

General

- The dictionary meaning of building is very simple.
- It simply indicates anything that is built with walls and a roof.
- The term building in civil engineering parlance is used to mean a structure having various components like foundations, walls, columns, floors, roofs, doors, windows, ventilators, stairs, lifts, various types of surface finishes, etc.
- As a civil engineer is mainly concerned with the construction of buildings, it is essential for him to acquire good knowledge of construction of various components of a building.

* Types of Buildings :-

- The building is 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, plinths, walls, floors, roofs, chimneys, plumbing and building services, fixed platforms, verandah, balcony cornice or projection, part of a building or anything attached thereto or any wall enclosing or intended to enclose any land or space and signs and outdoor display structures according to National Building Code of India.
- Tents, shamianas, tarpaulin shelters, etc. are not included in the definition of a building.

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

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

* GROUP A : Residential buildings :-

→ The buildings which are provided with sleeping accommodation for normal residential purpose, with or without cooking or dining or both the facilities, except any buildings classified under GROUP C.

The buildings of GROUP A are further sub-divided into five groups as follows :

- 1) Sub group A-1 : Lodging or rooming houses
- 2) Sub group A-2 : one or two family private dwellings
- 3) Sub group A-3 : Dormitories
- 4) Sub group A-4 : Apartment houses (flats)
- 5) Sub group A-5 : Hotels

1) Sub-group A-1 : Lodging or rooming houses :-

→ Any building or group of buildings under the same management, provided with separate sleeping accommodation for a total of not more than 15 persons, on either transient or permanent basis with or without dining facilities, but without cooking facilities for individuals, are included in this sub-group.

→ A lodging or rooming house is classified under sub-group A-2 if no room in any of its private dwelling unit is rented to more than 3 persons.

2) Sub-group A-2 : one or two family private dwellings :-

→ This sub-group includes any private dwelling which is occupied by members of a single family and has a total sleeping accommodation for not more than 20 persons.

→ If sleeping accommodation for more than 20 persons is provided in any residential building, it should be classified under sub-group A-3 or A-4 as the case may be.

→ If the rooms are rented to the outsiders, it should be for accommodating not more than 3 persons.

• A dwelling can further be classified under following six different types :

i) Detached houses

ii) Semi-detached houses

iii) Row of houses

iv) Apartments or flats

v) Duplex type apartments

vi) Skyscrapers.

→ The house may consist of a single tenement or a number of tenements.

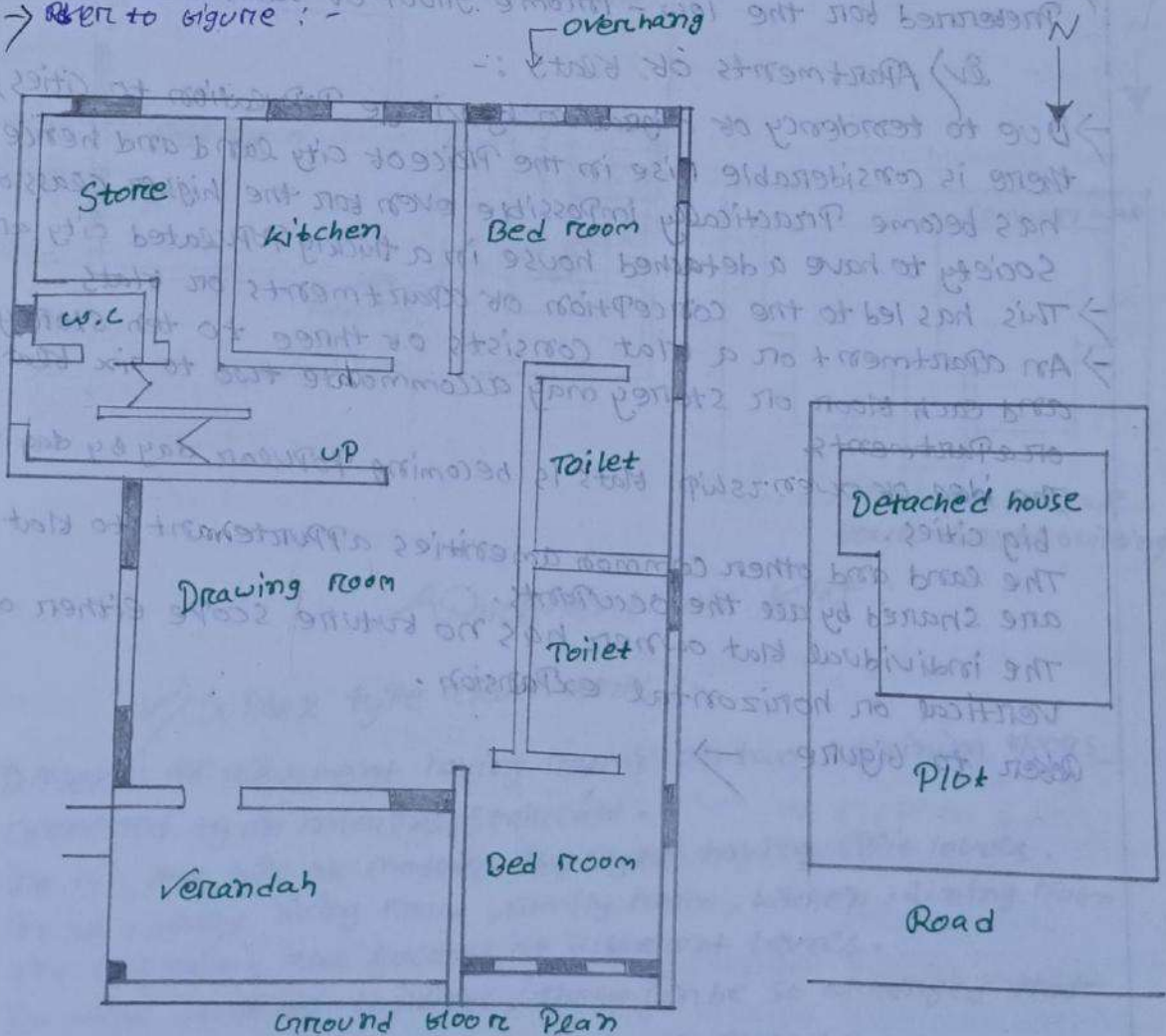
→ It should be noted that in housing parlance, a tenement

means a family unit.

→ Each category of residential building will now be briefly described.

2) Detached houses :-

- It is the usual tendency of any family to have a house surrounded by its own land.
- This has led to the formation of detached houses.
- The design of a detached house can be made by considering the individual requirements of the family to be accommodated in that house.
- Sufficient margins are left on sides, front and rear.
- It may also include amenities such as private garden, swimming pool, etc.
- A detached house permits the highest form of residence and it is applicable at places where land prices are comparatively low.
- Refer to figure :-



: Detached house :

ii) Semi-detached houses :-

- A common boundary wall in the form of structural barrier divides an independent plot into two units.
- Such a construction helps in securing many advantages of the detached type of houses and in addition, economy may be achieved by sharing expenses of common amenities such as water lines, drainage lines, electric cables, etc.

iii) Row of houses :-

- For providing reasonable accommodation to the labourers or workers, a row of houses with minimum requirements such as living room and kitchen, may be constructed.
- It may be single-storied or two-storied.
- The row-housing yields more net residential density and it is preferred for the low-income group of families.

iv) Apartments or flats :-

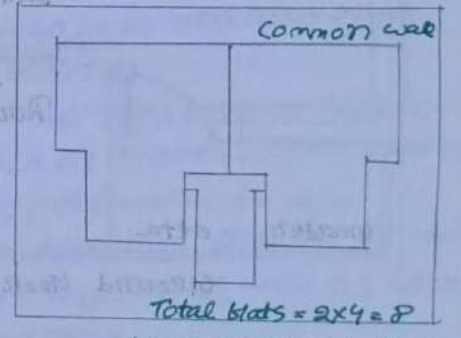
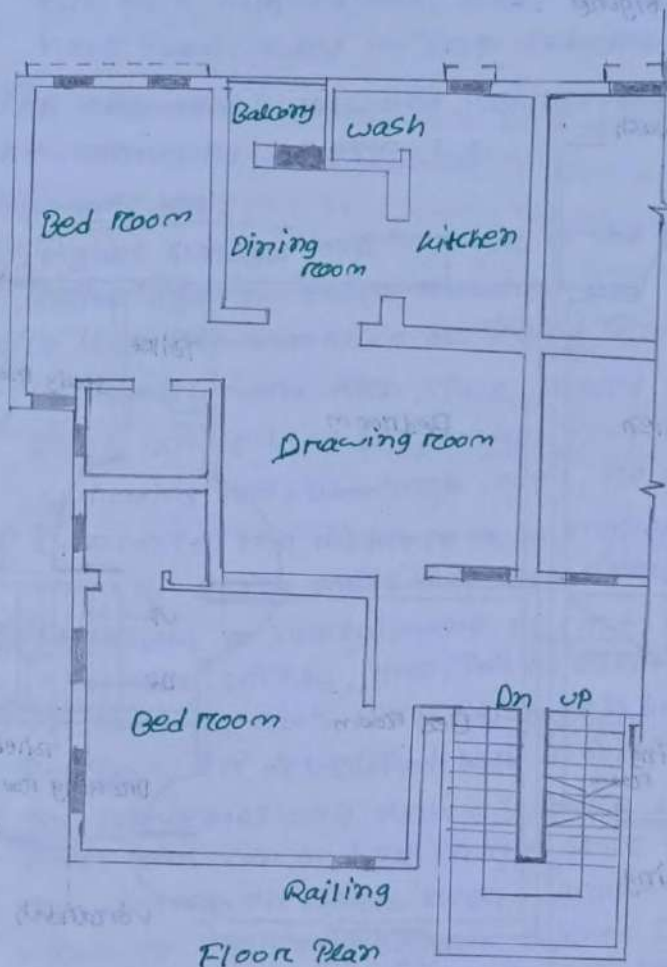
- Due to tendency of migration by village population to cities, there is considerable rise in the price of city land and hence, it has become practically impossible even for the higher class of the society to have a detached house in a thickly populated city area.
- This has led to the conception of apartments or flats.
- An apartment or a flat consists of three to ten storeys and each floor or storey may accommodate two to six flats or apartments.

The idea of ownership flats is becoming popular day by day in big cities.

The land and other common amenities appurtenant to flat are shared by all the occupants.

The individual flat owner has no future scope either of vertical or horizontal expansion.

Refer to figure →



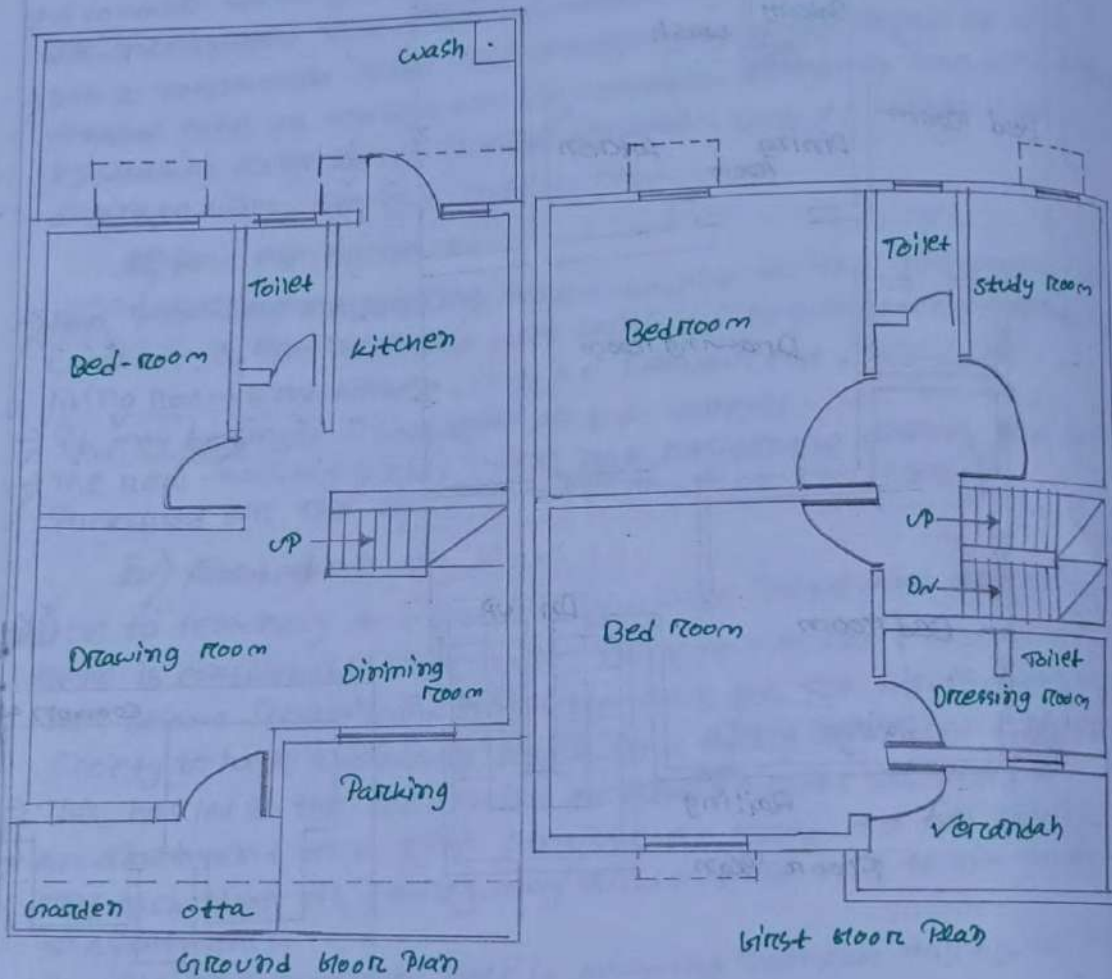
four storied building

Apartment or flat :

✓ Duplex type apartments :-

- Duplex is an apartment having rooms on two adjoining floors connected by an internal staircase.
- It is a one type of modern like style having split levels.
- In such houses living room, family room, kitchen, dining room and bed rooms are located at different levels.
- In multi-storied buildings, these can be so arranged that corridors fall on alternate block or even beyond.
- Along with good elevation split level has advantages of privacy, more air and light and more internal space with the vertical

movement from adjacent levels or only half the height of floor to ceiling. Refer to figure :-



: Duplex type apartments :

vi) Skyscrapers :

- The growing need of land and consequently sudden shooting rise in price of land in big cities further led to the conception of multi-storied buildings or as they are popularly known as Skyscrapers.
- As it always happens, the subject of skyscrapers is also divided between two schools of thoughts.
- Some town planners favour idea of skyscrapers while others do not agree on this point.

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→ many seminars and discussions have been arranged on this topic and experts from various fields of community life have participated in such debates.

• The arguments for and against the skyscrapers may briefly be mentioned as follows:

→ Arguments for:

- a) It gives sunlight and pure air to the residents and gives them relief against noise nuisance.
- b) It is a remunerative or paying proposition.
- c) It permits more open space around the building and this open space can be used for various purposes such as tennis court, swimming pool, badminton court, recreation area, etc.
- d) It reduces the distance to be travelled by the occupants, thereby saving their time and energy.
- e) It results in curtailment of costs of various services such as water supply, transport, electrification, drainage, etc.
- f) It saves precious land which can be utilized for agricultural purposes or developed for industrial units.
- g) The conveniences such as office, markets and also other amenities can be had in the same buildings.
- h) The staying on upper floors grants the pleasure of scenic views of near and distant objects such as roads, green farms, hills, mountains, trees, rivers, lakes, etc.
- i) They could be seen to symbolize the economic growth of town and their location could enhance the skyline as well as bear an expressive form of the urban imagery.

→ Arguments against:

- a) It becomes difficult for old people to undertake vertical travel when the lift or elevator of the building fails.
- b) The benefit of enjoying the charm of a private garden cannot be obtained by the residents.
- c) If located improperly and without any planning with respect to the surrounding features of the area, a skyscraper may spoil the skyline of a city. They should therefore be permitted only in special zones reserving most water fronts, hills and such other natural elements for other types of structures.

- d) It deprives the sunlight and air of others.
- e) It is quite likely that a skyscraper may cause an obstruction to air traffic and micro-wave transmission.
- f) The costs of construction and maintenance are high for skyscrapers because of the instalment of services such as lifts, fire fighting devices, etc. and design of structural elements for wind, earth quake etc.
- g) It may create Psychological Problems for children as they have no open space to play.
- h) There is considerable increase in the land value due to the construction of skyscrapers and it ultimately necessitates into the construction of more skyscrapers.
- i) There is fear of panic in case of emergency such as fire or earthquake.

3) Sub-group A-3 : Dormitories :-

→ This sub-group includes any building in which group sleeping accommodation is provided, with or without dining facilities, for persons who are not members of the same family, in any one room or a series of closely associated rooms under joint occupancy and single management. E.g. guest house's dormitories, school and college dormitories, military barracks, etc.

4) Sub-group A-4 : Apartment houses (flats) :-

→ These include any building or structure in which living quarters are provided for two, three or more families living independently of each other and with independent cooking facilities.

5) Sub-group A-5 : Hotels :-

→ These include any building or group of buildings under single management in which sleeping accommodation, with or without dining facilities, is provided for nine to more than 15 persons who are primarily transient, e.g. hotels, inns, clubs and motels.

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* GROUP B : Educational buildings :-

Any school, college building or day-care center used for educational purpose for more than 8 hours a week involving assembly for instruction, education or recreation and which is not covered by group D comes under this group.

* GROUP C : Institutional buildings :-

→ These include any building or part thereof, which is used for purpose like medical or other treatment or care of persons suffering from physical or mental illness, diseases or infirmity, care of infants, aged persons, etc.

This group is further divided into three sub-groups as mentioned below :

1) Sub-group C-1 : Hospitals and sanatoria

2) Sub-group C-2 : Custodial institutions

3) Sub-group C-3 : Penal institutions

1) Sub-group C-1 : Hospitals and sanatoria :

→ This sub group includes any building or group of buildings like hospitals, clinics, sanatoria, etc, which is under single management and is used for housing persons suffering from physical limitations because of health or age.

2) Sub-group C-2 : Custodial institutions :

→ This sub group includes any building or group of buildings like orphanages, homes for aged and infirm etc., which is under single management and is used for the custody and care of persons such as children, convalescents and the aged persons.

3) Sub-group C-3 : Penal institutions :

→ This sub group includes buildings like jails, prisons, mental hospitals, mental sanatoria and reformatories, etc, which is under single management and is used for housing persons under restraint or who are detained for penal or corrective purposes, in which the liberty of inmates is restricted.

* GROUP D : Assembly buildings :-

Any buildings or part of a buildings like theatres, assembly halls, drama theatres, auditorium, museums, exhibition halls, restaurants,

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Places of worship, dance halls, club house, air terminals, surface and marine public transportation service, recreation piers, sports stadium, gymnasiums, skating rinks, etc., where group of people gather for amusement, recreation, social, religious, patriotic, civil, travel or other similar purposes are included in this group.

This group is further divided into five sub-groups as mentioned below:

1) Sub-group D-1 :-

→ Any building with a raised stage, proscenium curtain, fixed or portable scenery or scenery loft, lights, motion picture booth, mechanical appliances or other theatrical accessories and equipment, fixed seats over 1000 persons and primarily meant for theatrical or operatic performances and exhibitions is considered in this sub-group.

2) Sub-group D-2 :-

→ This sub-group includes any building primarily meant for use as described for sub-group D-1 but with a capacity of less than 1000 persons.

3) Sub-group D-3 :-

→ This sub-group includes any building, its lobbies, rooms and other spaces connected thereto, primarily meant for assembly of more than 300 people without permanent seating arrangement, raised theatrical stage or theatrical accessories but may be with raised platform.

→ The buildings like dance halls, club halls, lecture halls, libraries, passenger terminals and buildings used for educational purposes for less than 8 hours per week are covered under this sub-group.

4) Sub-group D-4 :-

→ This sub-group includes any building primarily meant for use as described for sub-group D-3 but with a capacity of less than 300 persons.

5) Sub-group D-5 :-

→ This sub-group includes any building meant for outdoor assembly of people not covered by sub-group D-1, D-2, D-3 or D-4, like grand stands, stadia, amusement park structures,

10 reviewing stands and circus tents.

* GROUP E : Business buildings :-

→ Any building or part of a building which is used for the transaction of business (other than that covered by building in group F), for the keeping of accounts and records and similar purposes, barber shops, beauty parlours, lunch counters serving less than 400 people, is included in this group.

* GROUP F : mercantile buildings :-

→ This sub-group includes any building or part of building, which is used as shops, offices, stores, markets, showrooms for display and sale of merchandise, either wholesale or retail.

* GROUP G : Industrial buildings :-

→ This sub-group includes any building or part of a building in which products or materials of all kinds and properties are fabricated, assembled or processed.

→ These include assembly plants, smoke houses, gas plants, refineries, dairies, textile mills and saw mills.

* GROUP H : storage buildings :-

→ This sub-group includes any building or part of a building which primarily used for the storage or sheltering (including servicing, processing or repairs incidental to storage) of goods, wares or merchandise except those that involve highly combustible or explosive products or materials, vehicles or animals.

→ These include warehouses, cold storages, freight depots, transit sheds, store houses, truck and marine terminals, garages, hangars (other than aircraft repair hangars), grain elevators, barns and stables.

* GROUP I : Hazardous buildings :-

→ This sub-group includes any buildings or part of a building which is used as storage, handling, manufacture or processing of highly combustible or explosive materials or products which are liable to burn with extreme rapidity and/or which produce poisonous fumes or explosions or which are highly corrosive, toxic or noxious alkalis, acids or other chemicals producing flame, fumes and explosive, poisonous, irritant gases

or which require any material producing explosive mixtures or dust or which result in division of matter into fine particles subject to spontaneous ignition. This group includes the buildings which are used for :

i) → storage under pressure of more than 0.1 N/mm² and in quantities exceeding 70 m³ of acetylene, hydrogen, illuminating and natural gases, ammonia, chlorine, sulphur dioxide, carbon dioxide, methyl oxide and all gases subject to explosion, fume, toxic hazard ;

ii) → storage and handling of hazardous and highly inflammable liquids ;

* Important building components :-

Usually a building is divided into three parts :

- 1) Foundation
- 2) Plinth
- 3) Superstructure

• 1) Foundation :-

→ It is the part of a building constructed below ground level and which is in direct contact with sub-strata and transmits all the loads to the sub-soil.

• 2) Plinth :-

→ It is the building above the ground level and upto the floor level immediately above the ground.

→ The built-up area measured at the Plinth level is known as Plinth area.

• 3) Superstructure :-

It is the part of the building constructed above the Plinth level.

Following are the structural components of a building :

i) Foundation

ii) Plinth

iii) masonry or R.C.C. walls and columns in superstructure

iv) Basement, ground floor and upper floors

v) Sills, lintels and weather sheds

vi) Doors, windows and ventilators

vii) Roofs

viii) Stairs, lifts, ramps, etc.

ix) Building finishes like plastering, painting, whitewashing, flooring, etc.

x) Utility fixtures.

ii) Foundation :-

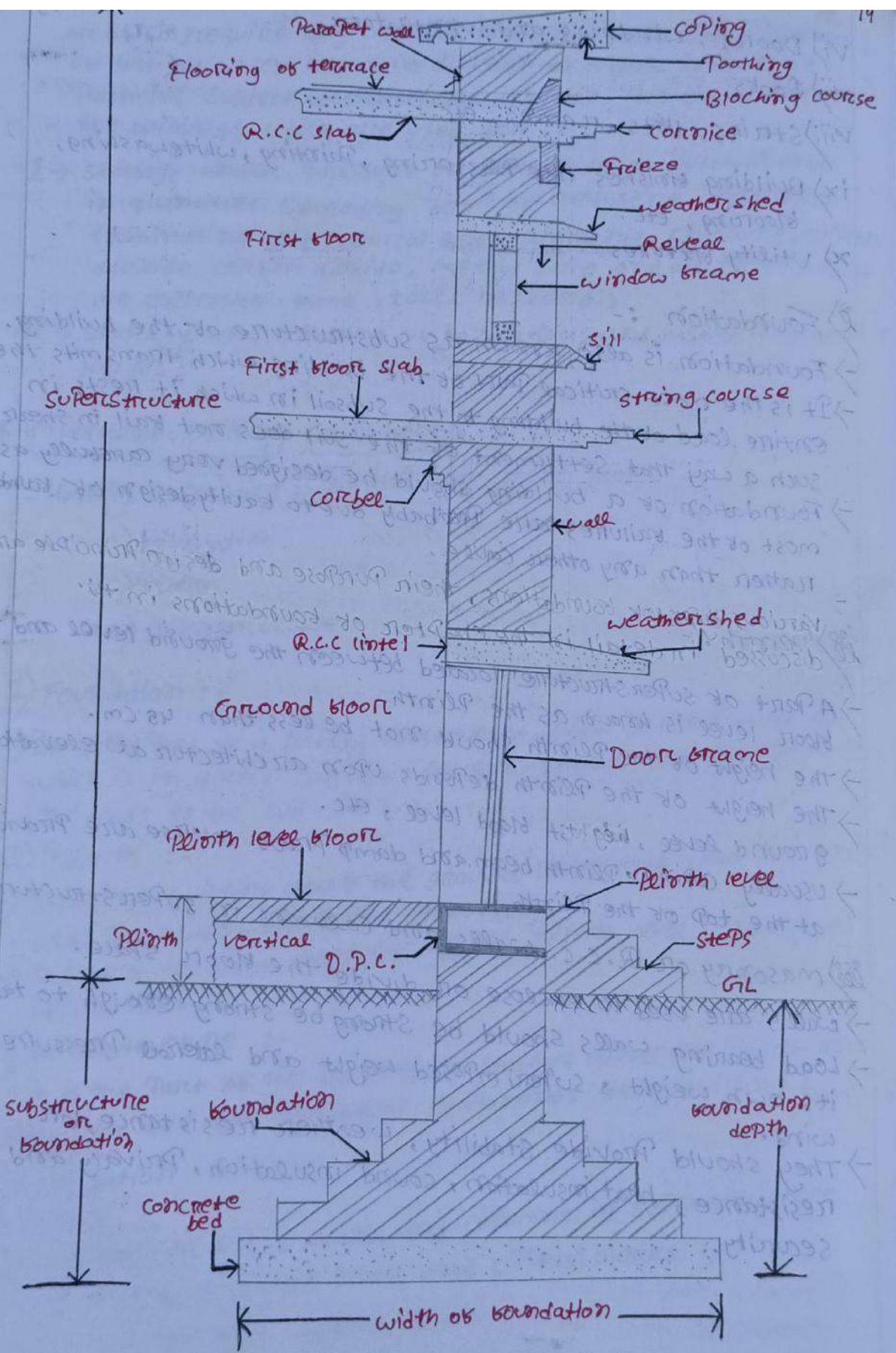
- Foundation is also known as substructure of the building.
- It is the most critical part of the building which transmits the entire load of the building to the subsoil in which it rests in such a way that settlement of the soil does not fail in shear.
- Foundation of a building should be designed very carefully as most of the failures are probably due to faulty design of foundation rather than any other cause.

iii) Plinth :-

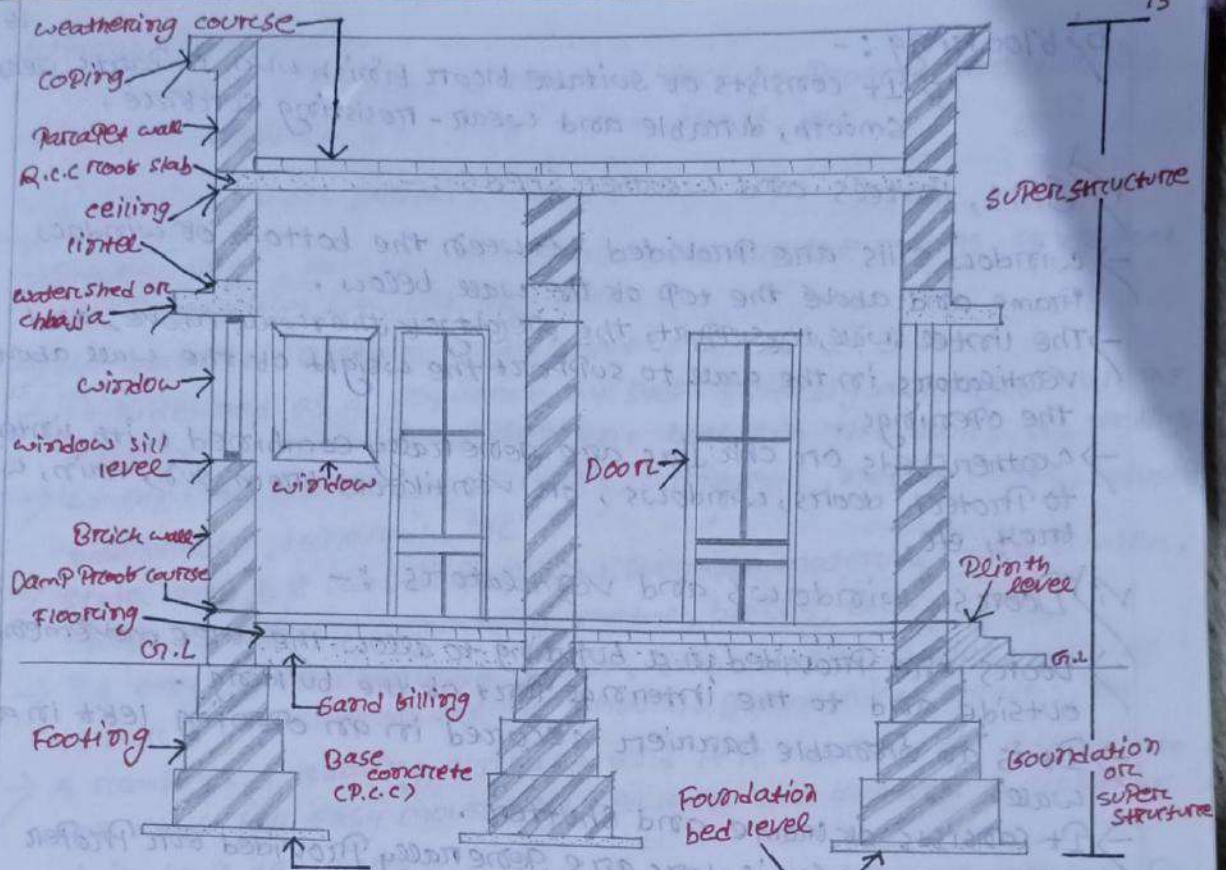
- A part of superstructure located between the ground level and the floor level is known as the plinth.
- The height of the plinth should not be less than 45 cm.
- The height of the plinth depends upon architectural elevation, ground level, highest flood level, etc.
- Usually coping, plinth beam and damp proof course are provided at the top of the plinth.

iv) masonry or R.C.C. walls and columns in superstructure :-

- walls are used to enclose or divide the floor space.
- Load bearing walls should be strong enough to take its own weight, superimposed weight and lateral pressure of wind.
- They should provide stability, weather resistance, fire resistance, heat insulation, sound insulation, privacy and security.



Components of a building



Components of a building

- iv) Basement, ground floor, and upper floors :-
- A Floor provides support to the occupants, furniture, fixtures and equipments of a building.
 - Different floors divide the building into different levels to provide more accommodation on a given plot of land.
 - The floor of a building immediately above the ground is known as ground floor.
 - All other floors above the ground floor is known as upper floors.
 - The floor below the ground level is known as basement floor or lower level floor.

Every floor has following two components :-

- a) Sub floor :-
- It is a structural component of a building which imparts strength and stability to support the super-imposed loads, durability, damp prevention, heat and sound insulation and fire protection.

b) Flooring :-

→ It consists of suitable floor finish which imparts clean, smooth, durable and wear-resisting surface.

✓ Sills, lintels and weather sheds :-

- window sills are provided between the bottom of window frame and above the top of the wall below.
- The lintel is provided above the openings of windows, doors and ventilators in the wall to support the weight of the wall above the openings.
- weather sheds or chhajjas are generally combined with lintels to protect doors, windows, or ventilators from sun, rain, wind blast, etc.

vi) Doors, windows and ventilators :-

- Doors are provided in a building to allow the free movement outside and to the interior part of the building.
- It is an openable barrier secured in an opening left in a wall.
- It consists of frame and shutter.
- windows and ventilators are generally provided for proper light, ventilation and vision.
- Their sizes and numbers should be properly determined as per requirements.
- when windows are provided for light and ventilation only, they may be fixed so that they cannot be opened.
- They are known as ventilators.

vii) Roofs :-

- A roof is the uppermost part of a building which is constructed in the form of a framework to give protection to the building against rain, heat, snow, wind frost, etc.
- A roof basically consists of structural elements provided at the top of building for the support of roof coverings.
- A roof consists of the following two components.

a) Roof decking :-

- It is a structural component which supports the roof covering. It may be flat, slopping, dome shaped, truss, etc.

b) Roof Covering :-

→ It is provided on the roof deck to protect the building against sun, rain, wind, frost, etc.

viii) Stairs, lifts, ramps, etc :-

→ Stairs, lifts, ramps, escalators, etc. are the means of vertical transportation between the floors.

→ out of these, a stair is the most common.

→ It is defined as a sequence of steps suitably arranged for the purpose of ascent and descent between the floors or landings.

→ It consists of treads, risers, stringers, newel posts, balustrade, handrail, etc.

→ Stair may be constructed of different materials like timber, stone, reinforced concrete, metal, bricks, etc.

→ It may be of different shapes like straight stairs, turning stairs, circular or helical stairs, geometrical stairs, etc.

→ A ramp is a sloping surface and it is adopted as a substitute for stair for easy movement between the floors. A slope of 1 in 10 is desirable.

→ The flooring of ramp should be of non-slippery material. Its shape may be straight, zigzag, spiral, curve, etc.

→ Escalators are ever moving flights of electrically operated stairs. These escalators are kept in motion by a revolving drum.

ix) Building finishes like plastering, painting, whitewashing, flooring, etc :-

→ To protect the exposed surface of walls and floors from the effects of atmospheric actions, building finishes are used. They improve the appearance of the structure as a whole and give smooth surface. They also rectify the defective workmanship or conceal inferior materials.

→ Plastering, pointing, painting, varnishing, distemping, white-washing, colour washing, flooring, etc. are considered as building finishes.

→ Plastering is a thin plastic covering which is applied on the surface of walls and ceilings. It removes the unevenness of the surface and imparts decorative effects.

→ Pointing is the process of finishing of mortar joints of either stone masonry or brick masonry. The joints are raked out to a depth of about 20 mm and then these spaces are filled up by a suitable mortar in the desired shape.

→ Painting, varnishing and Polishing are generally done on doors, windows, cupboards and other exposed wooden and steel components.

→ Whitewashing, colour washing and distempering are generally done on the plastered surface to protect them against weathering effects and to give better appearance.

→ Flooring is the process of finishing of the upper surface of the floor in order to give a pleasing appearance. The material like asphalt, brick, concrete, wood, glass, linoleum, marble stone, terrazzo, tiles, marbium, granite, granamite, ceramic tiles, etc. are used as flooring materials.

* Site investigation and ground techniques :-

General.

→ It is desirable to visit the site of work and inspect the same carefully from the view point of foundation details.

→ The nature and thickness of strata of soil may be estimated by studying the excavation details of nearby constructions or by examining the open side of a nearby well, etc.

→ The general inspection of site of work serves as a good guide for determining the type of foundation to be adopted for the proposed work and in addition, it help in getting the data with respect to the following items :

i) behaviour of ground due to variations in depth of water table ;

ii) disposal of storm water at site ;

iii) nature of soil by visual examination ;

iv) movement of ground due to any reason ; etc.

→ The load of the structure is ultimately transferred to the soil. It becomes therefore essential to know the quality and thickness of soil underground and such a study would assist in selecting an economical but safe design for the foundation of the structure.

→ The characteristics of the foundation soil i.e., its behavior under loading and also under different environmental conditions, are very important and it governs the selection and type of footing / foundation to be selected e.g., black cotton soil which is typically a cohesive soil requires a particular type of foundation and in most of the cases, under-reamed pile foundation is found to be suitable.

→ Therefore, site investigation borings the most important part in finding out the accurate value of soil parameters, that needs to be used in the design of the foundation.

→ The sub-soil exploration gives precise information with respect to the following conditions at site of the proposed work :

- i) location of ground water and its variation ;
- ii) nature and engineering characteristics of the soil and rock formation ; and
- iii) order of occurrence and extent of different soil strata .

• Depth of exploration

→ The depth of exploration will have to be decided very carefully .
 The term significant depth is used to indicate the depth upto which the increase in pressure due to structural loading is likely to cause perceptible settlement or shear failure of foundation .

The general rules to be adopted to decide the depth of exploration for various types of structures and site conditions are given in table :-

No.	Description	Depth of exploration
1	Adjacent footing with clear spacing less than twice the width	1.50 times the length
2	Base of retaining wall	1.50 times the base width or 1.50 times the exposed height of base of wall whichever is greater
3	Floating basement	Depth of construction

4 Isolated spread footings or raft foundations	1.50 times the width
5 Pile foundations	10m to 30m or more with minimum equal to 1.50 times the width of structure.
6 weathering conditions	1.50 m in general and 3.50 m in black cotton soil.

• Methods of site Exploration :-

Following are the various methods of site exploration :

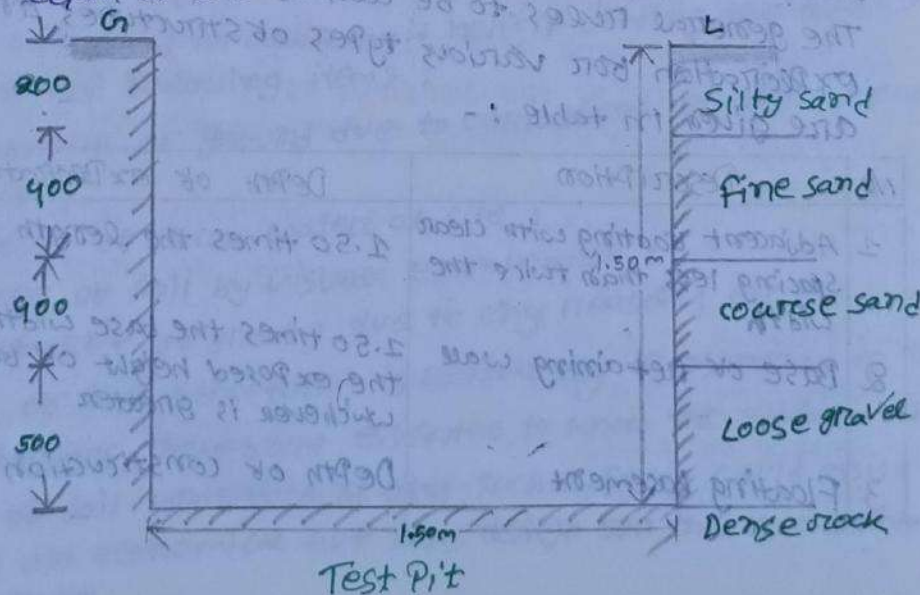
- 1) Test Pits
- 2) Probing
- 3) Auger boring
- 4) Wash boring
- 5) Sub-surface soundings
- 6) Test Piles
- 7) Deep boring
- 8) Geophysical method.

Each of the above method of site exploration will now be discussed in detail.

1) Test Pits :-

→ A square pit, known as a trial pit or a test pit, with side as about 1.50 m, is excavated upto a depth at which sufficiently hard soil is available.

→ The various strata of the soil can be inspected, studied and classified accordingly as shown in figure. This method is useful when hard soil is available within a maximum depth of 1.50 m.



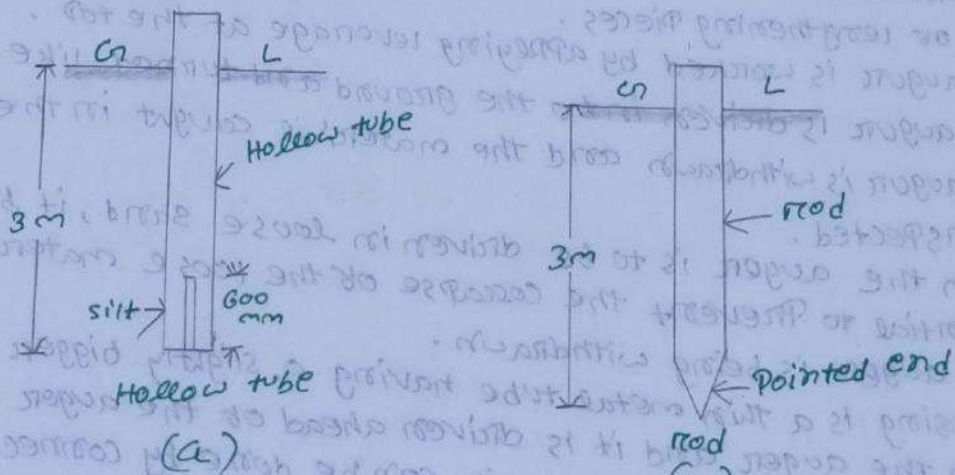
Following two points should be noted:

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- i) A sufficient number of test pits should be dug on the site to know the variation of the ground.
- ii) The test pits should be examined at all the exposed levels of the ground and these observations should be carried out as soon as the excavation of the test pits is completed.

2) Probing :-

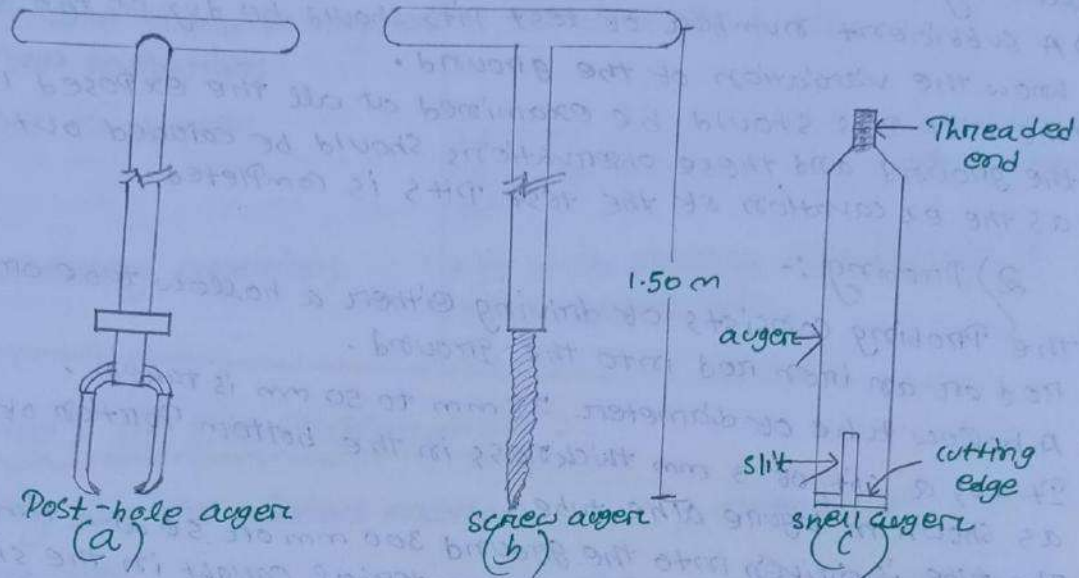
- The Probing consists of driving either a hollow tube or a steel rod or an iron rod into the ground.
- A hollow tube of diameter 35 mm to 50 mm is taken. It has a slit of 3 mm thickness in the bottom portion of 600 mm as shown in figure a.
- The tube is driven into the ground 300 mm or so at a time. It is then withdrawn and the material caught in the slit is inspected.
- In other case, a solid rod of steel or iron having a diameter of about 30 mm to 35 mm is taken and driven into the ground. The rod has a pointed end as shown in figure b.
- The rod is frequently withdrawn and the material stuck up at the pointed end is examined.



→ With the help of this method, it is possible to examine the ground to a maximum depth of 3m.

3) Auger boring :-

- An auger may be of Post-hole type or screw type or shell type. They all work in the same way, figure a, b & c show respectively a Post-hole auger, a screw auger and a shell auger.



→ figure C shows a typical shell auger, it consists of a hollow tube of diameter 75 mm to 100 mm.

→ The tube is provided with a cutting edge at the bottom.

→ A slit extending over a length of 600 mm to 900 mm is provided at the bottom of the tube to catch the material.

→ The length of the tube is about 1.50 m and it is provided with a threaded end so that it can be suitably extended with the help of lengthening pieces.

→ The auger is worked by applying leverage at the top.

→ The auger is driven into the ground and turned like a screw.

→ The auger is withdrawn and the material caught in the slit is inspected.

→ When the auger is to be driven in loose sand, it becomes essential to prevent the collapse of the loose material, when the auger is being withdrawn.

A casing is a thin metal tube having a slightly bigger diameter than the auger and it is driven ahead of the auger.

The lengthening of the casing can be done by connecting one pipe to the other.

With the help of this method, it is possible to inspect the ground bore a depth of 6 m to 8 m and in case of loose sand, the auger may be used even up to a depth of 15 m or so.