support the weight of the upper floors.
- A hospital that needs to be able to withstand earthquakes may require a structural system that uses special features such as base isolation or seismic dampers.

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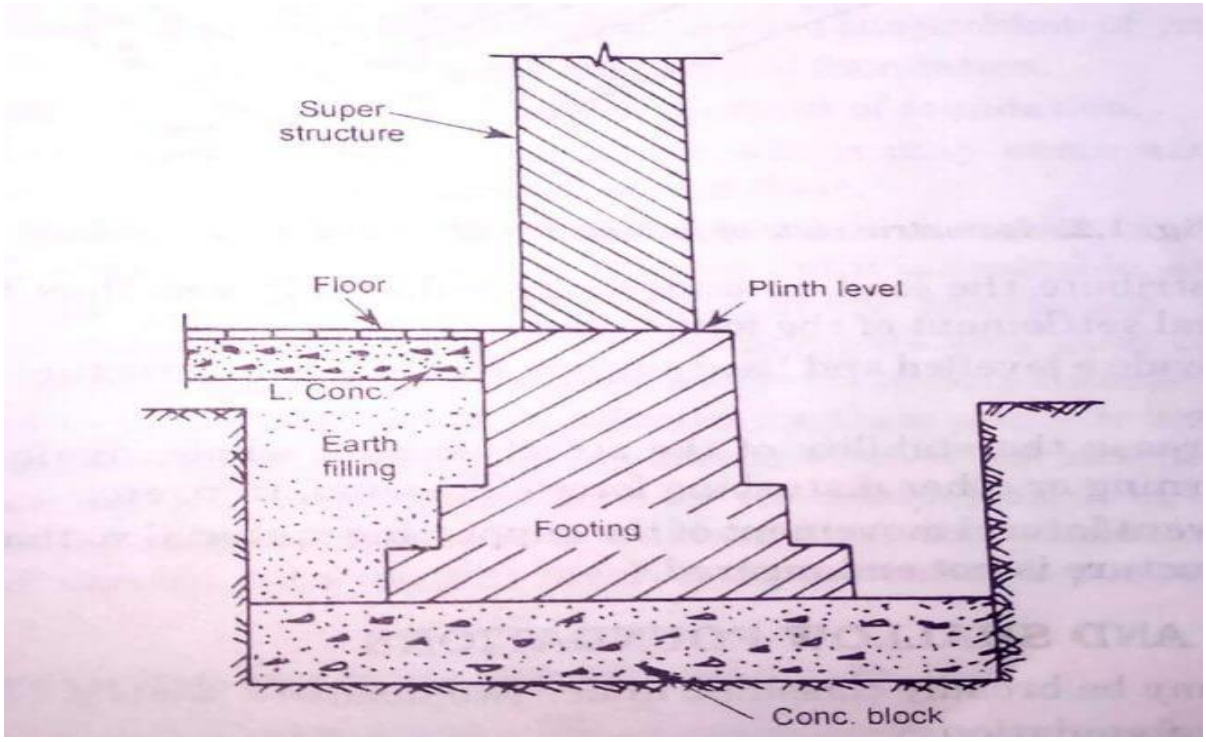
3.0 FOUNDATION:

It is a part of structural system that supports and anchors the superstructure of a building and transmits its loads directly to the earth. Foundation of a building as the name implies is the starting of a building construction on site really. Types of building, nature of soil and environmental conditions are the major determinant of type of foundation. Choosing a kind of foundation depends on, ground conditions, groundwater conditions, site – the environment (the buildings nearby) and structure of our building.



Purpose:-

There are numerous reasons a foundation is provided, some of which are:

- The most crucial purpose of providing Foundation is Structural Stability. Strength of the foundation determines the stability of the structure to be constructed.
- A properly designed and the constructed foundation provide an even surface for the development of superstructure at a proper level at over a firm bed.
- A well-designed foundation prevents the lateral movement of the supporting material (which is the soil in this case) and thus ensuring the safety of the superstructure from the detrimental effects of the lateral movements of soil.
- The foundation serves the purpose of completely distributing the loads from the structure to a large base area, and then the soil underneath. This uniform transfer of loads helps in avoiding unequal settlement of the building, which is one of the detrimental defects in building construction.

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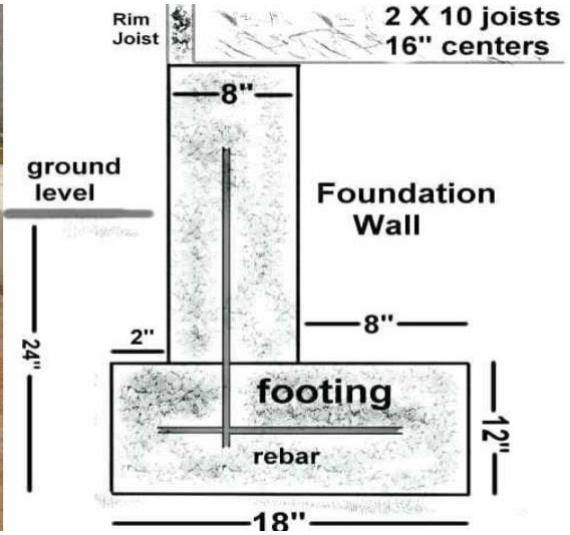
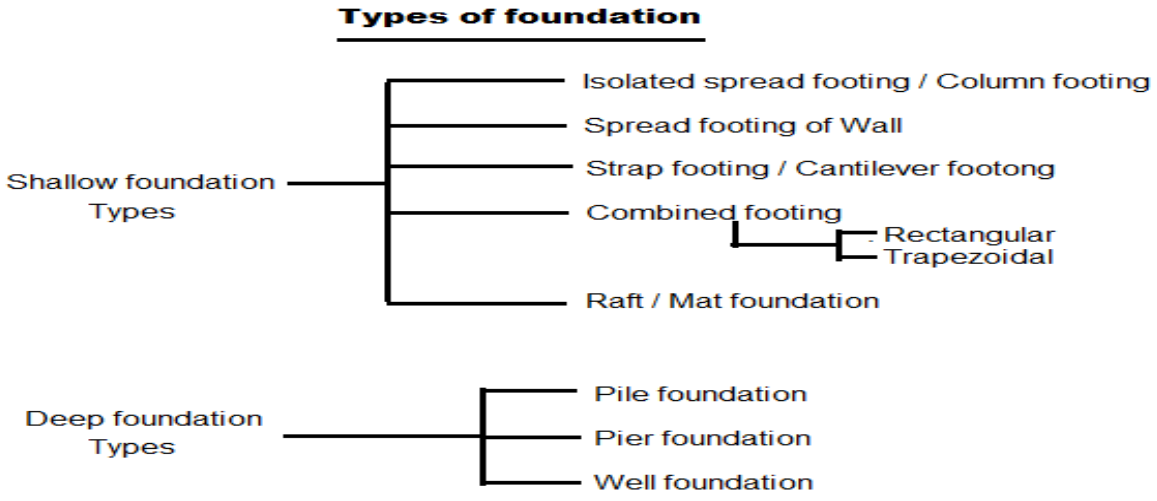
Difference between Foundation and Footing:

- Foundation is a structure which transfers the loads from the superstructure to the ground, while footing is the foundation which is in contact with the earth.
- A foundation can be shallow and deep, while a **footing** is a type of a **shallow foundation**. so, all footings are foundations but all foundations cannot be footings.



Types of Foundation:-

1. Shallow foundation: If the depth of foundation is less than the width of foundation then it is known as Shallow or stepped Foundation. It can be used where the bearing capacity of soil on which the structure is to be constructed is maximum. Minimum depth of this Foundation is 800mm and maximum depth not to be taken more than 4 meters.
2. Deep foundation: If the depth of footing greater or equal to the Width of footing, it is known as the deep Foundation. Deep Foundation is used where the bearing capacity of the soil is very low. The load coming from the superstructure is further transmitted vertically to the soil.



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Bearing Capacity of Soil

- ✓ When subjected to stress from loading, the soil has a tendency to distort. The soil's ability to resist displacement is influenced by a number of different variables, including its moisture content, relative density, internal friction angle and the way in which force is transmitted to the soil.
- ✓ The term "bearing capacity of soil" refers to **the maximum weight per unit area** that soil can support without succumbing or being displaced.
- ✓ If the soil underneath a building cannot support the weight of the structure being constructed, the structure may become unstable, which can result in fractures and other forms of damage.
- ✓ As a result, in order to circumvent this problem, the bearing capacity of soil must be taken into consideration while designing the foundation.

Soil Type	Allowable Bearing Capacity
Rock	3240
Soft Rock	440
Course Sand	440
Medium Sand	245
Fine Sand	440
Stiff Sand	100
Soft Clay	100
Very Soft Clay	50

❖ *Types of Bearing Capacity of Soil*

1. Ultimate bearing capacity (qu)

The **gross pressure** at the base of the foundation at which soil fails is called ultimate bearing capacity.

2. Net ultimate bearing capacity (qnu)

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By **neglecting the overburden pressure** from ultimate bearing capacity we will get net ultimate bearing capacity.

3. Net safe bearing capacity (qns)

By considering only shear failure, **net ultimate bearing capacity** is **divided** by certain **factor of safety** will give the **net safe bearing capacity**.

qns = qnu/ F

4. Gross safe bearing capacity (as)

When **ultimate bearing capacity** is **divided** by **factor of safety** it will give gross safe bearing capacity.

qs = qu/F

5. Net safe settlement pressure (anp)

The pressure with which the soil can carry without exceeding the allowable settlement is called net safe settlement pressure.

6. Net allowable bearing pressure (qna)

This is the pressure we can used for the design of foundations. This is equal to net safe bearing pressure if gnp > qns. In the reverse case it is equal to net safe settlement pressure.

❖ *Factors Affecting Bearing Capacity of Soil*

1. **Foundation width**

Soil with little cohesiveness might have its bearing capacity reduced if the foundation is too narrow. In cohesionless soil, where internal friction contributes significantly to soil shear strength, a wider foundation will support a greater load. Soil with infinite depth, consistent shear strength, and cohesive properties may support loads of any width foundation.

2. **Foundation depth**

A deeper foundation is necessary for increased bearing capacity. This is most noticeable in cohesive-free soil when the texture is homogeneous. The opposite is true if the foundations are pushed into a poor soil layer, which reduces their carrying ability.

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Unless the building is anchored by under-consolidated soil or compressible soil that is vulnerable to wetness, appropriate bearing capacity is typically assured by foundations set at depths where the weight of the structure matches the weight of the displaced soil.

3. **Surcharge and soil weight**

One cannot exclude the bearing capacity contribution of water table-influenced surcharge and subsurface soil. Construction, seepage, and elevation issues may be avoided if the water table is kept below the foundation's base. There will be no effect on the bearing capacity of soil from water table levels below the failure surface.

4. **Spacing between foundations**

When designing a foundation, it is advised that a minimum separation between footings that is 1.5 times the width of the foundation be taken into consideration. This will help prevent a loss in the foundation's carrying capacity.

5. **Dynamic motion and earthquake**

The bearing capacity of soil might diminish due to repeated movement, which would raise pore pressure. Earthquakes, vibrating equipment, and several other factors such as transportation, explosion, and pile driving all contribute to cyclic motions.

When pore pressures are higher than the soil confining tension, the foundation soil may become liquefied. The effective stress drops to zero due to liquefaction, leading to significant deformation and a decrease in bearing capacity.

6. **Frost action**

Changes in the bearing capacity of soil may occur gradually over time due to frost heave in particular soils that are in proximity to water and are exposed to subzero weather. Materials with a low cohesiveness, such as those made up of a lot of silt-sized particles, are more vulnerable to the effects of frost.

7. **Subsurface voids**

The bearing capacity of soil is diminished when subsurface voids are present within a crucial depth under the foundation. The critical depth is determined by the depth at which the pressure exerted by the foundation on the soil is no longer significant.

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8. **Collapsible and expansive soils**

When the soil is somewhat dry, its sturdiness and bearing capacity may increase significantly, despite its tendency to collapse and expand. However, because of changes in moisture content, the proportion of these soils might shift. As a result, there will be shifts in the structure's base on a global and regional scale. Soil movement brought on by rain and dry spells may cause long-term, severe damage to buildings.

9. **Potential heave**

Consolidometer testing, carried out in line with ASTM D 4546, may reveal the presence of a possible heave. The findings of this test are taken into account when deciding how to prepare the foundation soils so that they are better able to resist or isolate the anticipated soil heave.

10. **Soil reinforcement**

The bearing capacity of weak or soft soil may be significantly boosted by the installation of different types of reinforcement in the soil. These reinforcements can take the shape of metal links, strips, arrays, geotextile fabrics, or coarse aggregates.

11. **Seepage and soil erosion**

Seepage and erosion of the soil surrounding and beneath foundations may both lower the bearing capacity of the foundation soil and ultimately lead to its collapse.

How to improve bearing capacity

There are a number of ways to improve the bearing capacity of a soil, including:

1. Compaction: Compaction increases the density of the soil, which increases its bearing capacity.
2. Drainage: Drainage lowers the water content of the soil, which increases its bearing capacity.
3. Soil replacement: If the soil is of poor quality, it can be replaced with better quality soil.
4. Ground improvement techniques: There are a number of ground improvement techniques that can be used to increase the bearing capacity of the soil, such as deep soil mixing and jet grouting.

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