CHAPTER-1: INTRODUCTION

1.1 General

We build because most human activities cannot take place outdoors. We need shelter from sun, and snow. We need dry, level platforms for our activities. We need less light by day and more by night, than is offered actions. And water, and dispose of wastes. So we gather materials and assemble them into constructions we call Buildings in an attempt to satisfy these needs.

A *construction* is something made by man for one purpose or another. It may be a road or a path, a bridge, a dam, a dwelling place, airport or building etc.

A *building* can be generally considered as a structure consisting of floors, walls and roofs erected to provide covered space for different uses such as residence, business, entertainment, workshop etc. The majority of such construction is the out come of the design for better living conditions.

Activity 1 *What is the difference between a house and home?* *What is the difference between a house and a building?*

It is important for a house owner and house builder to know the functions of each elements and therefore familiar with the technical elements of a house.

The choice of building materials is one of the important criteria which determine the strength, quality and economy of any construction.

Ambient climatic conditions are also important in the design of buildings. A building located in areas where lengthy and heavy rains prevail requires good protection against rains; where as requirements for buildings located in dry regions are different.

Therefore, it is essential for civil engineering student to study

- the planning of a building/house,
- the technical elements of a building,
- the construction materials and methods,
- the cost and durability requirements in relation to the prevailing climatic condition, soils behaviour etc.

Buildings are normally constructed according to drawings and specifications prepared by architects and/or civil engineers. In all developed nations and in modern cities of developing countries, each construction should conform to the building regulation set by the concerned authorities.

Building codes lay down norms, which are required to be followed by the designer in evolving the particular design of a building. They give guide lines about, for instance, the minimum size windows and doors, height of floors; minimum front, side and near set backs; size of stair cases etc.

Proper design should ensure optimum utilization of build up space to satisfy functional and architectural requirements of people who live or work in the building.

For the construction of a house, among other factors, the following requirements must be satisfied.

1. A site on which to build the house,
2. Permission from local authorities to build the house,
3. materials for building the house, finance and
4. skilled labourers for erection of the house,
5. Professionals, such as architects and Engineers.

As each one of these requires money, the financial aspect is, therefore, very important and the cost must always be considered during all the planning and building stages. However, this does not mean that it is always economical to save money or to build cheaply "The poorest often builds the dearest" is often proved true.

1.2 Development of Building Construction

Man requires different types of buildings, such as; houses, schools, banks, offices, market halls, theatres, etc. for its activities.
These building activities and structures are important indicators of the country's social progress.
A building consists not only of the house but also of the site, roads, paths, the yard, the garden, the gale and the fence, etc should be planned so that the total results in a complete harmoniums unit.

Although the primary motive for building houses was and still is the desire for better living condition, the initial causes which compelled man to obtain a dwelling or look for a shelter were.

- fear for wild animals during night and the day
- seeking protection against the cold at night and against the heat during the day,
- shelter against rain, wind and
- The design for a place where every thing belonging to the family, such as cattle and equipment, could be gathered.

This is how a gathering place for the family, a dwelling, came about. Such a dwelling did not necessary have to be a building.

A cave with a grass spread over the floor and logs to sit on become a good living place and satisfied the need at the time.

The demand increased- this being the actual motive for all development- and so later the door was invented. Perhaps it was just a bit flat log, without hinge, placed before the entrance but even so the dwelling may now be called a building.
They had no furniture and the floor was used for all purposes: sleeping, sitting, fire place etc.
As development progresses a single room was then divided in to sections with or without partitions to meet varying needs using locally available material, be it timber, bamboo or stone as the case may be.

The history of development of house facilities reveals that man has been moulding his environment throughout the age for more comfortable living.

Now a days a house is built to meet the necessary requirements which vary greatly in different places

- where there is heavy rain, water tight roof is needed;
- in areas where there is strong wind, thick wall is required;
- in hot areas appropriate ventilation and all conditioning is required.

In general, a building should be well adapted to its purpose and appropriate building material should be selected so as to suit the specific requirement.

Originally, stone, sand, earth, grass, logs, skin etc were used as construction/building materials in there crude form. As technique advanced, the crude as well as the partly refined materials were replaced by others, specially made for different purposes such as dressed stones, bricks, cement, lime, gypsum, iron, timber, tiles, sheet metal, paints etc.
The uses if reinforced and pre-stressed concrete construction, production of prefabricated building components and the development of high quality building finishes triggered the rapid development of modern architecture and helped the designers to make new structures look more elegant.

1.3 Typical traditional House Construction in Ethiopia

There are different types of house construction in Ethiopia. A division based on climatic conditions and altitude is considered more appropriate. Accordingly, houses of the Low land-Kolla (<1400m), houses of Uplands-Woina Dega (1400-2700m), and houses of the High lands-Dega (>2700m).

Typical house construction in Ethiopia

1. HOUSING

As per recent estimate one quarter of the world's population doesn't have adequate housing. More than one hundred million are actually homeless, eating and sleeping in Public Street.

1.1. Typical house construction in Ethiopia

There are different types of house construction in Ethiopia. A division can be made in many ways. However, a division based on climatic condtions and altitude is considered to be more appropriate. Accordingly, houses of the low land –Kolla (<1400m); houses of uplands-Woina Dega (1400-2700m) and houses of high lands-Dega(>2700m).

A. Housing of the lowlands(kola)

The climate in these regions is hot and usually dry, so it is desirable to have a house, which gives protection against the burning sun during the daytime and against cold and wild animals during the night. Rains are scarce and if they occur, the ground dries quickly. There are frequent strong winds with plenty of dust. As the houses are not used during the daytime, windows are rare. However, a sufficient daylight pass through the doorway.

The particular shape of these houses, like houses in the other regions, is influenced mainly by the supply of locally available building materials. Wood is scarce, but stone and sand, earth and grass (Senbelet) are to be found in sufficient quantities at convenient distances from the planned building site. The walls are constructed of stone normally unshaped and laid with earth mortar (chika). On top of this building, twigs and branches are placed, with stones, sand or earth added above.

Two main types of houses are to be noted here: houses for permanent residence and houses for nomadic people.

Building for nomadic people must be easy to remove. It requires light construction in order to facilitate transportation by camel or another animal.

B. Houses of the highlands (Dega)

In these regions, due to frequent rainfall, wood and grass are the most important available building materials. In the construction of traditional houses in these regions, strong and termite resistant timber studs such as Tid and Eucalyptus are set at centre-to-centre distance of about 1.2m to 1.5m. Horizontal wailings are then nailed or tied to on to these vertical studs.

C. Houses of the Uplands(Woinadega)

Wood and stone are mostly available materials in these regions. The type traditional house construction in this region is generally similar to that of the highland house construction, except in differences in the use of construction materials.

Housing Agencies in Ethiopia

The development of an appropriate national housing policy must meet:

- To achieve the maximum net addition to housing supply be establishing nationwide program projects by targeting low-income groups

- The recognitions of housing as an important contribution to national economic development
- Priority given to urban housing over rural housing.

Housing agencies in Ethiopia:

1. Agency for Governmental Housing
2. Rental Housing Agency
3. Addis Ababa Housing Development Agency (Condominium)
4. Regional Housing Development Agency (Low Cost House - Condominium)

1.4 Building Terminologies and Building Classification

BUILDING TERMINOLOGIES

Building: is any defined structure construction of whatsoever material and used for residential, business or other purposes.

Foundation: the lowest artificially prepared part, which is in direct contact with sub-strata and transmit all the loads to the sub-soil.

Plinth: the middle part of structure above the surface of the surrounding ground level up to the surface of the floor, i.e. immediately above the ground.

Super-structure: the part of the structure constructed above the plinth level (ground floor level).

Basement/Cellar: the lowest storey of a building either entirely or partly below the ground level.

Plot/Site: is a parcel or pieces of land enclosed by definite boundaries.

Open space: It is the area, forming an integral part of the plot, left open to the sky.

Set Back Line: It is a line usually parallel to the plot boundaries, marked by the Authority, beyond which nothing can be constructed.

Building Line: This is the line to which the plinth of a building adjoining a street or extension of a street or on a future street may lawfully extend.

Covered Area: It is the ground area covered immediately above the plinth level by the building. It does not include the spaces covered by garden, wall structures, platforms, swimming pool, tank, foundation, drains, compound walls, uncovered portico/porch/enterance, gate, uncovered staircases, etc.

Orientation of Building: Orientation is defined as a method of fixing the direction of the building in such a way that it derives maximum benefit from sun, air and nature.

Storey: It is the portion of a building included between the surface of any and the surface of the floor next above it, or if there be no floor above it, then the space between any floor and the ceiling next above it.

Room Height: It is the vertical distance measured from the finished floor surface to the finished ceiling surface.

Balcony: It is a horizontal projection, including a handrail, or a balustrade to serve as passage or sitting out place.

Chajja/Sun Brake: It is a sloping or horizontal structure as overhang usually provided over openings on external walls to provide protection from sun and rain.

Porch: A roof supported on pillars in front of a veranda or in front of a building to park a car for a short while.

Water-Closet (W.C.): This is a privy/toilet with arrangement for flushing the pan with water.

Bath Room: This is the place for bathing purposes whose size shall not be less than 2.5 mx1.2 m or 1.8m^2 and height shall not be less than 2.2 m.

Corridor: It is a narrow veranda or a gallery or open communication to different parts of building.

Floors: These are the horizontal elements of building structure which divide a building into different levels for the purpose of creating more accommodation within a restricted space one above the other and provide support for the occupants, furniture and equipment of a building.

Parapet: a low wall or railing built along the edge of a floor or roof.

Domes: a dome is a special type of shell roof of semi- spherical or semi-elliptical shape which is used over large circular areas for assembly halls, gymnasiums, field houses and other monumental structures.

Ramps: These are the sloping structures either straight or curved for negotiating the changes in different floors or levels by vehicles or passengers.

CLASSIFICATION OF BUILDINGS

According to The National Building Code of India (SP:7-1970) A Building is generally defined as " *any structure for whatsoever purpose and of whatsoever materials constructed and every part thereof whether used as human habitation or not and includes foundations, walls, floors, roof, etc., part of a building or anything affixed thereto or any wall enclosing or intended to enclose any land space".*

A **building** is an assemblage that is firmly attached to the ground and that provides total or nearly total shelter for machines, processing equipment, performance of human activities, storage of human possessions, or any combination of these.

Building design is the process of providing all information necessary for construction of a building that will meet its owner's requirements and also satisfy public health, welfare, and safety requirements.

Architecture is the art and science of building design.

Building construction is the process of assembling materials to form a building.

Architects are persons legally permitted to practice architecture.

Engineers are experts in specific scientific disciplines and are legally permitted to design parts of buildings; in some cases, complete buildings.

Building construction is generally performed by labourers and craftspeople engaged for the purpose by an individual or organization, called a **contractor.**

The contractor signs an agreement, or contract, with the building owner under which the contractor agrees to construct a specific building on a specified site and the owner agrees to pay for the materials and services provided.

In the design of a building, architects should be guided by the following principles:

1. The building should be constructed to serve purposes specified by the client.

2. The design should be construct able by known techniques and with available labour and equipment, within an acceptable time.

3. The building should be capable of withstanding the elements and normal usage for a period of time specified by the client.

4. Both inside and outside, the building should be visually pleasing.

5. No part of the building should pose a hazard to the safety or health of its occupants under normal usage, and the building should provide for safe evacuation or refuge in emergencies.
6. The building should provide the degree of shelter from the elements and of control of the interior environment—air, temperature, humidity, light, and acoustics—specified by the client and not less than the minimums required for safety and health of the occupants.
7. The building should be constructed to minimize adverse impact on the environment.
8. Operation of the building should consume a minimum of energy while permitting the structure to serve its purposes.
9. The sum of costs of construction, operation, maintenance, repair, and anticipated future alterations should be kept within the limit specified by the client.

The ultimate objective of design is to provide all the information necessary for the construction of a building. This objective is achieved by the production of **drawings,** or **plans,** showing what is to be constructed, **specifications** stating what materials and equipment are to be incorporated in the building, and a **construction contract** between the client and a contractor. Designers also should observe construction of the building while it is in process. This should be done not only to assist the client in ensuring that the building is being constructed in accordance with plans and specifications but also to obtain information that will be useful in design of future buildings.

Buildings can be classified in to different groups depending up on their function (occupancy of use) or types of construction.

A. Classification of Buildings based on their function/occupancy:

1. ***Residential Buildings***: This includes buildings in which sleeping/living accommodation is provided. Private dwellings, apartment buildings, dormitories, hostels, etc. are included in this category.
2. ***Educational buildings***:: This refers to buildings used for school, college or day-care purposes. It includes any building used for educational instruction.
3. ***Institutional buildings:*** This includes buildings used medical or other treatment purposes, or care of people detained involuntarily for a period of time. Eg: Hospitals, prison etc.
4. ***Assembly buildings***: It refers to buildings where groups of people gather for amusement, recreation, social, religious, patriotic, civil, travel and other similar purposes. Eg: Theatres, Exhibition halls, Places of Worship, Public Transport Terminals etc.
5. ***Business buildings***: the buildings used for transaction of business, for taking or giving professional services and for the keeping of accounts and records and other similar purposes. Eg: City Halls, Court Houses, Libraries, Garages,, barber shops etc.
6. ***Mercantile buildings***:: This include buildings used for shops, stores, market, and for display and sale of merchandise, either wholesale or retail.
7. ***Industrial buildings***:: This refers to buildings in which products or materials of all kinds and properties are fabricated assembled, finished or processed.
8. ***Storage buildings*****: THIS** shall include buildings used primarily for the storage or sheltering of goods, wares or merchandise, vehicle or animals, row materials, agricultural products etc..
9. ***Hazardous building*****:** These buildings include those which are used for the storage, handlings, manufacture or processing of highly combustible or explosive materials/products.

B. Classification based on Type of construction:

In this type of classification buildings are classified on the basis of resistance to fire of the elements of the buildings. The fire resistance of a material is based on the length of time for which representative loaded test specimen of specified dimensions satisfy the criteria in respect of stability, integrity and insulation under fire. The grades are ½, 1, 2, 3, 4 and 6 hours. These grades are used to define the fire resistance of elements of a structure, which would resist fire. The term fire proof is not to be used in buildings since there is no building material that lives up to this name.

All material deteriorate in excess of heat and degree of fire resistance denotes the time a particular element of a structure will continue to function in fire. The term non-combustible should not be confused with fire resisting. For instance, timer in large sections, although combustible, can have a high fire resistance. On the other hand asbestos cement sheets or unprotected steel although non- combustible, they have little or no fire resistance. In view of the above classification of fire resistance, types of constructions may differ as follows:

1. Type-1 Fire resistance construction:; This includes buildings that are sufficiently fire resistant and withstand the effect of fire and prevents its spread to other rooms. It is a type of construction in which the elements of a building which include walls, columns, floors and the roof itself are non-combustible.

2. Type-2 Non-combustible construction: this is a construction in which the walls, partitions, structural elements, etc. are non-combustible with less fire resistance than required for the fire resisting construction.

3. Type-3 Heavy timber construction:: In these buildings, the design and type of materials used in their construction are such that all structural components have 2-hour fire resistance. Exterior walls are out of masonry or other non-combustible materials. Interior structural members including columns, beams, and girders are out of timber either in solids or laminated forms. Floors and roofs are also constructed out of heavy solids or laminated wood.

4. Type -4 Ordinary construction:: In these buildings, the design and type of materials used in their construction are such that all structural components have 1-hour fire resistance. Exterior walls are in masonry or other non-combustible materials while interior structural members could be partially or wholly out of wood of relatively smaller sections unlike the heavy timber construction.

4. Type -4 Wood Frame Construction:: This a type of construction in which practically the whole of the building is out of wood or other combustible materials.

Depending on the mode of house/floor/flat layouts, a house/building can be classified as follows.

A **detached house** is a free-standing residential building. It stands in its own landscape setting aloof/detached from other buildings. Typically only members of a single family live in this type of house. Most single-family homes are built on lots larger than the structure itself, adding an area surrounding the house, which is commonly called a yard/garden and garage. It fulfils all the requirements of ventilation, light and circulation. The entire space around the building is private to the owner and family, in most cases (depending on federal, state/provincial and local laws) you

can add on to the existing house if more room is needed and there are generally no property management fees such as the ones associated with condominiums and townhomes.

It is costly and need more land. All maintenance and repair costs—interior, exterior and everything in between—are at the owner's expense. There is often a lack of amenities such as pools and playgrounds. Landscaping and lawn upkeep costs are at the owner's expense.

House types include:

- Cottage, a small house typically consisting of four main rooms, two either side of a central corridor. It is common to find a lean-to/wing added to the back of the cottage which may accommodate the kitchen, laundry and bathroom.
- Bungalow, describes a medium to large sized freestanding house on a generous block in the suburbs/periphery, with generally less formal floor plan than a villa. Some rooms in a bungalow typically have doors which link them together.
- Villa, is used to refer to a large freestanding comfortable sized house, on a large block, generally found in the suburbs.
- Mansion, a very large house, usually of more than one story, on a very large block of land or estate.

Semi-detached housing consists of pairs of houses built side by side as units sharing a party wall and usually in such a way that each house's layout is a mirror image of its twin. They are attached by a common enterance and stair case. This type of housing can be thought of as being a half-way state between terraced or row housing and detached homes. Terraced housing is constituted by continuous row houses with open spaces at the front and back, while semi-detached houses have front, rear and any one side open spaces, and individual detached houses have open spaces on all sides.

Advantages

- It is cheaper to construct
- It provides good accomodatio n for an average family
- Because being surrounded on three sides by open space it almost gives the impact of being detached house.

Disadvantage: When the adjacent parts and gaps are different the appreance is generally non-uniform

A **terrace(d)** or **row house is** a style of medium-density housing where a row of identical or mirror-image houses share side walls. It is any house in a continous row of three or more. Terraced housing is constituted by continuous row houses with open spaces at the front and back The first and last of these houses is called an *end terrace*, and is often larger than those houses in the middle. It saves space, (no gaps only partition wall).

A **duplex house/apartment is a living space at two or more levels. It** is a dwelling comprising two units on two different floors.It provides the advantage of living on ground floor as well as on the first floor. It can be detached, semi-detached or multi-story housing.

Advantage

- Good light, air and ventilation
- proper segregation of functions
- Interflow of spaces
- Interesting spaces due to differences in levels

A **condominium**, or **condo**, is the form of housing tenure and other real property where a specified part of a piece of real estate/land (usually of an apartment house) is individually owned while use of and access to common facilities in the piece such as hallways, heating system, elevators, exterior areas is executed under legal rights associated with the individual ownership and controlled by the association of owners that jointly represent ownership of the whole piece. Colloquially, the term is often used to refer to the unit itself in place of the word "apartment". A condominium may be simply defined as an "apartment" that the resident "owns" as opposed to rents.

In modern property law, the individual ownership of one dwelling unit within a multidwelling building, with an undivided ownership interest in the land and other components of the building shared in common with other owners of dwelling units in the building is called condominium.

A condominium is a form of home ownership in which individual units of a larger complex are sold, not rented. Those who purchase units in a condominium technically own everything from their walls inward. All of the individual homeowners have shared rights to most common areas, such as the elevators, hallways, pools and club houses. Maintenance of these areas becomes the responsibility of a condominium association. Every owner owns a share of interest in the condominium association, plus an obligation to pay monthly dues or special assessment fees for larger maintenance problems.

- A condominium arrangement is not the best option for every potential homeowner. There can be a noticeable lack of privacy in the common areas--the pool must be shared with every other condominium owner, for example. It can also be more difficult to sell a condominium unit as opposed to a home with acreage. **Condo owners only own their units, not the ground beneath them.**
- **One thing to be aware of when living in a condominium setting is the political reality of an owners' association.** Decisions may be made in monthly meetings which will cost individual owners more money, but not necessarily deliver equal benefits for all. It can be nearly impossible to avoid being affected by at least one condo board decision, so active participation in meetings and discussions may be more compulsory than you might expect. Condominium living may be more advantageous financially than apartment rentals, but it does require more active participation in community events.

1.5 DESIGN AND PERFORMANCE REQUIREMENTS OF A BUILDING

1. PARTS OF A BUILDING

A building usually consists of the following two parts:

1. Sub- structure 2. Super-structure.

Sub-structure:

The part of a building below ground level is called *sub-structure or foundation*.

Sometimes, a part of a major building is constructed below ground level which provides accommodation. This portion of the building which provides accommodation below ground level is called *basement*. In such cases, basement along with other portion of the building is supported by the foundation lying below it. The part of the building which acts as foundation does not provide any accommodation but simply transmits the load of the building safely to the soil lying underneath. The construction of foundation is started from a specified level which is decided by the design engineer keeping in view the economy and safety of the building.

Super-Structure: The part of a building above ground level is called *super structure*

The super structure of a building usually consists of walls, floors. Verandas, Doors, windows, etc. which is briefly discussed below:

1. **Walls:** The structures constructed to enclose an area, to support suspended floors and roof, or to divide the floor area of a building into required number of rooms are known as walls.
   These are essential to provide privacy to the inmates and protect them from wind and weather.

2. **Roof**: The covering constructed over the enclosed space of a building is called roof
   It is essential to protect the inmates from weathering agencies such as sun, storm, rains, etc.
3. **Floors**: The surfaces which provide room for the occupants to live at different levels in a building are called floors
   Floors are essential to divide a building into different storeys and to provide a hard surface to levels.
4. **Veranda**: The covered outer portion adjacent to living rooms. Usually open on two or three sides, is called veranda.
   Veranda on the front side of the building is called front veranda, whereas it is called rear veranda when provided on the back side.
   Verandas are essential to protect the inmates from heat glare of the sun and direct showers of the rain.
5. **Doors**: The arrangements made to provide free access to inside and outside of the rooms of a building are called doors.Doors are essential to provide access to inside and outside of the rooms of a building.
6. **Windows**: The arrangements provided to allow for entry of air and light inside the rooms of a building are called widows. Windows are essential to provide fresh air and natural light to the inmates of the building.

Most of these components will be thoroughly discussed in subsequent chapters.

(See the Sectional View Diagram of Fig.1.1)

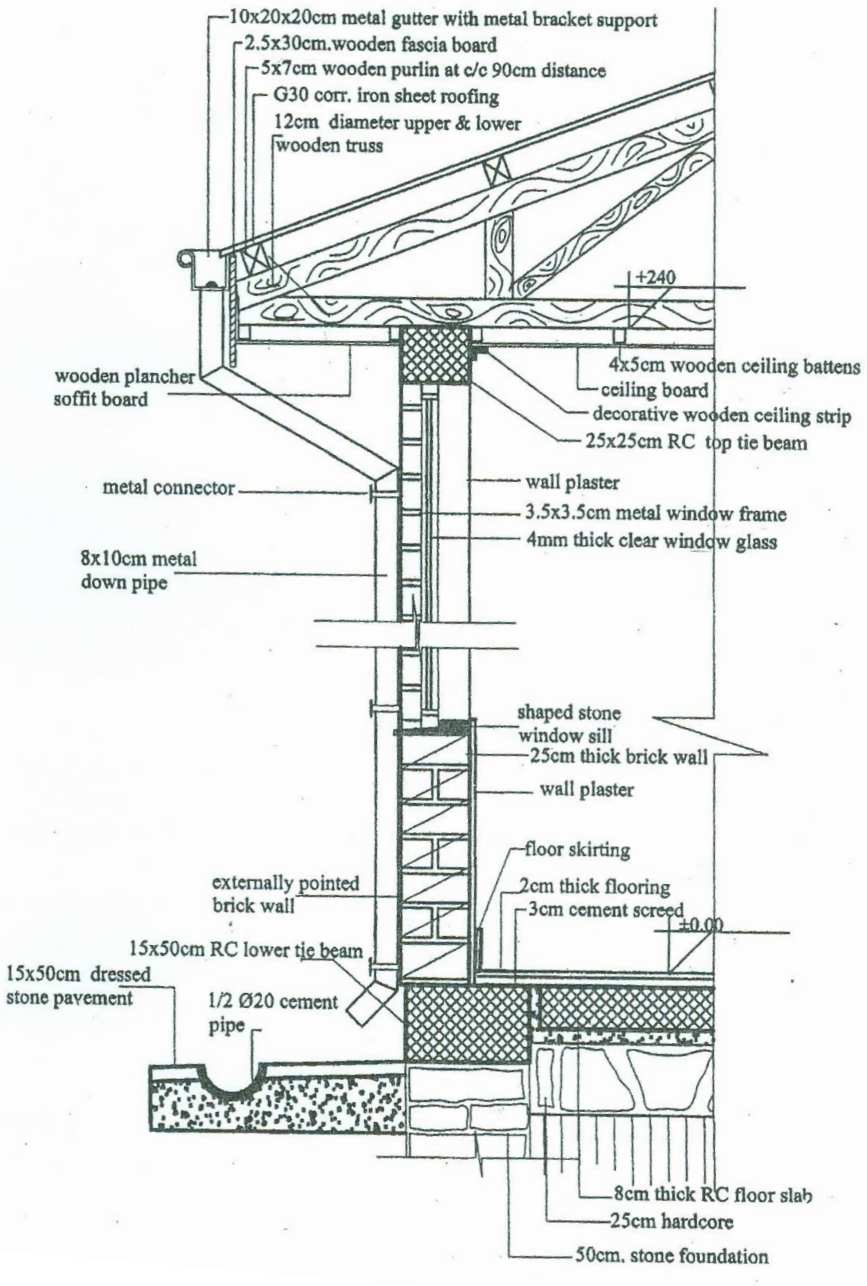

Fig.1.1. Sectional View of a Building

2. REQUIREMENTS OF A GOOD BUILDING

A building should satisfy the following basic design and performance requirements:

a) the structure should have adequate margin of satey, factor of safety above that necessary to support its normal loading;

b) it must have sufficient stiffness so that its distortion does not offend the eye or reduce thr efficency of the structure for its normal purpose; and

c) from performance point of view, the building should be so planned as to provide sufficient comfort and convenience to the occupant of the building.

To perform these functional requirements, a building should satisfy the following requirements in its design and construction:

Strength and stability,

- ✓ Durability,
- ✓ Heat and sound Insulation,
- ✓ Dimensional stability,
- ✓ Daylight and Ventilation of Buildings,
- ✓ Sustainability ,
- ✓ Zoning Ordinances,
- ✓ Orientation of Building,
- ✓ Protection against dampness, fire and termite,
- ✓ Security and Economical,
- ✓ Comfort and convenience.

a. Strength and stability

The strength of a material refers to the capacity of the material to withstand stress either in compression or in tension. The stability of structure or structural element refers to its resistance to large overall deformation, such as the over-turning of a wall or the buckling of a column upon loading. The loads in building are commonly classified as: dead loads, live or superimposed loads and wind loads. Dead loads are the static loads due to the weight of the respective structural members, viz., the wall partitions, roofs, slab and all other permanent fixtures in the building. It is absolutely essential to know the unit mass of construction materials in order to determine the dead load of a structure. To this effect, the characteristic unit masses of different construction materials are given in Ethiopian Standard Code of Practice for Loading, ESCP-1: 1983. Superimposed loads or live loads consist of moving or variable loads, due to materials stored on the roof or floors, due to people occupying the same. Typical characteristic live loads are given in the relevant Ethiopian Standard Code of Practice for Loading, ESCP-1: 1985.

Wind loads are loads, which can cause uplift on a building and reduce the pressure on foundation on the windward side and increases pressure on the leeward side. The effect of wind pressure increases with the height of the building.

b. Durability

Durability is defined as the time in over which a building remains serviceably and depends mainly the types of building materials, environmental exposure, and quality of workmanship, details in designing and the degree of maintenance. The design for durability should therefore include appropriate material selection based on climatic and

environmental conditions, care in the design and detailing of specific areas like joints, roofs etc.

c. Dimensional Stability

The stability refers to the resistance to dimensional change in building materials and structures due to elastic and plastic deformations as a result of applied loads and expansion and contraction due to changes in temperature and moisture content. In design the effect of elastic deformations are taken in to account by considering effective modulus of elasticity. The effect of plastic deformation, particularly at high stresses is accounted by introducing a proper load factor against failure in design. The effect of thermal movements and movements due to moisture changes, which result in cracking of buildings, are take care of by avoiding such material which deform, when unrestrained, as a result of moisture or temperature changes; providing unnecessary restraint to shrinkage or expansion of the material, and by using materials or combination of materials in building element which have large extensibility so that cracking cannot occur.

d. Sustainability

Sustainability may be defined as meeting the needs of the present generation without compromising the ability of future generations to meet. To achieve this, one should plan a building, keeping in mind of various principles of planning which include optimum utilization of space in a building, lighting consideration, and orientation of a building as a whole.

e. Comfort and convenience

This is one of the basic requirements of functional design of buildings and should be satisfied by proper planning of building and its units. To achieve this, one should plan the building using the basic principles which include optimum utilization of space in the building, lighting consideration and orientation a building as a whole.

f.Zoning Ordinances

The legal restrictions on buildings begin with local zoning ordinances, which govern the types of activities that may take place on a given piece of land, how much of the land may be covered by the building or buildings, how far buildings must be set back from each of the property lines, how many parking spaces must be provided, how large a total floor area may be constructed, and how tall the building may be.

g. Orientation of Building

The art of placing a building is such a position so that its front faces a particular direction is called Orientation of the building. The orientation also includes the arrangement of rooms of a building so as to provide natural comfort to the inmates. Orientation needs first consideration after selection of site for proper planning and design of a building.

Factors affecting orientation of a building:

1. **Surrounding of the site**: the building should be oriented that it suits surroundings of the site.
2. **Proximity of a road or a street**: the building should be so oriented as to provide easy approach from the nearby road or street.

3. **The sun's path and its relative position with respect to locality**: since the sun is the source of natural light and temperature, the building should be design in such a way that considering the sunset and sunrise direction.
4. **The direction and intensity of prevailing wind during summer and winter seasons**: the building should be so oriented that cool breeze enters the rooms during in summer but not in winter.
5. **The character and intensity of rain**: the building should be so oriented as to prevent the entrance of rain inside the room.

h. Daylight and Ventilation of Buildings

The supply of outside air into or the removal of inside air from the rooms of different buildings is called ventilation. The ventilation of a building is essential to adjust the flow of air currents through its rooms, corridor, etc. so as to remove foul air and to provide constant freshness of air in them. Day light is essential to promote the activities carried in the building, particularly in industrial building, promote safety of people using the building and create pleasant environment. The number and sizes of windows can be adjusted to satisfy the necessary day lighting in a building.

i. Heat and Sound Insulation :

Heat Insulation

The insulation of a building is very important factors to cut down the fuel cost in cold season and to reduce the load in air conditioning equipment during the dry seasons in some parts of the world. This is achieved by designing buildings in such a way as to maintain a fairly constant temperature of internal environment independently of the varying climatic conditions externally. The temperature that is needed depend upon the use to which the building is to be put.

Sound Insulation

High noise conditions result in uncomfortable living conditions, fatigue, mental strain etc. The insulation of sound is very important requirement for buildings such as hospitals, Educational institutions, offices and residential buildings located in noisy area. The problem of sound insulation can be solved through many ways: the use of appropriate construction methods such as cavity wall construction, airtight windows, floors with suspended ceilings etc.

j. Protection against dampness, fire and termite

One of the basic requirements of a building is to keep the building dry. The presence of moisture in any building structure deteriorates the material strength, reduces durability, and could cause partial or total failure of the structure. Dampness in buildings is generally caused by poor design and detailing, faulty construction and use of poor construction materials.

It is not possible to make buildings fireproof, as there are no material which is absolutely fire proof at high temperature. However, the chance of catching a fire in buildings can be reduced through adequate planning. Selection of appropriate construction materials and providing adequate means of escape in the design may reduce the effect of fire in buildings.

To avoid the risk of termites it is advisable to take due precautions in pre construction techniques of termite proofing such as filling of floor joints, use of better quality foundation materials , clearing building site containing dead wood and old tree stumps, and treat the soil with anti-termite chemicals.

k. Security and Economical

Due consideration should be given in designing and constructing external walls and openings to protect a building from burglary and theft.

The consideration of Economical aspects, keeping in view the functional and durability requirements of a building is very important. The designer must exercise economy at every stage of planning, design, construction, maintenance and operation of building.

3. STEPS IN BUILDING CONSTRUCTION

Building construction involves a number of steps in office as well as in building sites. The design and building drawing are to be completed in design offices, whereas construction and supervisions are made in construction sites.

A. SITE SELECTION AND SITE PLAN

The site of a building greatly affects its planning, design and construction. It may be selected as required or accepted as available. It is expected that an engineer/ architect have either to make a choise of suitable site or plan his building structure to suit the available site. The selection of site depends upon the purpose for which the proposed building is to be constructed.

The main factors that should be considered while making the selection of site for a building are us under:

1. *Level of the site*: The level of the site must be higher than that of its surroundings so as to provide good drainage.
2. *Climatic conditions:* The intensity of rainfall and sub–soil water level should be low so as to avoid dampness in the building. This factor is to be considered in case the choice is not limited to any part of the country.
3. *Sub-soil conditions*: A hard stratum should be available at a reasonable depth so as to construct the foundation of the building safely and economically.
4. *Availability of modern amenities*: The site must be within municipal limits so that modern amenities like water supply, electricity. Drainage lines, roads, etc. can be made available in near future if there is no provision at present.

5. *Local authority regulations*: a site which comes within the limits of an area where the bylaws of local authority enforce restrictions regarding proportion of plot to be built up, vacant spaces to be left in front and sides, heights of buildings, etc. should be preferred.
6. *Availability of other facilities:* The site should provide as easy access from the nearest road and offer sufficient light and air; there should be also good and cheap transport facilities available near the site. It is always better if pubic services like the fire brigade, police station, etc are also not very far off from the site.
7. *Surroundings*: The situation and surroundings of the site must be such as to suit the purpose for which the building is to be constructed.

A site plan is, therefore, a plan which locates the area belongs to any building, showing all the details of interior together with surroundings. It shows, among other things, the boundary of the plot, shape of site and exterior house dimensions, setback lines at the front, back and sides; name and width of existing streets and roads; size and location details of utility lines if there is any, and direction of North line.

B. PLANNING

A house is not merely constructed as a "shelter" but it is expected to create a happy environment inside as well as out side. The same is true for public buildings. Buildings should fulfil the physical, emotional, social and biological needs of person(s) who are going to occupy them. The design should not separate the building from its surroundings. It should integrate both.

The basic objectives planning of buildings are to arrange all the units of a building on all floors and levels according to their functional requirements, making best use of the space available for a building. The shape of such a plan is governed by several factors such as human factor, climatic conditions, site location, surrounding environment, local bylaws etc.

Some of the important factors to be considered in planning are:

1. *Aspect*:

Aspect is the arrangements of doors and windows in the external walls of a building in such away as to allow the occupants to enjoy natural gifts such as sunshine, breeze, scenery, etc. It is very important in planning since it provides comfort, ventilation and good environment to live.

A room which receives light and air form a particular side, is said to have aspect of that direction. For instance for a kitchen, E-aspect; for bedrooms, SW-aspect or W-aspect; and for reading rooms, class rooms, stairs, etc., N-aspect is preferred.

Typical Aspects and Sun diagram are shown below in Fig 1. It is clear from the figure that a kitchen should have a E-aspect, so that the morning sun would refresh and purify the air and keep the kitchen cool during the remaining period of the day. Likewise, the dinning and living rooms should have an S or SE/SW-aspect.

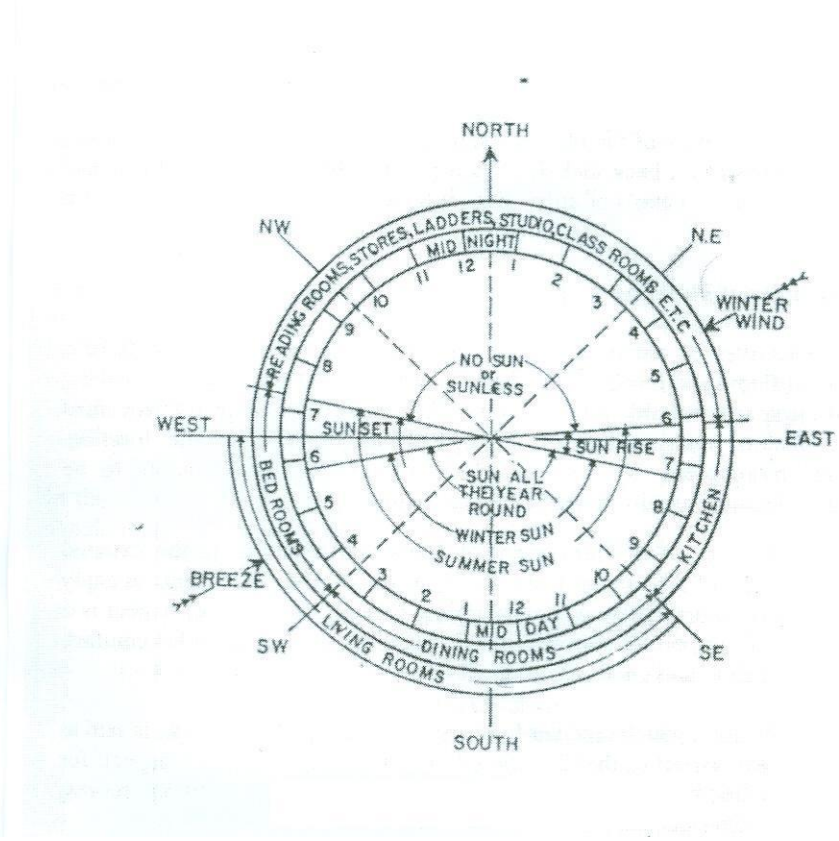

Fig.1.2 Orientation of a building wrt sun direction/Aspects and Sun diagram

2. *Prospect*: Prospect is the impression, the house is likely to make when looked at from the outside.
   Therefore it includes the attainment of pleasing appearance by the use of natural beauties; disposition of doors and windows etc.
3. *Privacy*: It is one of the important participles in the planning of buildings of all types in general and residential buildings in particular. It requires consideration in two ways: privacy of one room from another and privacy of the whole building from the neighbouring buildings, public streets, etc.
4. *Grouping*: means the dispositions of various rooms in the layout in a typical fashion so that all the rooms are placed in proper correlations of their functions and in due proximity with each other. Its objective is to maintain the sequence of their functions with least interference.
5. *Flexibility*: means planning a room or rooms in such a way that, though originally designed for a specific purpose, if/they may be used to serve other overlapping purposes when need arises.
6. *Circulation:* Circulation refers to the space provided for movement. It includes the space provided for movement on the same floor either between the rooms or within the room called horizontal circulation and between the different floors through stairs or lifts called vertical circulation. Passages, corridors and lobbies serve the purpose of horizontal circulation, whereas staircases, ramps, and etc. serve as vertical circulation. For better

circulation, care should be taken to ensure that the links between enterances, passages and stair cases are planned in proper relation.

7. *Aesthetic merit*: is the effect produced by the elevations and general layout of the plan. Elevations therefore should speak out the internal facts and indicative of the character.
8. *Economy*: is one of the factors, which affect planning. The economy of the client may affect the libraries of the architect or engineer and may also require alterations and omissions in the original plan.

C. DESIGNING

The definition of design varies and covers many aspects. Design is a process which can include the following:

- *Blending* the various aspects of a certain problem with the aim of arriving at a best solution within the given scope;
- *Selecting* the best solution for a problem under given circumstances which is the culmination of knowledge and experience;
- *Performance* of social and cultural acts of an individual within a society;
- *Creation* i.e., forming out of a set of given elements and organisms which has its own order and is completed in itself, and
- Design is *an act of conveying a human message*, thus accumulating past tradtion and passing them to future generation.

In civil engineering construction works, there are basically four major types of design:

1. *Architectural design* is in a sense the humanization of space.
2. *Structural design* centres about the conception, designing and construction of structural systems that are needed in support of human activity.
3. *Electrical design* focus on the provision of adequate electric power and assembly of associated electrical equipment to fulfil specific purpose.
4. *Sanitary design* involves mainly on the supply and distribution of clean water and waste sewerage disposal system design.
5. *Mechanical design* this design involves the designing of mechanical equipments like Boiler, Air conditioner, Dust sucker and etc

4. MATERIALS USED IN THE CONSTRUCTION OF BUILDING

The following materials are used in the construction of building:

i. Wooden logs
ii. Mud
iii. Grass
iv. Stones
v. Bricks and other clay products such as floor tiles, roofing tiles, etc
vi. Cement such as Portland cement, white cement, coloured cement, etc.
vii. Lime.
viii. Aggregates in the form of broken bricks, crushed stone, gravel, sand, etc

ix. Timber and timber products such as plywood, hard board, batten board, etc.
x. Metals in the form of rolled steel sections, mild steel and medium tensile steel bars for concrete reinforcement. High tensile structural steel, plain and corrugated galvanised iron sheets, expanded metal, etc.
xi. Pain varnishes and washes, etc.
xii. Glass in various forms such as glass wool, flint glass, etc
xiii. Plastic materials.
xiv. Insulating materials.
xv. Asbestos cement corrugated sheets and fittings.
xvi. Bituminous materials such as asphalt, tar, etc
xvii. Door and window fittings.
xviii. Earth.
xix. Clay.
xx. Water, etc.

Assignment 1

1. Discuss about the different types of house construction in Ethiopia with main emphasis on a division based on climatic condition and altitude.
2. Draw the perspective view of the house/building which is commonly constructed in your locality. Also describe the methods and steps of construction of such a house.