UNIT-3

Construction Site Selection Criteria

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 3

Construction Site Selection Criteria

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 acquisition of desirable location quite complex. Climate change regulation is a new but important factor to consider when sitting new building because, 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 sub-divided into a variety of everyday commercial uses.

Class A1 – Shops and retail outlets

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

The property in this area could 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
- Florist
- Funeral directors
- Premises where goods for sale are displayed
- Premises where "domestic or personal" goods or services are hired from
- Premises where articles are deposited for washing, cleaning or repair

Class A2 – Professional services

Class A2 moves on to cover "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:

- 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 are to sell “Food and drink”, either to be consumed on site, or on or offsite in the case of hot food.

Class A4 – Drinking establishments

Drinking establishments such as public houses, wine bars or other such establishments.

Class A5 – Hot food and takeaway

For the sale of hot food consumption 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, professional advice is advisable 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 use 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

Relating 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 addresses types of heavier industrial processes for minerals, again except where quarry or mine based. Some examples here are “producing rubber from scrap”, “boiling or running linoleum gum” and “manufacturing acetylene from calcium carbide”.

Class B6 - Special industrial group D

Activities can be broadly summarised as those involving work with oils, gums, resins and some other types of chemical compounds, 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

Covers processes for materials of animal origin and includes 14 different uses. These range from processing potential food stuffs such as the boiling or cleaning of tripe or curing fish to more general processes which nonetheless involve animal products. An example here is producing manure or activities processing “skins” (such as leather).

Class B8 - Special industrial group F

Applies to properties which 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, guest houses. This 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 does cover such 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, 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) allows for 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 fell within the previous C3 use class, to be provided for i.e. a small religious community may fall into this section as could a homeowner who is living with a lodger.

Class C4

Houses In Multiple Occupations - 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 6 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 occupations 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 Stuff

Class D2

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

- Cinemas
- Concert halls
- Bingo halls or casinos,
- Dance halls

- Swimming baths, skating rinks, gymnasiums or “area for other indoor or outdoor sports or recreations, not involving motorised vehicles or firearms.

Zoning and Other Factors

Local authorities’ land restriction 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 railways lines and also prevent noisy, polluted and hazardous buildings from interring with residential communities designed to e free from these nuisances. It is also desirable for developers to secure location close to important transport facilities such as highways and railways due to high demands for such prime infrastructure.

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

Environmental Impact Study (EIS)

Developmental activities are accompanied by some positive, as well as, some negative effects on the surrounding ecosystem. It is therefore imperative for developers to consider factors which 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 radio-active sources
- Hazardous conditions
- Energy supply and natural resources depletion
- Protection of environmentally critical areas i.e. flood plans, wet-lands, 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 professional 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 effect 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 building include:

- Availability of physical resources, such as, good water supply, power supply, and material supply
- Climatic considerations such as temperature, humidity, solar radiation, rainfall, and wind, etc.
- Physical factors such as the contour 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 have to be considered first. This is because 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 could be mechanical or electronic. Also, the design of the structure may be done in such as manner 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 as well as assist in creating god building designs and services based on the natural climatic conditions and minimize any negative effect of the building project on the environment.

Climate is the average weather condition 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 the sea level, its geophysical latitude, wind condition, humidity, rainfall pattern, temperature and the nature of the land. Selecting a site must first be based on the climatic conditions available and the natural condition 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 climate, walls having the highest dimension should face north-south direction because this arrangement reduces the heat load that the building receives from the sun. Avoid west-facing orientation as it is counterproductive. Arranging groups of buildings with narrow streets by placing east-west walls close together will provide mutual shading an 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 build on stilts to allow cross ventilation and to avoid slow-moving wind close to the ground surface.

c) Monsoon climates require low rise buildings with average density of buildings on sites. The buildings are normally designed similar to hot-climate buildings but it can be quite a difficult task for designers due to the constantly changing weather pattern 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 description of the above in order to help 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 for 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 how much moisture it contains determines its engineering characteristics.

Critical information can be obtained through laboratory test 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 cutting and foundations.

Spending money on this preliminary investigation helps to avoid:

- expensive site-preparation, (cut and fill, drainage of the sub-soil etc),
- rectification of damage caused to buildings (due to settling, sliding, and tilting), and
- 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 also, the general history of the site.

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

Topographical Data

Visual inspection is used to study the basic land form of the site. Sometimes there is the need 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.)
- Hood plains, swamps, and quick sand, etc.

Geological Data

The success or failure of the construction work depends on our understanding of the geological history of the site. In planning, designing and construction of structures, the topography, hydrology, 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 inter-relationships. It is believed that the earth's crust started hardening up about 4 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 the clouds and later raid started falling and rain water from the higher elevation collected together to form all of the water bodies such as the lakes, the sea and the rivers.
Surface deposits are located on top of the bedrock from which it is formed. These are normally between 3-30 M thick and contain minerals. Surface deposits are derived from the weathering the bedrock which deposits them as sediments and are transported either 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 on some locations due to weathering. The nature of weathering, water content, types of mineral salts and extent of fragmentation determines the engineering properties of the soil layer. Other geographical features such as faults in the earth's crust may influence sitting 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 disappearing or mergence of large land masses.
Geologically, building sites are most unstable but extensive studies are providing insight into how geological feature function to help us design suitable structures to deal with potential catastrophic natural phenomenon.

Structure of Rock

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

Igneous Rocks

They 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

They are basically formed from igneous or sedimentary rocks which have been altered by temperature and pressure with 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:

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

ii. Fracture: Most sedimentary or metamorphic rocks do not have massive structure and are mainly stratified. These characteristics make them susceptible to water seepage along their bedding planes, causing more fractures and damages compare 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 having their 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 their 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 sloppy 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 water level of 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 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 used of rocks) and civil engineering. Major projects requiring geological contribution need input from the following:

i. Preliminary investigation using published information, such as geological maps
ii. A details 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 arrived at and quantitative detail at the critical points on the site
v. Testing of soils and rocks to assess their suitability, particularly their mechanical properties, either in site or in the laboratory

These activities should be undertaken by experts.

Hydrology of the 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 or ponds. Also search and identify drainage basins or watershed which has the potential to overflow during heavy rain and find its 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. Sub-surface 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 are 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 regulation and development policies will be required to tackle the losses as a result of improper situating of building on flood plains.

Before undertaking any major development in flood-prone areas, there is the need to gather data on past floods, estimate future floods and come up with solution of 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. But 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 basement
- Absence of marshes and swamps
- There should be enough room for draining rainfall and sewage
- Provision of surface and subsurface storm drains

Water Supply Requirement

Selecting an adequate source of water supply is primarily determined by the daily consumption requirements and also 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 has to be considered. Water related health issues also have to 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 diseases.

During the planning and site selection phase, the choice of underground water supply will require the studying 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 done 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 in determining the ideal site 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 bed rock
- 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 of the building and the 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 of heavy structures
- Not too many holes should be drilled and the depth to drill should be reasonable
- 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 very critical to perform bearing capacity load test

- All potential foundation problems due to ground water etc. Should be considered
- For residential buildings a simple pit or bore hole test is sufficient for investigating soil structure with additional information obtained from nearby buildings
- Large buildings having columns reaching to the foundation require groundwater investigations. Bore holes should be drilled at every column location and building corner to obtain samples for analysis and to understand the engineering properties of the soil and any variations present
- Large buildings, such as, factories, which 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 take the necessary action to ensure they are stable enough to handle all loads
- Vibration effects from power plants and pumping stations requires complete investigation of the subsurface. Boreholes can be used to conduct studies to obtain information on faults, shear zones and rock characteristics
- Samples from all land fill sites should be taken for shear fracture and fill settlement tests. When using sites containing land fill, remove any crust present to a depth of a least a metre and replace with new fill. Piles for supporting building should be driven through fill to firm ground

Description of Soils

Terms for describing different types of soils must be common knowledge to 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. For sand, having one dominant component and 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 material for foundations of building besides rock. They flow freely and have a high bearing capacity. Unlike clay, gravels do not shrink or swell.

Sands

Just like gravel, sands are also good foundation material only when they have been compacted together to make them 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 build on clayey soil experience settlement after some years.

The services of soil mechanic should be sought 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 is describes the maximum load that the soil is capable of carrying without shear failure.

Allowable Bearing Pressure

It 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***