UNIT-8

Preliminary Investigations, Location and Site

Learning Outcomes

By the end of this unit the learner will be able to:

- ✓ Describe the classification of different types of buildings for planning and design.
- ✓ Understand the criteria for Location and Site Selection.

Unit 8

Preliminary Investigations, Location and Site Selection

Before undertaking any building project, the first and most critical thing to decide upon is the location of the building. Due to the scarcity of land, it is becoming more and more difficult to obtain an ideal location to build. Moreover, developmental control rules make the acquisition of desirable locations quite complex. Climate change regulation is a new but important factor to consider when siting new buildings, as the construction and use of a building can have a negative impact on the ecosystem.

Types of Buildings

Buildings are normally classified based on occupancy and the method of construction employed. Developmental control rules and building bylaws are strictly based on the occupancy criteria; therefore, the occupancy classification is crucial for planning and design purposes.

Class A – Shops (Including some services)

This heading is further subdivided into a variety of everyday commercial uses.

Class A1 – Shops and retail outlets

For those in Class A1, the customers, in every case, should be "visiting members of the general public".

The property in this area might include:

- Shops (where goods are sold)
- Post offices
- Premises where tickets are sold and travel agents
- Premises selling cold food (intended for consumption off site)
- Hairdressers
- Florists
- Funeral directors
- Premises where goods for sale are displayed
- Premises where "domestic or personal" goods or services are hired
- Premises where articles are deposited for washing, cleaning or repair

Class A2 – Professional services

Class A2 covers "financial and professional services". Again, these must be offered to the general public. This time, the specification is that "principally" the clients or customers of these types of businesses will again be visiting the premises for:

- Financial services
- Professional services - except those involving health or medical services

Any other services deemed "appropriate" for location within a shopping area

Class A3 – Food and drink

Class A3 consists of one use, namely premises which sell "Food and drink", either to be consumed on site, or on or off site in the case of hot food.

Class A4 – Drinking establishments

Theses are drinking establishments such as public houses, wine bars or other such establishments.

Class A5 – Hot food and takeaway

These are premises for the sale of hot food intended for consumption off the premises.

Class B – Further business and industrial activities

This class covers many common business activities and is prefaced by the provision for "all or any of" the activities described in Class B1:

Class B1 – Business

- Offices - except those already mentioned within Class A2
- Premises for Research and Development
- Industrial processes which "can" take place within a residential area without damaging the "amenity of that area"

Since these classes are described in quite general terms, it is advisable to seek professional advice before proceeding with negotiations to occupy commercial premises. As the remaining Classes in Part B continue, the uses begin to relate to increasingly specific industrial processes.

Class B2

General industrial use for the purpose of carrying on an industrial process other than one falling within class B1 or within classes B3 to B7 below.

Class B3 – Special industrial group A

This class relates to activities which must be registered according to the Alkali, Etc. Works Regulation Act 1906. The exceptions are those activities which fall into the subsequent Classes B4 to B7, assigned to "Special Industrial Group B".

Class B4 - Special industrial group B

Class B4 relates to certain types of metal works, although not those carried out in a quarry or mine (or adjacent to one).

Class B5 - Special industrial group C

This class addresses types of heavier industrial processes for minerals, again except those that are quarry- or mine-based. Examples include “producing rubber from scrap”, “boiling or running linoleum gum” and “manufacturing acetylene from calcium carbide”.

Class B6 - Special industrial group D

Activities that can be broadly summarised as those involving work with oils, gums, resins and some other types of chemical compounds are dealt with in Class B6. The first entry in this Class makes it clear that petroleum and petroleum products are not included.

Class B7 - Special industrial group E

This class covers processes for materials of animal origin and includes 14 different uses. These range from processing potential foodstuffs such as the boiling or cleaning of tripe or curing fish to more general processes which nonetheless involve animal products. Examples include manure production or activities processing “skins” (such as leather).

Class B8 - Special industrial group F

This class applies to properties that are used “for storage or as a distribution centre”.

Class C – Hotels, Hostels and Dwelling Houses

Class C1

Class C1 deals with hotels, boarding houses and guest houses. It does not include premises which offer care as part of their services. That is to say, these premises are ‘regular hotels’ open to the general public, rather than those for guests or residents with special needs.

Class C2

Class C2 covers the following types of premises, providing they are residential:

- Hospitals and nursing homes.
- Schools, colleges or training centres

Class C3

Class C3 addresses use as a “dwelling house”, as a principal or secondary residence. The classifications were updated in 2010.This class is made up of three different parts:

C3(a): those living together as a single household as defined by the Housing Act of 2004, or what could be construed as a family.

C3(b): up to six people living together as a single household and receiving care e.g. supported housing schemes such as those for people with learning disabilities or mental health problems.

C3(c): groups of people (up to six) living together as a single household. This allows for those groupings that do not fall within the C4 HMO definition, but which fall within the previous C3 use class; for example, a small religious community or a homeowner living with a lodger may fall into this category.

Class C4

Houses In Multiple Occupation - small shared houses occupied by between three and six unrelated individuals, as their only or main residence, who share basic amenities such as a kitchen or bathroom.

Large houses in multiple occupation with more than six people sharing are unclassified by the Use Classes Order. In planning terms they are described as being *sui generis*. In consequence, a planning application will be required for a change of use from a dwelling house to a large house in multiple occupation or from a Class C4 house in multiple occupation to a large house in multiple occupation where a material change of use is considered to have taken place

Class D – Non-Residential Institutions

Class D1

Class D1 covers many 'public' services (which do not fall under Class A):

- Medical or health services premises which don't form a part of the practitioner's home
- Crèches, day nurseries or day centres
- Premises for education
- Premises which display works of art without commercial transactions (sale or hire)
- Museums
- Public libraries or reading rooms
- Public or exhibition halls
- Premises "for, or in connection with, public worship or religious instruction"
- General use

Class D2

Class D2 addresses the use of premises for entertainment and leisure purposes:

- Cinemas
- Concert halls
- Bingo halls and casinos
- Dance halls
- Swimming baths, skating rinks, gymnasiums or "areas for other indoor or outdoor sports or recreations, not involving motorised vehicles or firearms".

Zoning and Other Factors

Local authorities' land restrictions as well as other political factors must be considered when choosing a site for buildings. Usually, local governmental agencies partition lands into different zones for different purposes. Certain zones may only be used for industrial and commercial activities while others are reserved for residential building projects. This is mainly done to ensure the two types of zones do not intermingle, for safety reasons.

By dividing lands into zones, it becomes easy to plan transport routes such as roads and railway lines and also prevent noisy, polluting and hazardous buildings from interfering with residential communities designed to be free from these nuisances. It is also desirable for developers to secure locations close to important transport facilities such as highways and railways due to high demand for such prime infrastructure.

Tax issues also have to be factored in when choosing locations for buildings. Tax incentives are given by some central governments to people willing to build industries in some underdeveloped areas. Thus, many municipality bylaws and government agency control rules directly affect building projects.

Environmental Impact Study (EIS)

Developmental activities tend to have both positive and negative effects on the surrounding ecosystem. It is therefore imperative for developers to consider factors that affect the environment during the early phase of planning. Site developers must take note of the following factors:

- Air quality
- Water quality and quantity
- Solid wastes
- Noise
- Radiation from nearby radioactive sources
- Hazardous conditions
- Energy supply and natural resources depletion
- Protection of environmentally critical areas, i.e. flood plains, wetlands, beaches and dunes, unstable soil, steep slopes, aquifer recharge areas
- Land use in coastal areas
- Redevelopment in built-up areas
- Density and congestion mitigation
- Neighbourhood character and continuity.

Need For Expertise in Site Selection

Nowadays, it has become more necessary than ever to engage professionals in site selection processes to assess and analyse key requirements to successfully construct a building in a particular location. The need for professionals is mainly due to dynamic growth of population, legislative requirements, building restrictions and environmental considerations.

Criteria for Location and Site Selection

It is important to select the very best site for building a structure for a specific purpose because the location tends to have effects on:

- Cost of the project
- Accessibility
- Structural techniques required
- Extent and nature of site preparation needed

Basic Requirements

Factors that affect the suitability of a site for all types of buildings include:

- Availability of physical resources, such as good supplies of water, power and materials
- Climatic considerations such as temperature, humidity, solar radiation, rainfall and wind, etc.
- Physical factors such as the contours of the site and nature and condition of the soil

Climatic Considerations

When selecting a site for construction, the climatic conditions of that particular site must be considered first, since climate affects people and their economic activities. The nature of climatic conditions depends on the location of the site on the globe. The site-climate relationship has to be considered because activities on the site can also affect the climate. Apart from the natural climatic conditions affecting a particular site and building, artificial conditions can also be used to control the climate in buildings. These devices might be mechanical or electronic. In addition the structure may be designed in such a way as to create certain climate effects.

It is desirable to understand the physical parameters that affect climate. These parameters are used to determine the ideal site location, to assist in creating good building designs and services based on the natural climatic conditions and to minimise any negative effect of the building project on the environment.

Climate is the average weather conditions existing at a particular place over a period of time. The climate depends on several factors such as the elevation of the site in relation to sea level, its geophysical latitude, wind conditions, humidity, rainfall patterns, temperature and the nature of the land. Selection of a site must first be based on the climatic conditions available, and the natural conditions must be considered in the design to take full advantage of the benefits with less emphasis on artificial climate control in order to reduce the cost of the building project.

Guidelines for Choosing Sites Based On Climatic Considerations:

a) When building in hot, dry climates, walls having the highest dimensions should be constructed in a north-south direction because this arrangement reduces the heat load that the building receives from the sun. A west-facing orientation should be avoided as it is counterproductive. Arranging groups of buildings with narrow streets by placing east-west walls close together will provide mutual shading and reduce the amount of heat retained by the external walls.

b) Natural ventilation is the main criterion for choosing an ideal orientation for buildings in warm, humid climates. Buildings are normally widely spaced, have elongated shapes and are built on stilts to allow cross-ventilation and to avoid slow-moving winds close to the ground surface.

c) Monsoon climates require low-rise buildings with an average density of buildings on sites. The buildings are normally designed similarly to hot-climate buildings but this can be quite a difficult task for designers due to the constantly changing weather patterns from season to season.

Topographic Considerations

In addition to climate consideration, site selection should also take into account the following factors:

- Topographic data
- Geological information
- Hydrology of the area
- Soil types of the site

A typical site consists not only of buildings, streets and social amenities but also the ecosystem, which is made up of all of the living things in that area, the surrounding environment and the climate. A good site plan should include detailed descriptions of the above in order to aid future planning.

Certain categories of data from past experiences in site selection can be used to provide guidance in selecting suitable location. For example, data on foundation conditions and water tables can be very useful. Knowledge of the type of earth or rock is useful for excavation, understanding drainage, properties and how they support plant life and existing structures. The type of soil and the amount of moisture it contains determine its engineering characteristics.

Critical information can be obtained through laboratory tests but field reconnaissance can be an excellent means of gathering essential information to build a picture of the site. Some other methods of obtaining information include data from geological maps, small test pits, data from previous projects on or near the site and, perhaps, information from existing cuttings and foundations.

Spending money on this preliminary investigation helps to avoid:

- expensive site preparation, (cut and fill, drainage of the subsoil etc),
- rectification of damage caused to buildings (due to settling, sliding and tilting)
- discomfort due to dampness, insanitation and flooding, etc.

Data can also be gleaned from plants and trees on the site. They provide information on the soil, water, climate and the general history of the site.

We will briefly outline, in the next section, how data can be collected and used to reach conclusions when undertaking a building project.

Topographical Data

Visual inspection is used to study the basic land form of the site. Sometimes it is necessary to also prepare detailed maps. When gathering topographical data, the following features should be considered:

- Elevation above sea level
- Orientation of the site (e.g., east to southeast, etc.)
- Slopes in percentage (0 to 3%, 3 to 8% etc.)
- Surface waters (such as ponds, streams, rivers and drainage patterns)
- Hills and valleys (visibility, etc.)
- Flood plains, swamps and quicksand, etc.

Geological Data

The success or failure of the construction work depends on our understanding of the geological history of the site. In the planning, design and construction of structures, the topography, hydrology and geology of the bedrock and ground surface are all factors that have to be considered.
Geological factors determining site selection include:

- Ground stability and its relevance to the foundation design for various structures
- Ease and cost of excavating different kinds of formations/ground
- Susceptibility of various kinds of ground to erosion

Investigating the geology of an area involves finding and indicating the type of surface deposits and bedrock formations and their interrelationships. It is believed that the earth's crust started hardening up about four billion years ago, resulting in a solid formation. Later on, gases such as hydrogen, nitrogen, carbon dioxide, oxygen and water vapour escaped from the interior of the solid crust through vents into the atmosphere. The water vapour formed clouds and, later, rain started falling; rainwater from the higher elevations collected together to form water bodies such as lakes, seas and rivers.
Surface deposits are located on top of the bedrock from which it is formed. These are normally between 3 and 30 metres thick and contain minerals. Surface deposits are derived from the weathering of the bedrock which deposits them as sediments that are transported by water, wind or ice to a different section. Residual deposits are layers which cannot be transported. Other non-transportable deposits occur as a result of organic matter accumulation; peat is formed by the accumulation of dead plants.
Several layers of soil may be found in some locations due to weathering. The nature of weathering, water content, types of mineral salts and the extent of fragmentation determines the engineering properties of the soil layer. Other geographical features such as faults in the earth's crust may influence the siting of large structures such as hydroelectric dams. Critical changes in the earth's crust can result in volcanic eruption, fracture of fault lines, earthquakes and the disappearance or emergence of large land masses.
Geologically, building sites are most unstable but extensive studies are providing insights into how geological features function to help us design suitable structures to deal with potentially catastrophic natural phenomena.

Structure of Rock

Rocks are classified based on their mode of formation. Types of rocks include metamorphic, igneous and sedimentary rocks.

Igneous Rocks

These are formed from molten lava

Sedimentary Rocks

Examples include sandstone, limestone and dolomite. They are formed when loose sediments are compacted to the extent that the various layers stick to each other.

Metamorphic Rocks

These are formed from igneous or sedimentary rocks which have been altered by temperature and pressure from the earth's crust. An example is marble, a metamorphic rock from limestone which is extensively used in construction.

The structure of rocks makes it possible to predict some physical behaviour such as the following:

i. Permeability: the measure of the ability of water to flow through rocks. Metamorphic rock (sandstone) tends to have higher permeability than igneous rocks (granite).

ii. Fracture: Most sedimentary or metamorphic rocks do not have a massive structure and are mainly stratified. These characteristics make them susceptible to water seepage along their bedding planes, causing more fractures and damages compared to igneous rocks. Igneous rocks, on the other hand, are relatively large and have cracks and fissures which allow water to dissolve into the cracks. The water reacts with the rock to cause chemical changes.

Ground Stability

The stability of the ground depends on a number of variables. One of these variables is the slope. For rocks that have bedding planes or fractures in the same direction as the slope of a hill, there will be the propensity for landslides to occur when they encounter water. Cuttings made in rocks for the purpose of road construction or foundations have horizontal planes forming almost vertical faces to make them stable.

During heavy rains, the water saturates the slope-forming rock material, causing its mass and gravitational pull to increase. The friction which existed between the layers of rocks before the rain fell is drastically reduced and subsequently results in rock slides in sloped areas.

Construction at Rock Sites

The ground for building dams and the rocks below the foundation ground must not be pervious to water. The rising level of the water table and the deposition of sediments on the foundation must also be investigated thoroughly. Leakage may occur if fault lines are filled up with pervious material and/or opened joints are present in the structure.

Site geology also influences construction involving tunnelling. The geology is the main determinant of the type of feasibility studies employed, the designs and planning, and the method for execution of the tunnel project and the associated risks.

Siting quarries also requires the input of geological studies. Full information of geological studies can be obtained from advanced Geological textbooks. Quarries are used to produce crushed stones, building stones, marble etc., for construction work.

Engineering Geology

This discipline involves the study of geology (properties and use of rocks) and civil engineering. Major projects requiring geological contributions need input from the following:

i. Preliminary investigation using published information, such as geological maps

ii. A detailed geological survey of the site, possibly with aerial photographs
iii. Applied geophysical surveys to provide information about the sub-surface geology
iv. Boring, drilling and excavation to provide confirmation of the results so far obtained and quantitative details at the critical points on the site
v. Testing of soils and rocks to assess their suitability, particularly their mechanical properties, either on site or in the laboratory

These activities should be undertaken by experts.

Hydrology of Sites

It is important to investigate and gain knowledge of the nature of both surface and underground water conditions. Surface water sources include rivers, lakes, streams and ponds. It is also necessary to search and identify drainage basins or watersheds which have the potential to overflow during heavy rain and find their way into the building site.

Take precautionary measures when situating buildings in flood plains, and also understand the position of any underground water table and any seasonal changes in its level. Subsurface hydrological resources such as aquifers and wells are important when there is the need to provide water to homes and industries nearby.

Flood Plains and Flood Protection

It has been discovered that many buildings located in flood plains become automatically exposed to flooding during heavy downpours. Research shows that building companies which build on flood plains usually encroach on the site in ignorance of the devastating effects of the flood, with their eyes on profits only. Building regulations and development policies will be required to tackle the losses as a result of improper siting of buildings on flood plains.

Before undertaking any major development in flood-prone areas, it is necessary to gather data on past floods, estimate future floods and devise methods that are capable of dealing with flooding. By careful and meticulous design, structures and buildings can be constructed to offer protection from flooding through effective reduction of water entering buildings. However, the best option is clearly to avoid building critical infrastructure in areas prone to flooding.

Groundwater and Drainage

The following factors also affect selection of a site:

- Choosing a site with low water table to prevent flooding of basements
- Absence of marshes and swamps
- There should be enough room for draining rainfall and sewage
- Provision of surface and subsurface storm drains

Water Supply Requirements

Selection of an adequate source of water supply is primarily determined by the daily consumption requirements and by the maximum quality that would be required in extreme situations. The supply of protected water from municipalities, as well as from deep and shallow wells, must be considered.

Water-related health issues must also be investigated by competent persons to ensure the safety and quality of the water supply. Measures should be put in place to deal with potential sources of disease. During the planning and site selection phase, the choice of underground water supply will require the study of the nature of the soil and water table, the nature of the geology, the extent of drainage area which will replenish the source and, finally, the type of well and how much it will cost.

Soil Exploration

Studies should also be conducted to understand the nature of the soil at the site in relation to its usefulness to plants and animal life. This section will focus on the soil's engineering properties in relation to the structure to be built. The heavy weight of structures is carried by the land on which they are sited. Thus, before construction commences, it is imperative to obtain subsurface soil samples via drilled holes for analysis. The information is useful for determining the ideal site on which to build a strong foundation which will link the structure to the earth. Building foundations on solid grounds will prevent shifting and sagging.

Factors affecting Site Exploration

- Depth to seasonal high water table
- Depth to bedrock
- Drainage characteristics
- Suitability for the functioning of septic tanks, excavation and grading
- Value as foundation material
- Susceptibility to compaction
- Susceptibility to erosion
- The pH rating
- Soil fertility

General Considerations

The load and function of the building determine the type of site exploration to undertake. The following are useful guidelines to follow:

- For heavy structures, the entire depth of soil should be investigated to the level of the bedrock. Depth exploration for lighter structures is usually not as deep as that for heavy structures.
- Not too many holes should be drilled and the depth to drill should be reasonable.
- An exploratory programme on the site should include laboratory testing of soil and rock.
- Information on all earthwork should be obtained.
- The cost of building determines how much exploratory work needs to be done.
- It is vital to perform a bearing capacity load test.
- All potential foundation problems due to groundwater, etc. should be considered.
- For residential buildings a simple pit or borehole test is sufficient for investigating soil structure, with additional information being obtained from nearby buildings.

- Large buildings with columns reaching to the foundations require groundwater investigations. Boreholes should be drilled at every column location and building corners to obtain samples for analysis and to understand the engineering properties of the soil and any variations present.
- Large buildings, such as factories that make use of machinery, will require a good foundation to carry the heavy loads. Vibrations from machines can affect soil characteristics. Underground water may also displace or move floor slabs and settlement footings. Sufficient holes should be drilled to determine the nature of subsurface soil formation and the necessary action should be taken to ensure they are stable enough to handle all loads.
- Vibration effects from power plants and pumping stations require a thorough investigation of the subsurface. Boreholes can be used to conduct studies to obtain information on faults, shear zones and rock characteristics.
- Samples from all landfill sites should be taken for shear fracture and fill settlement tests. When using sites containing landfill, remove any crust present to a depth of a least a metre and replace with new fill. Piles for supporting buildings should be driven through fill to firm ground.

Description of Soils

Terms for describing different types of soils must be common knowledge among engineers. Terms include sand, clay, silt and gravel. Natural soil is known to consist of a mixture of these types of soil, in addition to organic matter. With sand, having one dominant component and a smaller proportion of another type of soil, the soil in the smallest amount is taken as the adjective when describing the type of soil. For example, sandy clay has clay as the major component and sand as a minor component.

Behaviour of Soil Types:

Gravels

They are ideal materials for foundations of buildings besides rock. They flow freely and have a high bearing capacity. Unlike clay, gravels do not shrink or swell.

Sands

Like gravel, sands are also good foundation materials but only when they have been compacted to make them sufficiently dense to keep them from flowing.

Silt

This type of soil is prone to shrinking and swelling. Silt may cause settlement when used as foundation material.

Clayey Soil

Clay retains water due to strong cohesive forces between its microscopic particles. Foundations built on clayey soil experience settlement after a number of years.

The services of a soil mechanic should be engaged for situations when all of the soil types are present on the site. The soil expert will help to predict the behaviour of structures built on this complex soil formation.

Safe Bearing Capacity

The safe bearing capacity of soil describes the maximum load that the soil is capable of carrying without shear failure.

Allowable Bearing Pressure

This is a measure of the ability of the soil to withstand all loads from safe bearing capacity, the foundation and structures and how the building reacts to any settlement that will occur.

Further Reading:

- ✓ **Kimmons (1989), *Project Management: A Reference for Professionals***
- ✓ **George D. Hack (1999), *Site Selection for Growing Companies***