CHAPTER 1

INTRODUCTION

Let's begin by looking at the methods of building and the people involved, in the construction of buildings.

Methods of Building

In general there are two methods of building namely;

1. The conventional or traditional methods.
2. The modern or industrialized methods.

Conventional or traditional methods. This is the construction of smaller structures such as a domestic dwelling house of one or two storeys using locally produced materials.

Modern or industrialised methods: This is the construction of big or relatively big structures using factory-produced components, which are manufactured to a module or standard increment.

The building team

Building is essentially a team effort in which each member has an important role to play.
Fig 1.1a shows the organization structure of a typical team and the role of each member is defined below:

Building owner. This is the client; the person who commissions the work and directly or indirectly employs everybody.

Architect. This is the person engaged by the building owner as his agent to design, advise and ensure that the project is kept within cost and complies with the design.

The clerk of works. This person is employed on large contracts as the architect's on-site representative. He has only liaison powers and cannot issue instructions on his own behalf; he can only offer advice.

Quantity surveyor. This is the person engaged to prepare bills of quantities, check tenders, prepare interim variations and advise the architect on the cost of variations.

Engineers. These are specialists such as a structural engineer employed to work with the architect on that particular aspect of design.

Site agent. This is the person who on large contracts acts as the engineer's on-site representative.

Contractor. This is a person or a company employed by the building owner, on the architect's advice to carry out the constructional works. He takes his instructions from the architect.

Surveyor. This is the person employed by the contractor to check and assist the quantity surveyor in preparation of interim valuations and final accounts. He may also measure work done for bonus and sub-contractor payments.

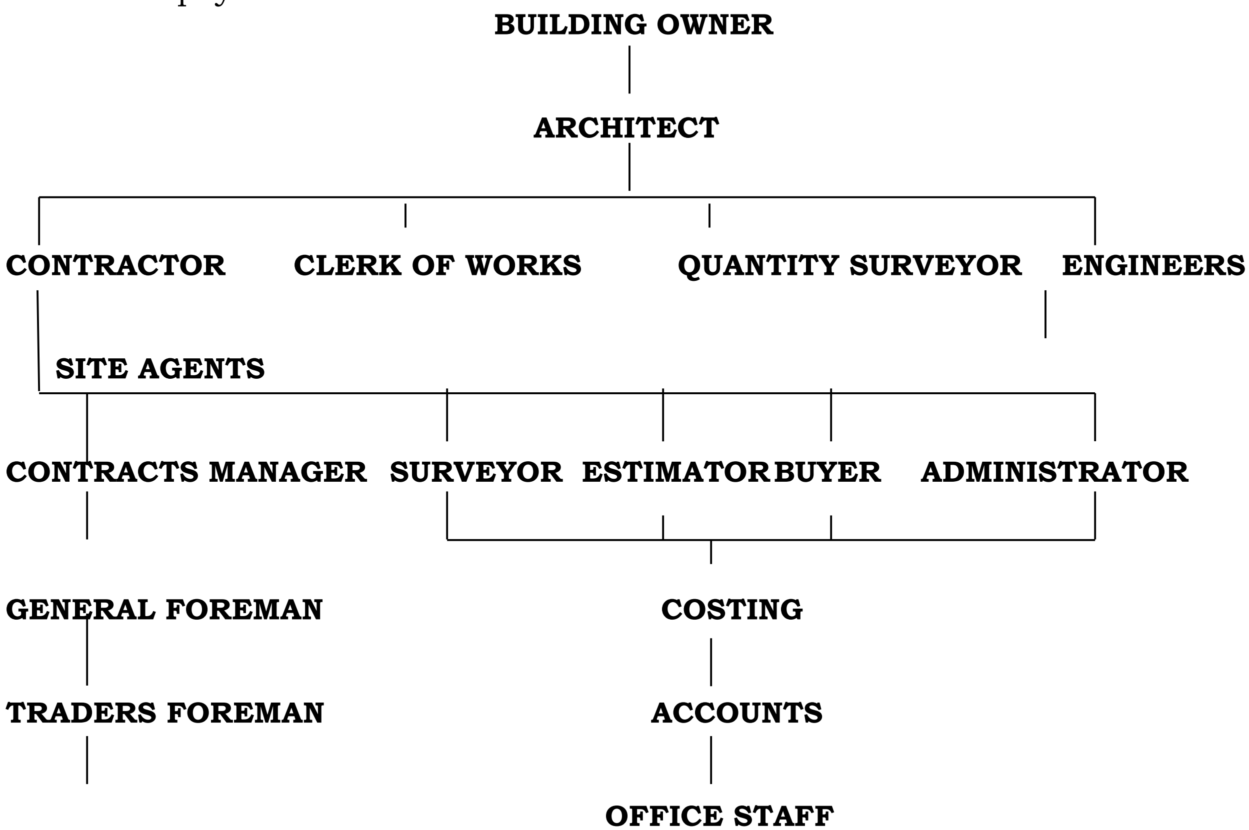


Fig.1.1a The building team

Estimator. This is the person who prepares unit rates for the pricing of tenders and carries out pretender investigations in to the cost of the proposed contract.

Buyer. This is the person who orders materials, obtains quotations for the supply of materials and services.

Accountant. This is the person who prepares and submits accounts to clients and makes payments to suppliers and sub-contractors. He may also have a costing department, which would allocate the labour and material costs to each contract to assist with the preparation of future tenders and with the preparation of accounts.

Administrator. This is the person who organizes the general clerical duties of the contractor's office for the payment of wages, insurances and all necessary correspondence.

Contracts manager. This is the person who liaises between the office and the site and has overall responsibility for site operations.

General foreman. This is the contractor's on-site representative, responsible for the day- to- day running of the site.

Traders foreman. This is the person who is in-charge of a trade gang.

Operatives. These are the main work force on the site, including tradesmen, apprentices and labourers.

The size of the building firm or the size of the contract will determine the composition of any team. For the medium sized contract some of the above jobs may be combined: the surveyor may also fulfill the function of the estimator.

CHAPTER 2

SITE AND TEMPORARY WORKS

SITE WORKS

Choice of a site

There are a number of factors that should be considered when selecting a building site and these include the following

1. The cost of the land where the site is located.
2. The climate of the area.
3. The aspect of the site; which helps to determine the amount of sunlight received on the various elevations of the building that in turn helps in the planning and location of the habitable rooms.
4. The elevation of the site is also important since an elevated site is preferable due to it's being drier and easier to drain as compared to the low-lying ones that are likely to be cold and damp.
5. The prospect of the site. The site should be able to command a pleasant view and the adjoining land uses should be compatible.
6. Availability of facilities. The site should ideally have access to schools, shops, parks, sports facilities, swimming pools, community centers and good public transport facilities.
7. The site should have access to adequate services like electricity, water mains and sewers.
8. The site subsoil's should merit special consideration because of their effect on the building work especially when it comes to choice of a foundation.
9. Site contamination should be taken into consideration. One should avoid former industrial sites that could involve expensive site works to remove potential hazards.
10. The water table of the site should be known. It's important that the building is erected well above the highest ground water level.
11. Subsidence of the site especially in mining areas should also be taken into consideration.

Site investigations

All potential building sites need to be investigated to determine their suitability for building and the nature and context of preliminary work that will be needed.

During site investigation particular attention is given to the following;

1. Nature of the soils and its probable load-bearing capacity which is usually done by means of trial holes or borings since there may be variations over the site.
2. The level of the water table should also be established since a high water table may necessitate subsoil drainage and could cause flooding in winter.
3. Ordinance survey maps, which could show the presence of disused mines or former ponds.
4. The position and size of main services like sewers should be determined and it's advisable to take framework of levels over the site so as to ease the draining of the site.
5. The environment of the site should also be taken into account. This includes the mature trees on the site, which ought to be retained, or which are even subject to tree preservation orders or the site being located within a conservation area.
6. Investigations should also include approaching local planning authorities to ascertain whether there are any special or significant restrictions that could adversely affect the development of the site, and the position of the building line or base line.

Site clearing

This is the demolition of existing buildings, the grubbing out of bushes and trees and the removal of soils to reduce levels on the site prior to construction.
Site clearing is important because it rids the site of any obstruction to the process of setting-out. The method chosen for the carrying out site clearing (whether mechanical or manual) is determined by overall economics.

Demolition

This is the partial or complete removal of a structure. Before demolition a series of steps have to be taken and these are as follows.

1) Remove carefully all saleable items such as copper, lead, steel fittings, domestic fittings, windows, doors and frames.
2) Examine condition and thickness of walls to be demolished and those to be retained.
3) Check for the relationship as well as the condition of adjoining properties that may be affected by the demolition.
4) Check on the nature of support to balconies, heavy cornices and stairs.
5) Check whether the demolition will cause unbalanced thrusts to occur in the roof and framed structures.
6) Check whether demolition will extend to public footpath or beyond boundary of site.

7) The services to the structure should be sealed off, protected or removed and the service providers should be notified.
8) All flammable or explosive materials such as oil drums and gas cylinders should be removed before demolition commences.
9) Adequate insurance should be taken out by the contractor to cover all claims from workmen, any third party and claims for loss or damage to property including roads, pavings and services.
10) Local authorities have to be notified.

There are four factors that determine the method of demolition to be used and these are:

a) *Type of structure.* Whether the structure is storied, framed structure, reinforced concrete, chimney etc.
b) *Type of construction.* Whether it's a masonry wall, concrete or of structural steel construction.
c) *Location of site*. Whether the site in the middle of a busy town or a less populated neighborhood.
d) *The type of demolition.* Whether the structure needs a complete or partial demolition.

Methods of Demolition

1. *Hand demolition.* This involves progressive demolition of a structure by operatives using hand-held tools.
2. *Pusher arm demolition.* This is progressive demolition using a machine fitted with a steel pusher arm exerting a horizontal thrust on to the building fabric.
3. *Deliberate collapse demolition.* Involves the removal of key structural members causing complete collapse of the whole or part of the building.
4. *Demolition ball techniques.* This is carried out by swinging a weight or demolition ball suspended from a crane against the fabric of the structure. This can be by vertical drop, swinging in line with the jib or slewing jib.
5. *Wire rope pulling demolition.* Involves the use steel wire ropes on which pulling tension is gradually applied.
6. *Demolition by explosives.* Involves charges of explosives placed within the fabric of the structure and detonated to cause partial or complete collapse. It should be carried out with the advice and supervision of an expert.

Leveling sloping sites

Sloping sites should be levelled before commencing any construction work. There are three methods that can be employed to level slopes and these include:

I. **Cut and fill**: This is where soil cut from the higher section of the sloping site is used to level the lower section there by leveling the site. It's the most common method because if properly carried out, the amount of cut will equal to the amount of fill.

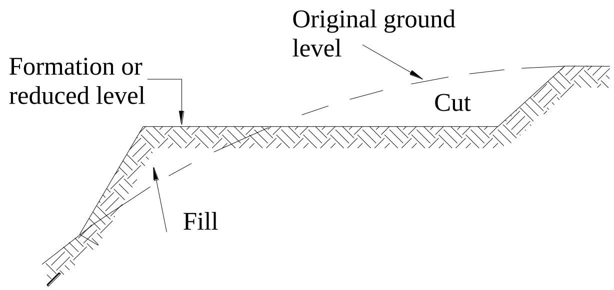


Fig 2.1a Cut and fill method of leveling

II. **Cut**: In this method soil is cut and then ferried away so as to level the site. This method has the advantage of giving undisturbed soils over the whole site but also has the disadvantage of the cost of removing the soil from the site.

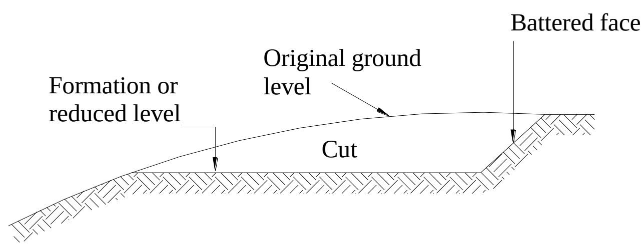


Fig 2.1b Cut method of leveling

III. **Fill**: This is where soil is ferried from somewhere else and is filled on the site so as to level the slope. This method is not recommended because if the building is sited on the filled area there would be a risk of settlement at a later stage.

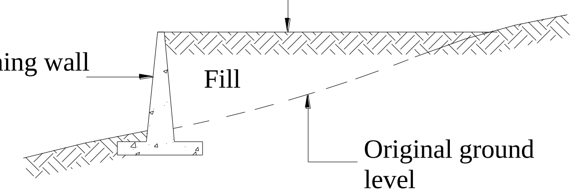


Fig 2.1c Fill method of leveling

Storage of building materials

The type of storage facilities required for any particular material will depend upon the following factors:

1. Durability
2. Vulnerability to damage
3. Vulnerability to theft

The following are some of the building materials and how they can be stored on a building site.

a) **Cement and lime**
These require a dry store free of draughts, which can bring in moist air. These should not be stored for long periods on site; therefore provision should be for rotational use so that the material being used comes from the old stock.

b) **Aggregates (sand)**
These require a clean firm base to ensure that foreign matter is not included when extracting materials from the base of the stockpile. Different materials and grades must be kept separately so that the ultimate mix batches are consistent in quality and texture.

c) **Brick and blocks**

Should be stacked in stable piles on a level and well-drained surface. Facing bricks and light-coloured bricks should be covered with tarpaulin or polythene sheeting to prevent them from discolouring by atmospheric pollution and adverse weather conditions.

d) **Roof tiles**

These should be stacked on edge and in pairs, head to tail, to give protection to the nibs. This is because tiles have a greater resistance to load when it is imposed on the edge.

e) **Timber**

This should be stored on a rack of tubular scaffold with a sheet roof covering to enable its moisture content remain constant. This is because timber is hygroscopic.

f) **Ironmongery, hand tools and paints.**

These are the most vulnerable items on a building site and therefore should be kept in a locked hut/store and only issued against an authorized stores requisition.

Setting-out

This is the process of positioning a building on site. **See fig 2.2a.**

The stages involved in the above process are as follows;

1. The first task is to establish the baseline or building line from which the rest of the building can be setout. This line is determined by the highway authorities and in urban areas it's approximately 8meters from the back of the public path.

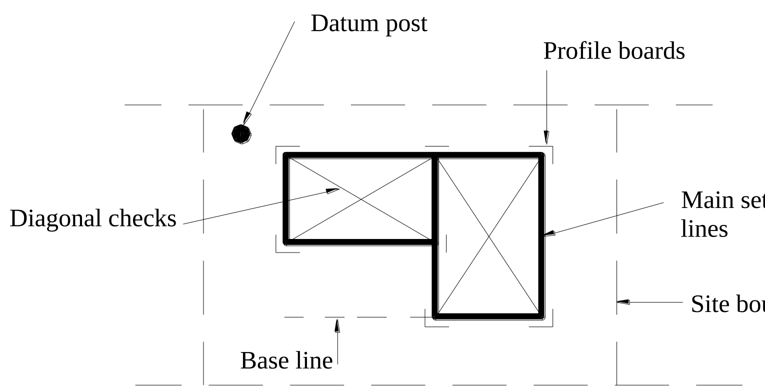


Fig 2.2a Setting out

2. The next step is to position the front of the building on the baseline by checking the dimensions between of the new building and the side boundaries.
3. Flank walls are then set-out at right angles to the baseline often using the large builder's timber square or the 3:4:5 triangle (Pythagoras theorem).The builder's square is a right-angled triangular timber frame with sides varying in length which is used by placing it against the baseline while two pegs are driven in on the return side. By sighting across the two pegs, a third peg can be driven in the same straight line and thereafter a bricklayer's line can be stretched between them. If the builder's square is not available, a right angle can be set out based on the right-angled triangle whose sides are in the ratio of 3:4:5 (derived from the Pythagoras theorem). A peg is first driven in at the corner of the building and a distance of 3m is measured back along the baseline. A peg is driven in at this point and the ring of the measuring tape is placed over a nail driven into the top of the peg. The tape is held at the 12m mark (3+4+5=12) against the ring on the first peg and with the tape around the corner peg, the tape is stretched out to give the position of the third peg at the 7m mark. The line extended through the third peg is at right angle to the baseline.
4. A check should now be made of the setting-out lines for right angles and correct lengths. This can be done by using the site square or diagonal checks as shown in **fig 2.2a**
5. To secure permanent line markers, profile boards (**see fig 2.2b**) are established at corners of the building and at wall intersections. Nails or saw cuts on the profile boards demarcate the width of walls and also locate the position of the foundation trench.

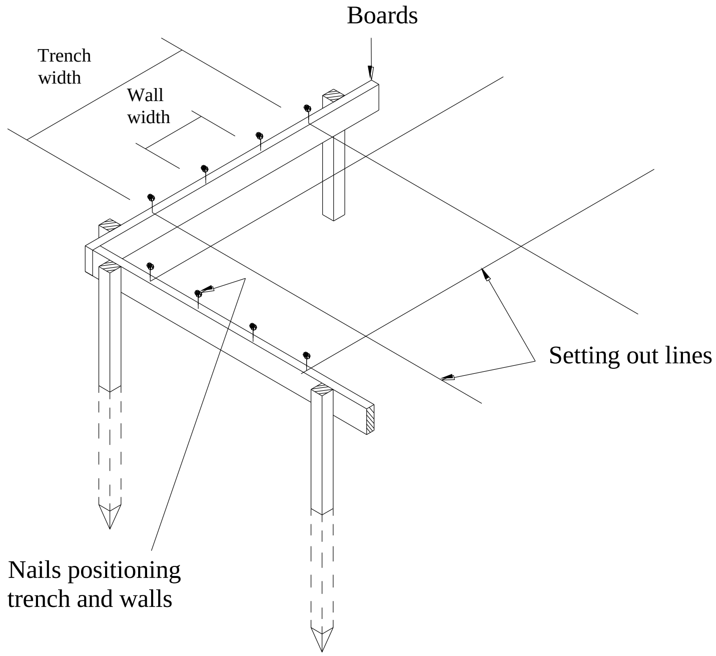


Fig 2.2b Profile board

The relevant tools for the work of clearing out are;

1. A steel tape for measuring
2. A large timber builder's square used in corners
3. A saw for cutting profile boards
4. A hammer for nailing.

Establishing a datum level

A datum level is a fixed point of known level on site that is used to determine floor and drain invert levels. There are two ways of establishing a datum level and these are;

I. It can be established by transferring levels from the ordnance bench mark (ODM) to the building site using the dumpy tilting or automatic level and leveling stuff. Ordnance bench marks are levels indicated on an ordinance survey map that are found cut or let into the sides of walls and near by buildings.

II. Where there are no benchmarks on or near the site a suitable permanent datum must be established and this could be a post set in concrete or a concrete plinth set up on site. **See fig 2.2a**

Excavations

There are two types of excavations; Trench excavations and basement excavations.

- Trench excavation is the digging of narrow trenches of required depth and width in which a foundation can be laid. On small contracts this can be carried out manually but on large contracts the use of mechanical trench diggers is more economical. When digging the trenches, approximately 150mm is allowed for hand trimming in the trench bottom so as to form an accurate line and level and the process is called **bottoming of trenches**. The trimmed surface is then covered with hardcore stones to protect the soil from drying out and shrinking.
- Basement excavation is the digging of a large pit in which a basement of a building can be constructed. This carried out by excavators.

The method of excavation and timbering to be used will depend upon the following factors;

1. Nature of the subsoil's which determines the type of plant or hand tools required and the amount of timbering necessary.
2. Purpose of the excavation that determines the minimum widths and depths.
3. Presence of groundwater, which may necessitate the need for interlocking timbering, water pumps or dewatering techniques.
4. Position of the excavation that may impose certain restrictions such as the need for a license, highway authority or police requirements when excavating in a public road.
5. Non-availability of the right type of plant for bulk excavations may mean that a different method must be used.
6. Presence of a large number of services may restrict the use of machinery.
7. The disposal of the excavated spoil may restrict the choice of plant due to the load and unload cycle not keeping pace with the machine output.

The principal machines needed for excavations include;

1. **A dragline**: This excavates below it's own level.

2. **A face shovel:** This digs in deep faces below it's own level.
3. **A drag shovel or backator**: Digs below it's own level and towards it 'self. It's primarily used for trench excavations.
4. **Skimmer**: This is used for shallow excavations and is particularly useful in leveling and roadwork.
5. **Grab and clamshell**: Used for moving loose materials.
6. **A bulldozer and angle dozer**: Used for bulk excavations and grading.
7. **A rooter**: It's a tractor drawn toothed scarifier used for breaking up hard surfaces.

Boning rod (traveller)

This is a T-shaped piece of timber that is moved along a line sighted across the tops of two adjacent sight rails or profile boards to ensure that the base of a foundation trench is leveled or that the drain trench is cut to the required gradient (slope).

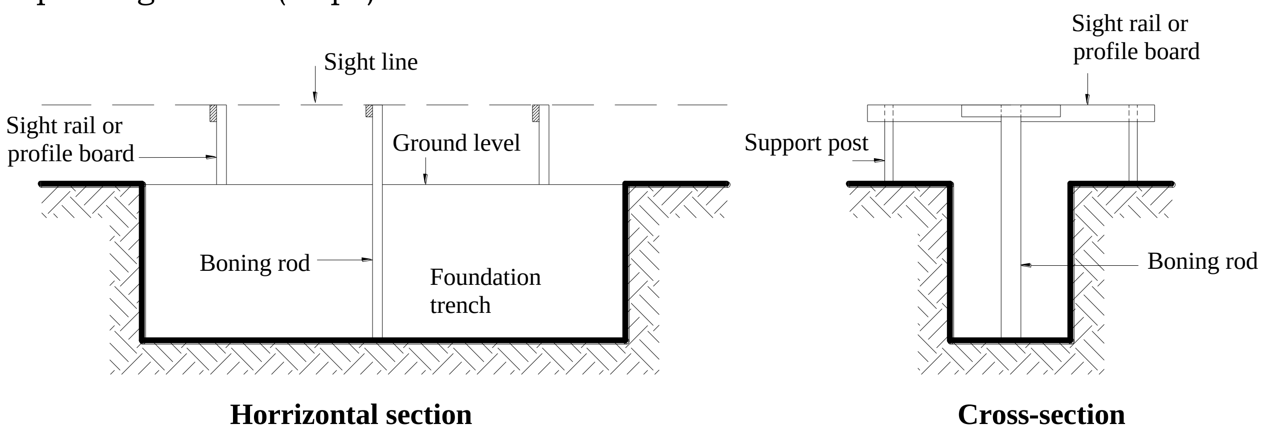


Fig 2.2c Boning rod

SITE TEMPORARY WORKS

Timbering.

This is the process of laying temporary supports to the sides of excavations and is some times called **planking and strutting.**

The sides of excavations need these supports so as to;

1. Protect the operatives while working in the excavations.
2. Keep the excavations open by acting as a retaining wall to the sides of the trench.

The amount of timbering required to the sides of excavations will largely depend on the following;

1. Depth of the excavations,
2. Nature of the soil to be upheld,
3. Vibration and loads from traffic or other causes,
4. Position of the water table,
5. Climatic conditions,
6. Time for which the excavation is to remain open.

The timbers suitable for timbering include;

1. Scots pine
2. Baltic redwood
3. Baltic white wood
4. Douglas fur
5. Larch
6. Hemlock.

Fig 2.3a,b,c and **d** show typical details of timbering to trenches in hard soils, firm soils, dry loose soils and wet loose soils.

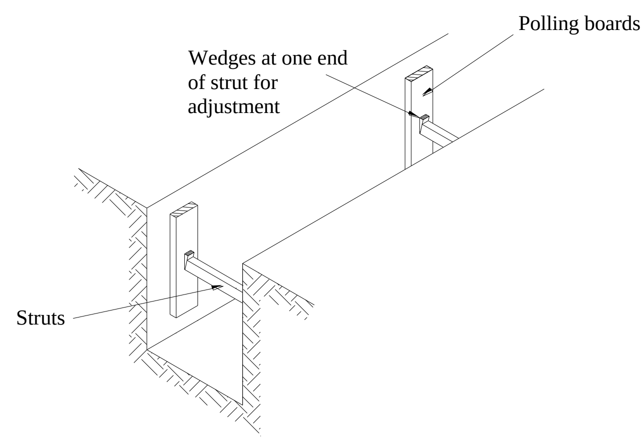


Fig 2.3a Timbering in hard soils

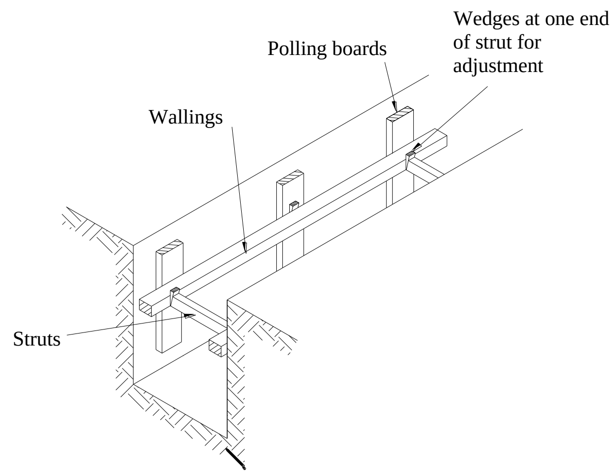
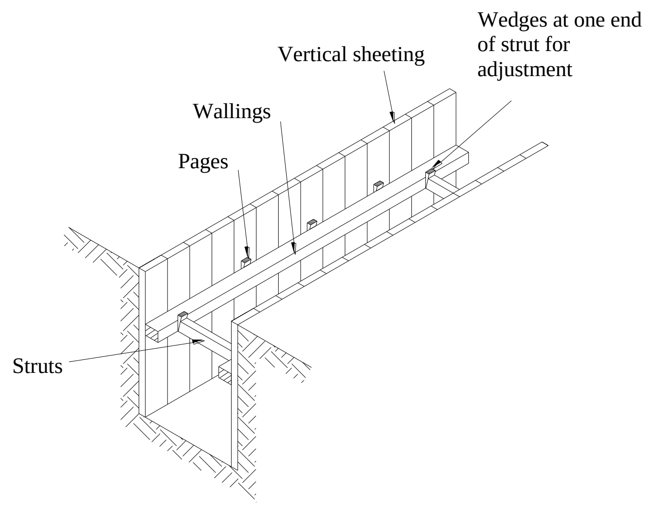


Fig 2.3b Timbering in firm soils



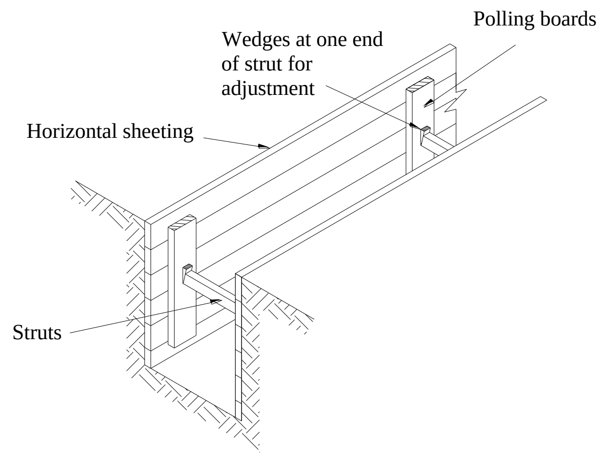


Fig 2.3c Timbering in loose wet soils

Fig 2.3d Timbering in dry loose soils

Site fencing

A building site can be given a degree of protection by surrounding it with a fence, which should fulfil the following functions;

1. It should define the limit of the site or compound,
2. Should act as a deterrent to the would-be trespasser or thief.

Fig 2.4a shows the three types of fences and these include;

a. Cleft chestnut pale fence
b. Chain link fence
c. Close boarded fence.

The type of fencing chosen will depend upon the following;

1. Degree of security required
2. Cost implications
3. Type of neighborhood
4. Duration of contract.

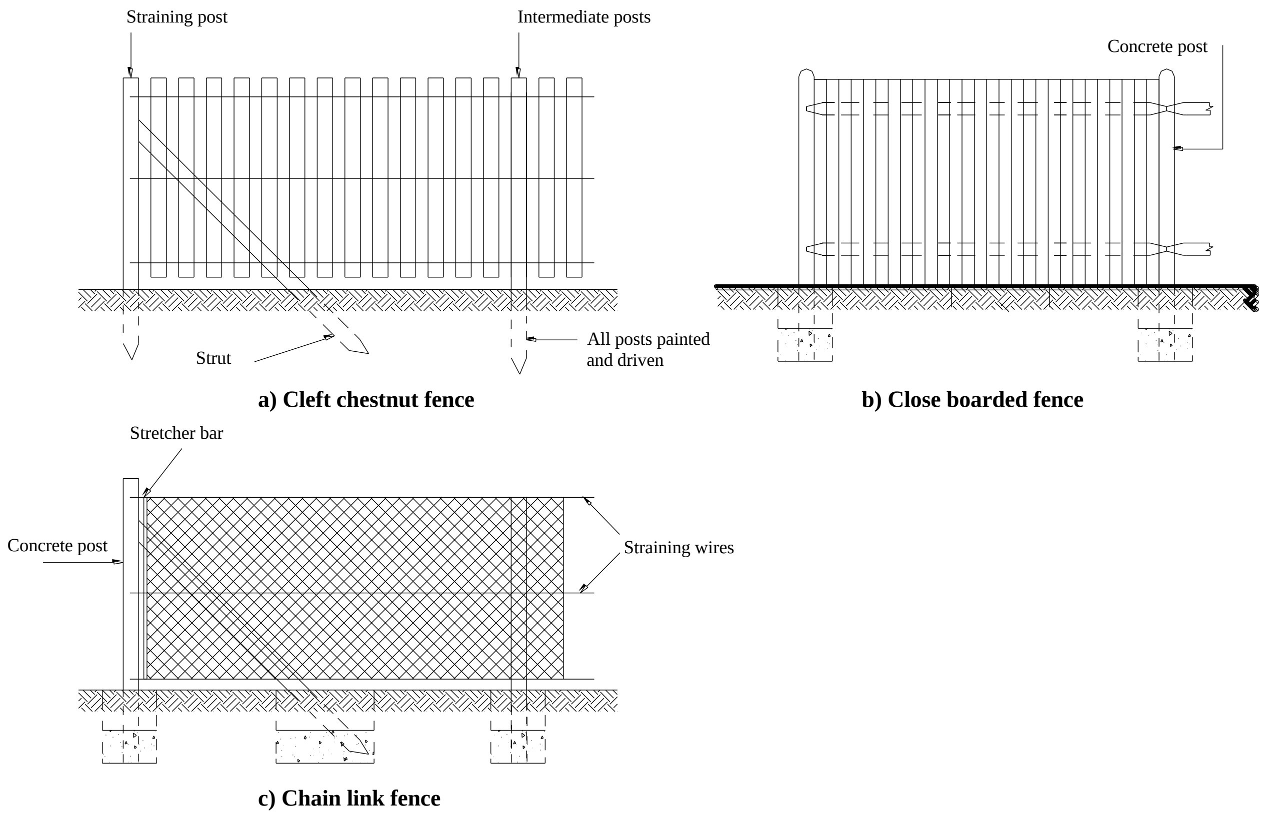


Fig 2.4a Types of site fencing

Site hoardings

These are close boarded fences or barriers erected adjacent to the highway or public footpath to prevent unauthorised persons obtaining access and to provide a degree of protection for the public from the dust and noise associated with building operations.

Written permission in form of a license should be obtained from the local authority to erect a hoarding. This license sets out the conditions and gives details of duration, provision of footway for the public and the need for lighting during the hours of the darkness.

There are two common types of hoarding and these include the following;

1. **Vertical hoarding:** This type of hoarding consists of a series of closed panels securely fixed to resist wind loads and accidental impact loads. It can be free standing or fixed by stays to the external walls of an existing building. **See fig 2.5a**

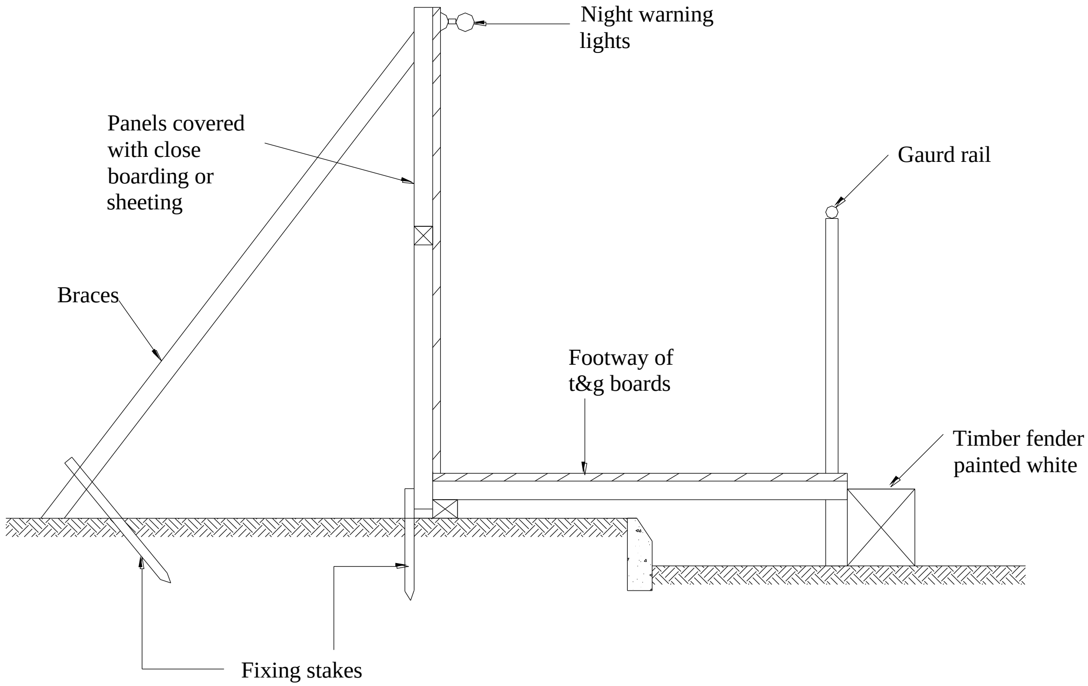


Fig 2.5a Free standing vertical hoarding

2. **Fan hoarding:** This type of hoarding is placed at a level above the normal traffic height and arranged in such a manner that any falling debris is directed back towards the building or scaffold. **See fig 2.5b**

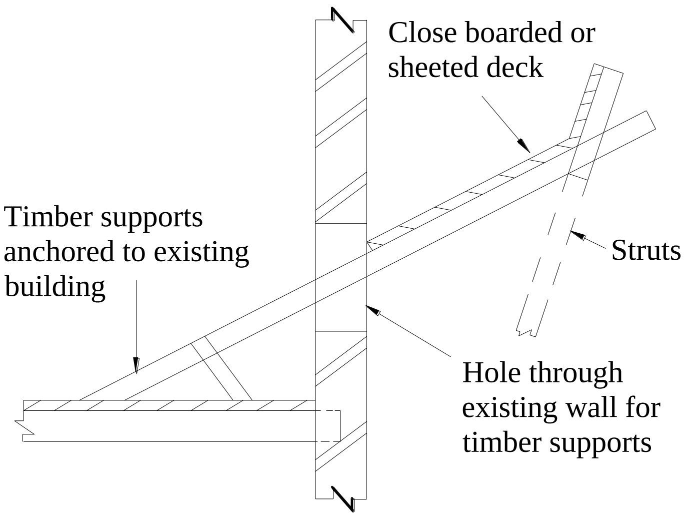


Fig 2.5b Fan hoarding

Shoring

This is the process of applying temporary supports to a building to avoid the danger of it collapsing on any person.

The functions of shoring or the situations where it's commonly required are as follows;

1. To give support to walls which are dangerous or are likely to become unstable due to subsidence, bulging or leaning.
2. To avoid failure of sound walls caused by the removal of subjacent supports such as where a basement is being constructed near to a sound wall.
3. To give support to an adjacent building or structure during demolition works.
4. To support the upper part of the wall during formation of a large opening in the lower section of the wall.
5. To give support to a floor or roof to enable a support wall be removed and be replaced by a beam.

Structural softwood is the usual material used for shoring members it's strength to weight ratio compares favourably with that of structural steel.

Types of shoring (shoring systems)

There are three shoring systems; namely:

1. **Dead shoring:** This type of shoring is used to support dead loads, which act vertically downwards. It consists of a vertical prop or leg with a head plate, sole plate and some means of adjustment for tightening and easing the shore.
   The steps taken or the operational sequence for erecting a successful dead shoring arrangement are as follows;
   a) Carry out a thorough site investigation to determine;
      i) Number of shores required,
      ii) Bearing capacity of soil and floors,
      iii) Location of under ground services which may have to be avoided.
   b) Fix ceiling struts between suitable head and sole plates to relieve the wall of floor and roof loads. The struts should be positioned close to the walls.
   c) Strut all window openings with in the vicinity of the shores to prevent movement or distortion of the opening.
   d) Cut holes through the walls slightly larger in size than the needles to enable them pass through.
   e) Cut holes through ceilings and floors for the shore legs.
   f) Position and level sleepers on a firm base.
   g) Erect, wedge and secure shoring arrangements.

Upon completion of the builders work it's advisable to leave the shoring in place for at least seven days before easing the supports to ensure that the new work has gained sufficient strength to be self-supporting. **See fig 2.6a**

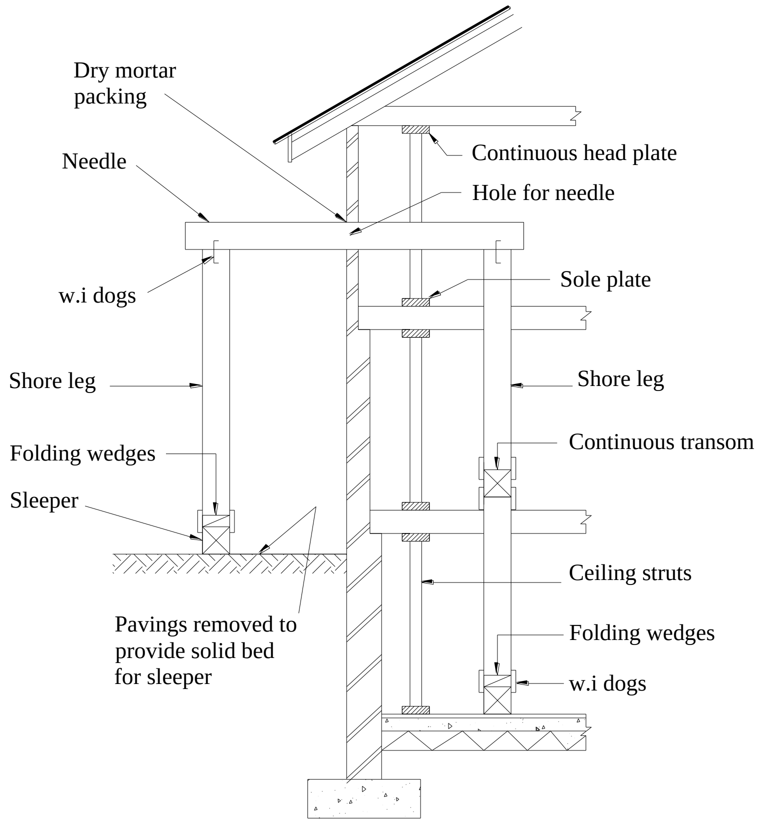


Fig 2.6a Dead shoring

2. **Raking shores:** This shoring arrangement transfers the floor and wall loads to the ground by means of sloping struts or rakers. One rake for each floor is required and ideally should be to an angle between 40° and 70° with the horizontal.
   The steps taken or the operational sequence for erecting raking shores are as follows;

   a) Carrying out site investigations as described for dead shoring,
   b) Mark out and cut mortises and housings in wall plates,
   c) Set out and cut holes for needles in external walls,

d) Excavate to a firm subsoil and lay a grillage platform and sole plate,
e) Cut and erect rakers commencing with the bottom shore,
f) Fix cleats, distance blocks, binding and if necessary cross bracing over the backs of the shores. **See fig 2.6b**

3. **Flying shores:** These shores fulfil the same functions as raking shores but do so between any parallel surfaces. This has the advantage of providing a clear working space under the shoring. The site operations for the setting out and erection of flying shoring systems are similar to those for raking shoring. **See fig 2.6c**

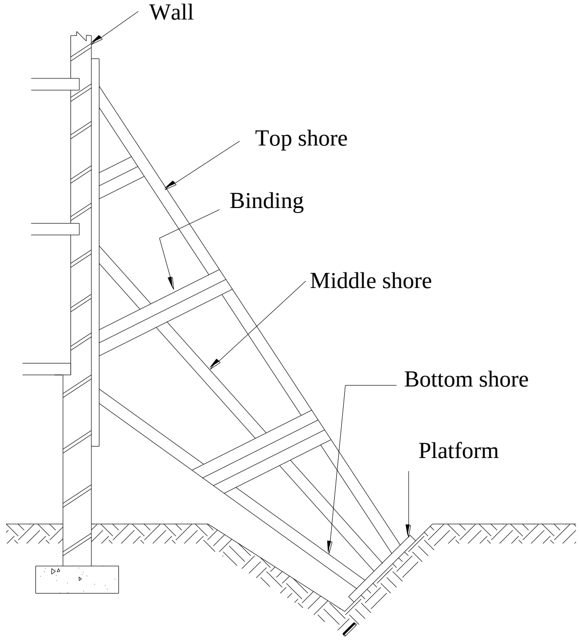


Fig 2.6b Raking shore

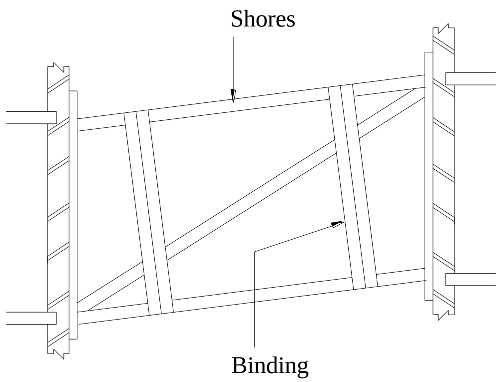


Fig 2.6c Flying shore

Scaffolding

This is the process of putting up a temporary structure (scaffold) from which persons can gain access to a place of work in order to carry out building operations. This includes any working platforms, ladders and guardrails.

There are two basic forms of scaffolds and these are:

a) **Putlog scaffolds:** This type of scaffolding consists of a single row of uprights set away from the wall and tied to the building with cross members called putlogs. The uprights or standards are joined together with horizontal members called ledgers and the whole scaffold is erected as the building rises. It's mostly used for buildings of traditional brick construction. **See fig 2.7a**

b) **Independent scaffolds:** This has two rows of uprights or standards, which are tied by cross members called transoms. This type of scaffold does not rely upon the building for support and is therefore suitable for use in conjunction with framed structures. **See fig 2.7b**

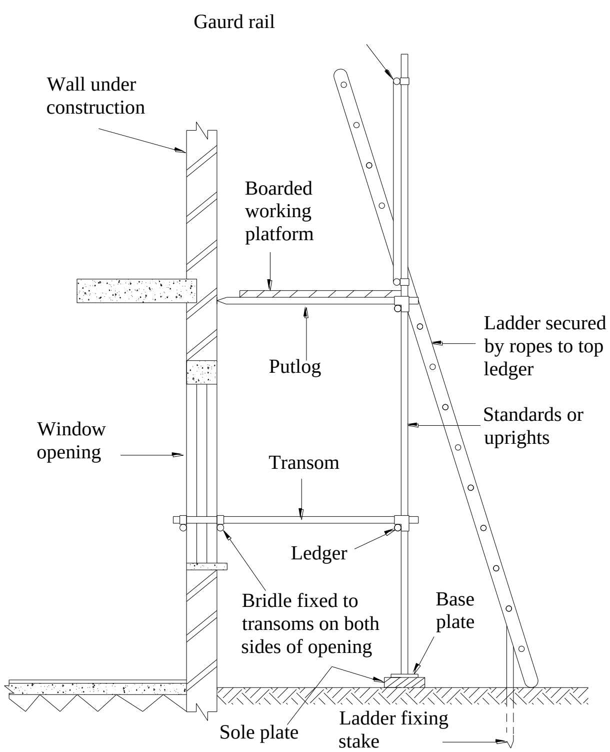


Fig 2.7a Putlog scaffolding

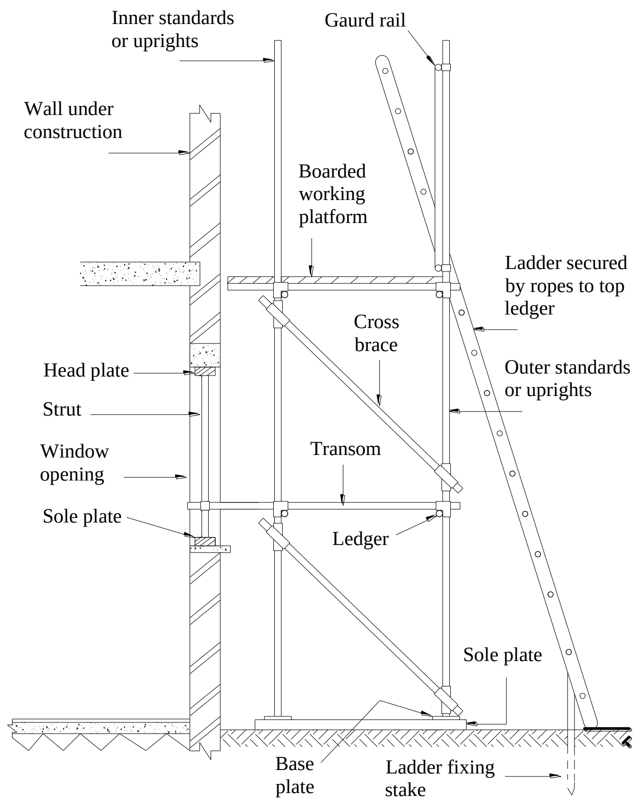


Fig 2.7b Independent scaffolding

The materials used for scaffolding include;

I. Tubular steel

II. Tubular aluminum
III. Timber.

Timber scaffold

Logs obtained from young fairly straight trees, which are cut to about 4m lengths are used. The members are lashed together with wire or rope and nails may also be used to join one piece to another.

Advantages

1. In areas where timber is plentiful it is cheap and easily obtained.
2. No fittings used.
3. No extra maintenance costs.
4. Easily cut to size.
5. Wastes and old logs can be sold as firewood. It therefore has high scrap value

Disadvantages

1. Use is restricted to low-rise buildings only.
2. As the logs are made from young trees, they are prone to insect attack, thus limiting their length of usefulness.
3. Large holes are left in the wall after use and these need to be patched.
4. Regular replacement is essential in order to avert likely failure resulting from over dried logs.

Tubular scaffold

Steel and light-alloy tubes are the commonest materials used for this type of scaffolding and metal coupling fittings are used to secure members together.

Advantages

1. Less likely to deteriorate compared to timber.
2. If correctly used its more rapidly erected.
3. More convenient for internal work owing to wider range of widths.
4. Takes up less space when stored.
5. Used for multi-storey buildings

Disadvantages

1. High cost of preservation.
2. High initial cost.
3. Many types of couplers needed.

Gantries

These are elevated platforms used when the building being maintained or under construction is adjacent to a public footpath. A gantry over a public footpath can be used to support an independent scaffold, housing units of accommodation or storage of materials. **See fig 2.8a**

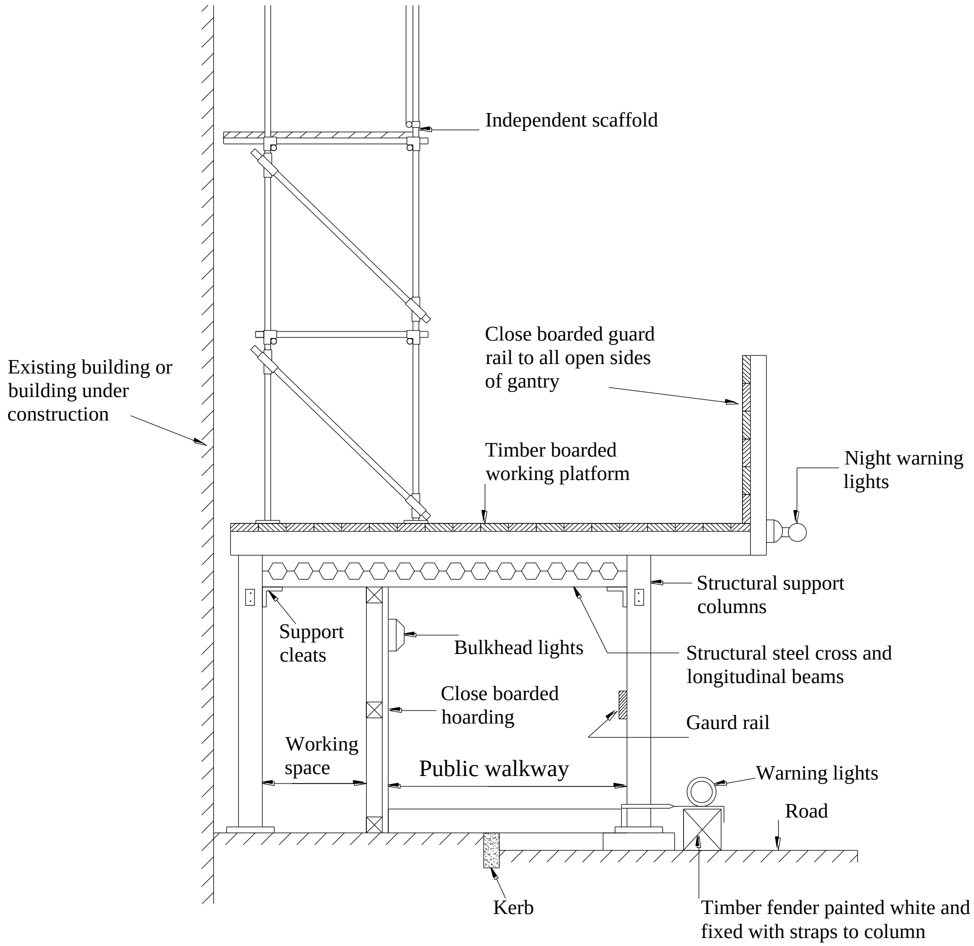


Fig 2.8a Gantry

Formwork

These are moulds or boxes into which wet concrete can be poured and compacted so that it will flow and finally set to the inner profile of the box or mould.

To be successful in it's function a formwork must fulfill the following requirements;

1. It should be strong enough to support the load of the wet concrete.
2. It must not be able to deflect under load which load includes wet concrete, self-weight and superimposed loads such as operatives.
3. It must be accurately set out because concrete being a fluid when placed, it will take up the shape of the formwork.
4. It must have grout-tight joints since grout leakage can cause honey combing of the surface or produce fins which have to be removed.
5. It's size should be designed so that it can easily be handled by hand or by mechanical lifting device.
6. The formwork should be designed such that it can easily be assembled and dismantled without any members being trapped.
7. Formwork material must be chosen so that it can be easily fixed using either double-headed nails, round wire nails or wood screws.

The requirements for formworks enumerated above makes timber the most suitable material for general formwork. However the moisture content of the timber should be between 15 and 20% so that the moisture movement of the timber is reduced to a minimum.

If the timber is dry it will absorb moisture from the concrete, which will weaken the resultant concrete member and also cause the formwork to bulge and swell thereby giving an unwanted profile to the finished concrete.

If the timber is wet (with a high moisture content) it will shrink and cup which could result in open joints and leakage of grout.

Types of formwork

1. **Foundation formwork:** This formwork consists of side and end panels, which are firmly strutted against the excavation faces to resist the horizontal pressures of the wet concrete and to retain the formwork in the correct position. Ties are also required at the top of the formwork to act as a top

restraint. **See fig 2.9a**

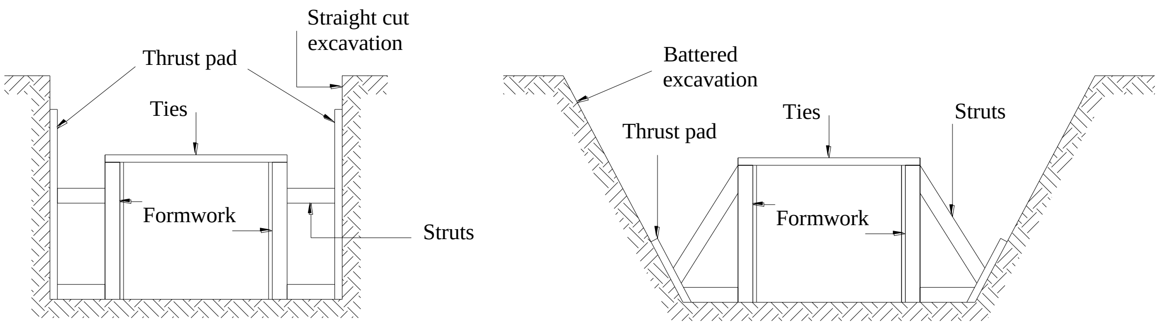


Fig 2.9a Foundation formwork

2. **Column formwork:** A column form or box consists of a vertical mould, which has to resist considerable horizontal pressures in the early stages of casting the concrete. The formwork is constructed to the full storey height of the column with cut outs at the top to receive the incoming beam forms. Some raking strutting is required to plumb and align the column forms until the concrete has hardened. **See fig 2.9b**

3. **Beam formwork:** This consists of a three-sided box that is supported by cross members called head trees that are propped to the underside of the soffit board. In the case of framed buildings support to the beam box is also provided by the column formwork. **See fig 2.9c**

4. **Slab formwork:** Floor or slab formwork consists of panels framed or joisted and supported by the beam formwork with intermediate propping. Adjustment for levelling purposes can be carried out by using small folding wedges between the joists. **See fig 2.9d**

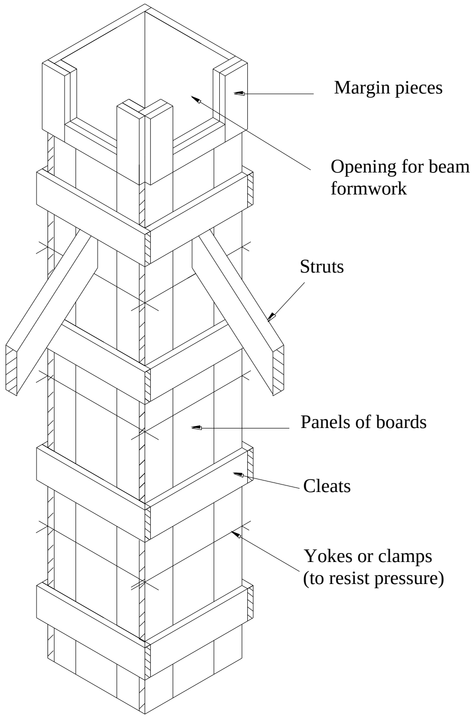


Fig 2.9b Column formwork

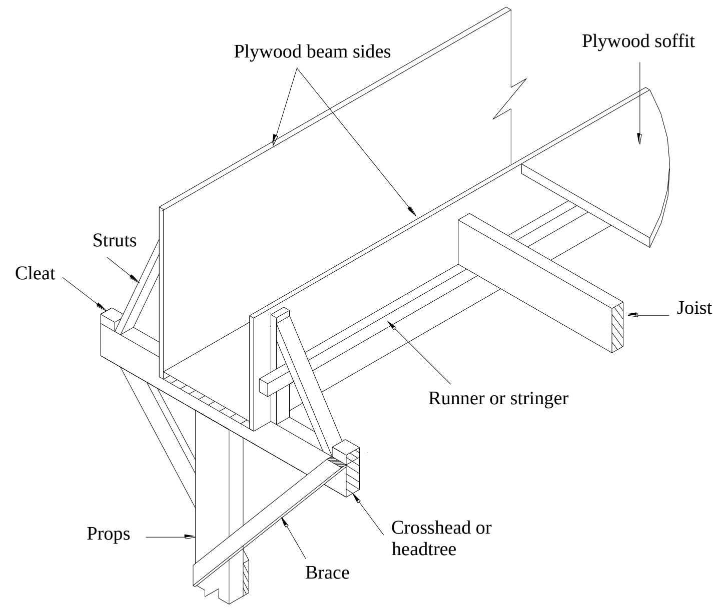


Fig 2.9c Beam formwork

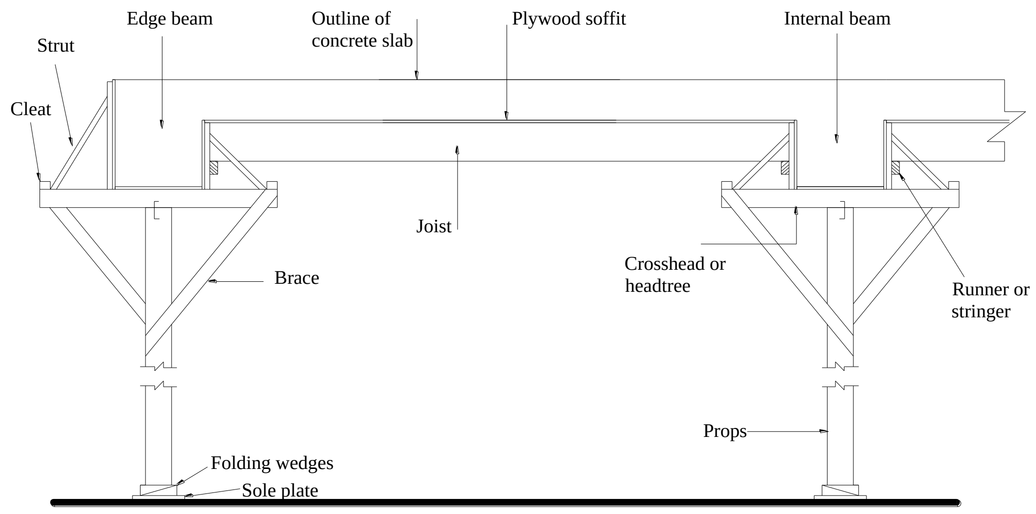


Fig 2.9d Slab formwork

Centres

These are temporary structures usually of light timber construction whose function is to support arches of brick or stone while they are being built until when they are sufficiently set to support themselves and the load over the opening. **See fig 2.10b,c** and **d.**

The type of centre to be used will depend upon the following:

a) The weight to be supported
b) The span
c) The width of the soffit

Turning piece

This is a temporary wooden support shaped to the profile of the arch soffit to support the arch during construction. **See fig 2.10a**

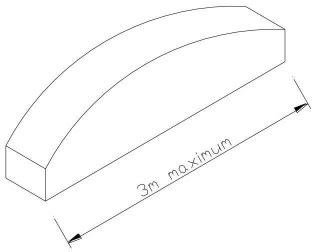
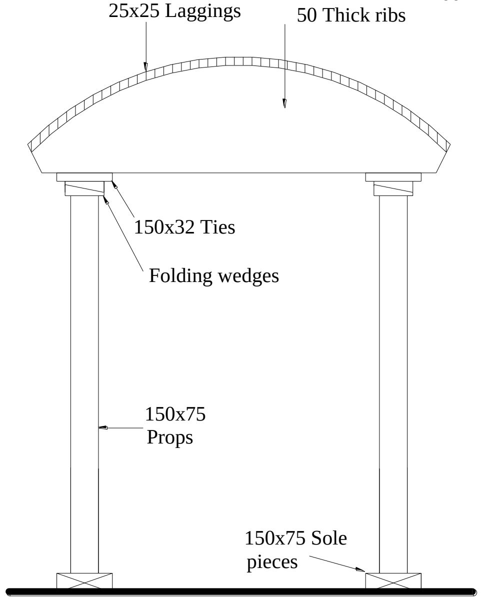


Fig 2.10a Turning piece



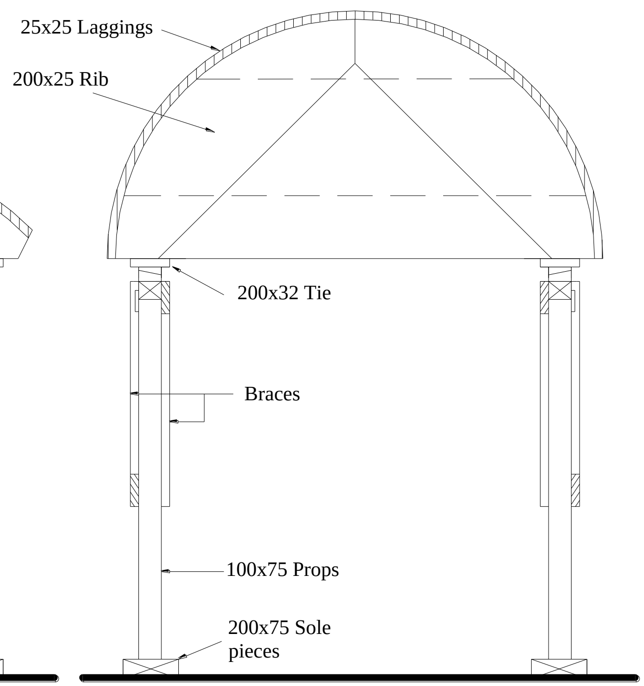


Fig 2.9b Center for small span arches **Fig 2.9c Framed center for medium span arches (up to 1500mm)**

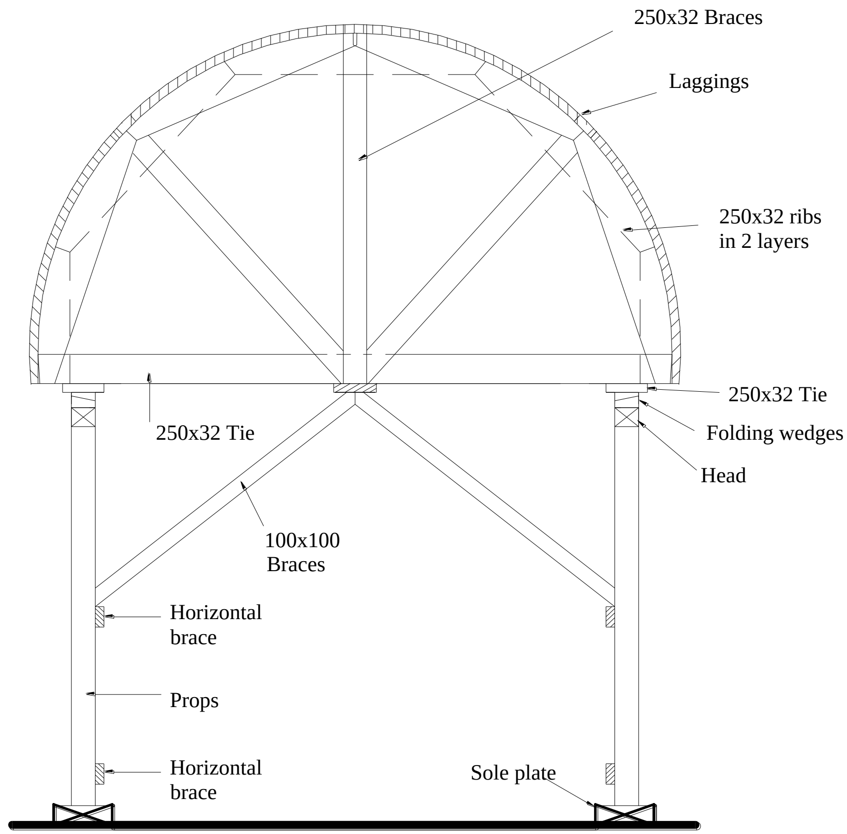


Fig 2.9d Framed center for wide spans (up to 4000mm)

EXERCISE

1(a) Define the following terms:
- (i) Site clearing
- (ii) Setting out
- (iii) Datum level

(b) With the aid of sketches show how you can level the ground.

(c) (i) What is timbering
- (ii). Show how timbering is done in firm soils

2(a) Why is it necessary to clear a site prior to setting out.

(b) State in order of first to last the stages taken on setting out ready for trenching. Name the relevant tools for the work.

3(a) (i) Explain why and where timbering is necessary to apply in building construction.
- (ii). Draw a simple sketch of the type of timbering you would use to cater for the site that has wet-loose soils.

4(a) List five points to be considered when selecting a building site.

(b) Explain the following terms as related to the building industry:
- (i) Site preparation
- (ii) Hoardings
- (iii) Profile
- (iv) Timbering
- (v) Scaffolding

(c) List any five equipments required for setting out a domestic house.

5(a) Draw an annotated diagram of the following:
- (i) A corner profile
- (ii) Timbering in a firm ground

(b) Give a brief description of the following as related to a site:
- (i) Fence
- (ii) Store
- (iii) Pegs

(iv) Boarding

6(a) Describe the use of the following mechanical plants on a building firm:
(i) Excavator (ii) Dumper
(iii) Vibrator (iv) Brick elevator

7(a) Explain the following terms as related to the building site:
(i) Site investigation
(ii) Bearing capacity of sub-soils
(iii) Bearing pressure
(b) With the aid of sketches describe how timbering is done in loose sub-soils.

8.(a) Briefly give the relevance of the following on a building site:
(i) Drawing office
(ii) Workshops canteen
(iii). Store
(iv) Hoarding
(v) Pegs

9. Define the following terms in building construction
(i) Quoin pegging
(ii) Diagonal checking
(iii). Building line

CHAPTER 3

FOUNDATIONS

Foundations

A foundation is the base on which a building rests and it's purpose is to safely transfer the load of the building to a suitable subsoil.

A foundation should fulfill the following requirements of building regulations;

1. Safely sustain and transmit the ground and combined dead and imposed loads so as not to cause any settlement or other movement in any part of the building or of any adjoining building or works.
2. Should be of such depth or be so constructed as to avoid damage by swelling, shrinkage or freezing of the subsoil.
3. Should be capable of resisting attack by deleterious material, such as sulphates in the subsoil.

The choice of foundations and there design for domestic buildings depends mainly on the following;

1. Type of building,
2. The total loads of the building,
3. The nature and bearing capacity of the subsoil,
4. The nature of the site i.e. whether the site is levelled or sloping.
5. The method used for levelling the site; i.e. whether cut and fill, cut or fill.

The nature and bearing capacity of the subsoil can be determined by;

1. Trial holes and subsequent investigations,
2. Bore holes and core analysis,
3. Local knowledge of the site area.

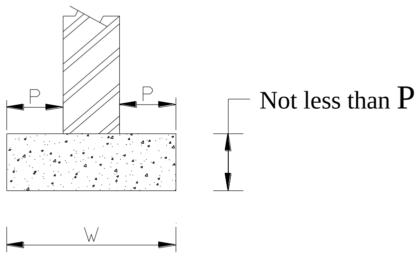
Foundation sizing

The size of a foundaion is basically dependent on two factors and these are;

6. Load being transmitted

7. Bearing capacity of the subsoil under the proposed foundation. The bearing capacities for different types of subsoil may be obtained from the table to Approved Document A.

Having ascertained the above, then the size of the foundation can be determined as follows;



$$\text{Minimum foundation width (W)} = \frac{\text{Total load of building per metre}}{\text{Bearing capacity of subsoil}}$$

Types of foundations

a) **Strip foundation:** Is a foundation with a continuous strip of concrete, which provides a continuous ground bearing under the load bearing walls. This type of foundation is recommended for buildings up to four floors in height built on firm subsoil. **See fig 3.1a**

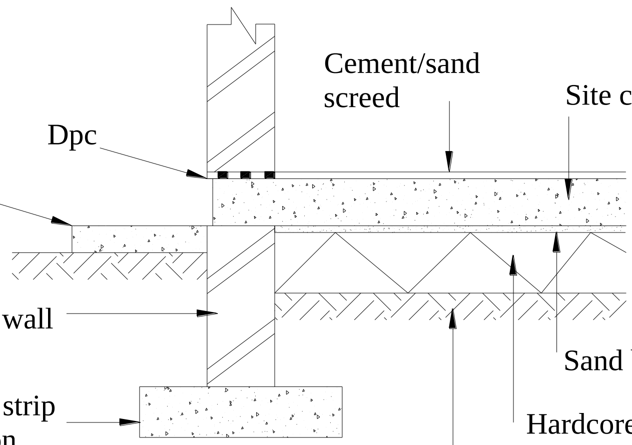


Fig 3.1a Strip foundation

b) **Stepped strip foundation:**

On a sloping site the most economic procedure is to use a stepped strip foundation, which reduces on the amount of excavation, backfill, surplus soil removal and trench timbering. The section of a stepped foundation is similar to that of a strip foundation but the elevation is different as a result of the step that follows the sloping ground **See fig 3.1b**

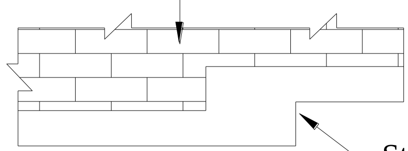


Fig 3.1b Stepped strip foundation (elevation)

c) Wide-**strip foundation:** This has a wide continuous strip of concrete, which spreads the load over a larger area of soil. This foundation is recommended on subsoil whose load bearing capacity is low, and these include marshy ground, soft clay silt and made ground. **See fig 3.1c**

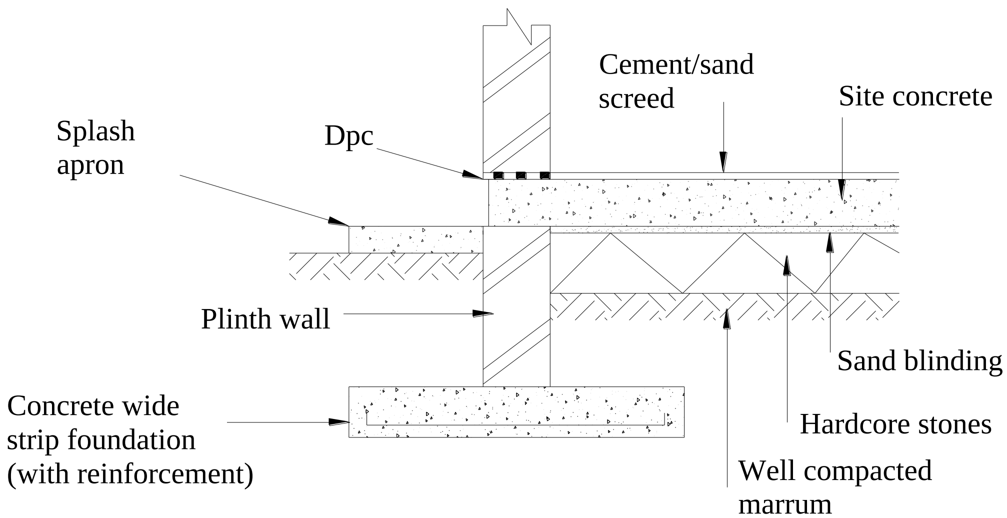


Fig 3.1c Wide strip foundation

b) **Deep-strip foundations:** Is a foundation with a narrow deep continuous strip of concrete, which provides greater resistance to fracture from unequal settlement. This foundation is recommended in shrinkable clay soils where it counteracts the variable soil conditions at different seasons. Because of the reduced width of the foundation trench, the quantity of excavation, backfill and surplus soil removal are also reduced. **See fig 3.1d**

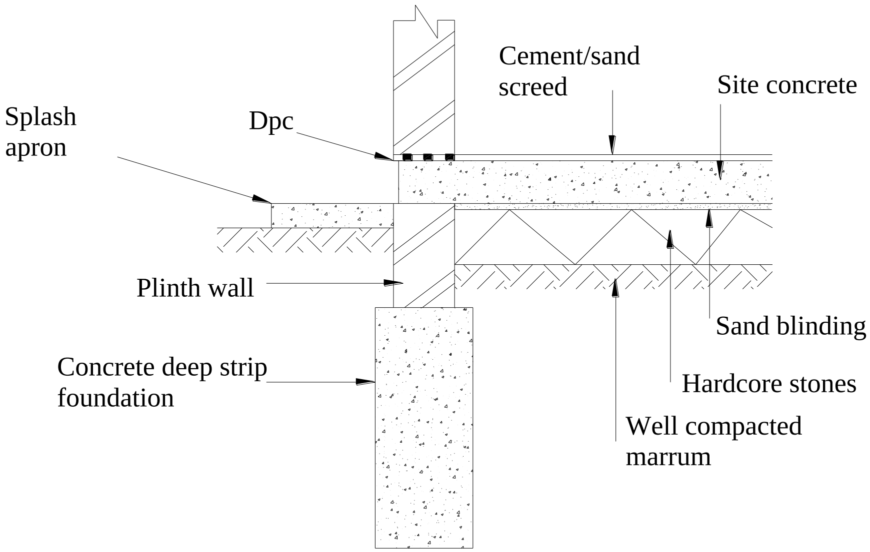
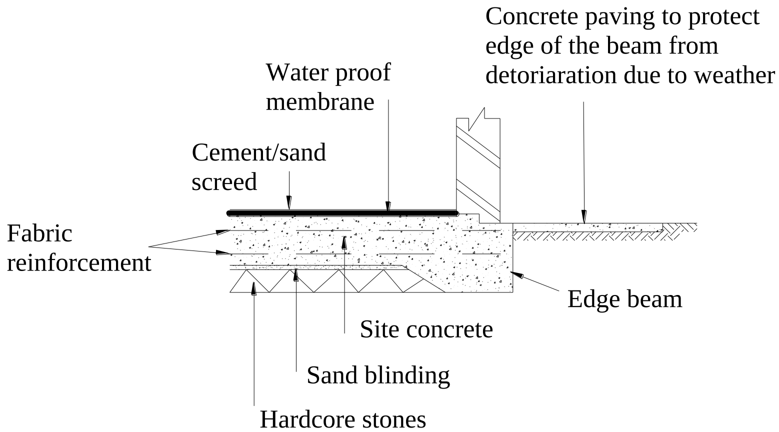


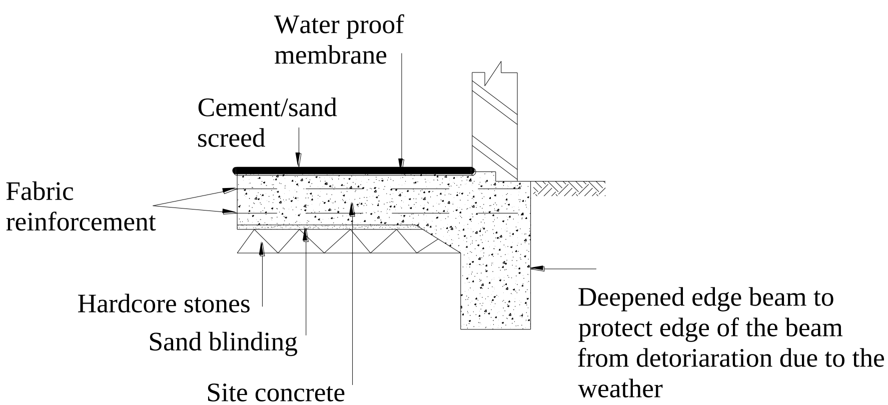
Fig 3.1d Deep strip foundation

c) **Raft foundations:** This consists of a reinforced concrete slab of up to 300mm thick that covers the whole area of the building and usually extending beyond it. The slab is often thickened under the load bearing walls and the reinforcement is often in the form of two layers of fabric reinforcement, one being near the top and the other near the bottom of the slab. These foundations are best suited for use on soft natural ground, fill sites or on sites that are liable to subsidence as in mining areas. The ground from the edge of the raft should be protected from deterioration by the weather and this can be achieved in one of the following ways;

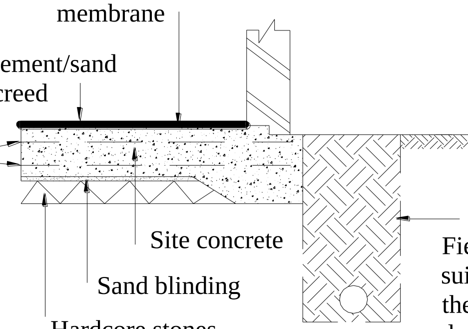
- **I.** Laying concrete paving around the building as shown in **fig 3.1e (i)**
- **II.** Deepening the edge beam as shown in **fig 3.1e (ii)**
- **III.** Laying a field drain in a trench filled with suitable fill as shown in **fig 3.1e (iii)**


Concrete paving to protect
edge of the beam from
detoriaration due to weather
Water proof
membrane
Cement/sand
screed
Fabric
reinforcement
Edge beam
Site concrete
Sand blinding
Hardcore stones

(i)


Water proof
membrane
Cement/sand
screed
Fabric
reinforcement
Hardcore stones
Sand blinding
Site concrete
Deepened edge beam to
protect edge of the beam
from detoriaration due to the
weather

(ii)



(iii)

Fig 3.1e Raft foundations

d) **Isolated or pad foundation:** These are isolated foundations that are used to support and transmit loads from piers and columns. The size of the foundation can be reduced by providing steel reinforcement towards the bottom of the foundation running in both directions. **See fig 3.1f**

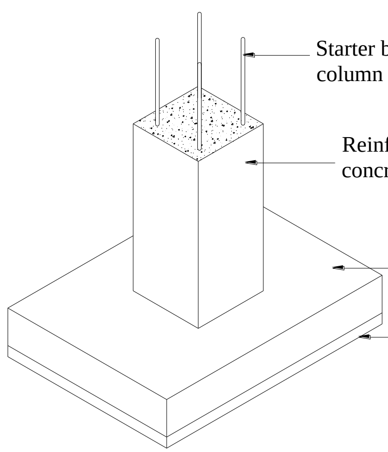


Fig 3.1f Isolated or pad foundation

e) **Short-bored pile foundations:** These consist of short concrete piles cast in holes bored in the ground and spanned by light reinforced concrete beams for load bearing walls. These foundations where devised to provide economical and satisfactory foundations for houses built on shrinkable clay. S**ee fig 3.1g**

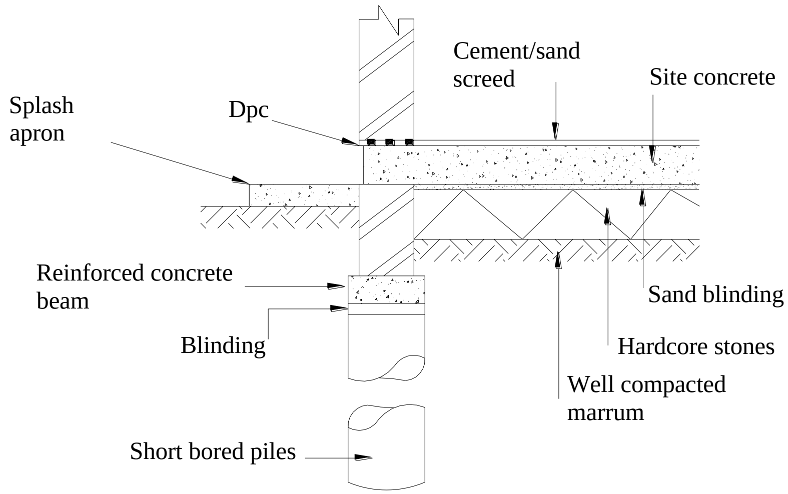


Fig 3.1g Short-bored pile foundation

f) Piled foundations: These foundations consist of a shaft/pile, which is driven to pass through soft deposits, penetrating dense sand or gravel until the base rests on the bedrock. The shaft/pile then acts as a column for the building. These foundations are frequently used with multi-storey buildings and in cases where it is necessary to transmit the building load through weak and unstable soil conditions to a lower stratum of sufficient bearing capacity.

Terminologies used in foundations

1. **Back fill:** Materials excavated from site and if suitable used to fill in around the walls.
2. **Bearing capacity:** Safe load per unit area that the ground can carry.
3. **Ultimate bearing capacity** or maximum passive pressure of ground**:** is the maximum safe load per unit area that the ground can carry.
4. **Bearing pressure:** The pressure produced on the ground by the loads.

5. **Made ground:** Refuse, excavated rock or soil deposited for the purpose of filling in a depression or for raising the site above it's natural level.
6. **Settlement:** Ground movement which may be caused by;
   i). Deformation of the soil due to imposed loads,
   ii). Volume changes of the soil as a result of seasonal conditions.
   iii). Mass movement of the ground in unstable areas.

Foundation failure

The major sign of a building whose foundation has failed is the developing of cracks throughout the structure and this is as a result of the foundation settling (sinking) or tilting. There are three main causes of foundation failure and these are as follows:

a) *Failure due to loading*. When the combined loadings of the building are transmitted down the wall, the subsoil beneath the foundation is compressed and it reacts by exerting an upward pressure to resist foundation loading. If foundation load exceeds ***maximum passive pressure*** of ground (i.e. ***ultimate bearing capacity***) a downward movement of the foundation occurs. This downward movement or settlement may not be uniform through out the building and because some parts are sinking more than others then cracks develop in the wall. The remedy is to increase the plan size of the foundation (wide strip) so as to reduce the load per unit area. Alternatively the loadings being carried by the foundation should be reduced.

b) *Failure due to subsoil movements*. Soils especially clay that shrinks on drying and swells again when wetted often cause movement in shallow foundations. Similar volume changes can occur due to water held in the subsoil freezing and expanding - this is called ***Frost Heave***. The movement in the subsoil causes the walls to be drawn outwards leading to cracks in the wall and openings to develop between the sides of the foundation and the ground. Water may then enter through the formed openings and soften the ground below the foundation leading to settling (sinking) during the following rain season. This problem can be avoided by increasing the depth of foundation to at least 1000mm below ground level where ground movement is very slight and therefore cannot affect the stability of the foundation.

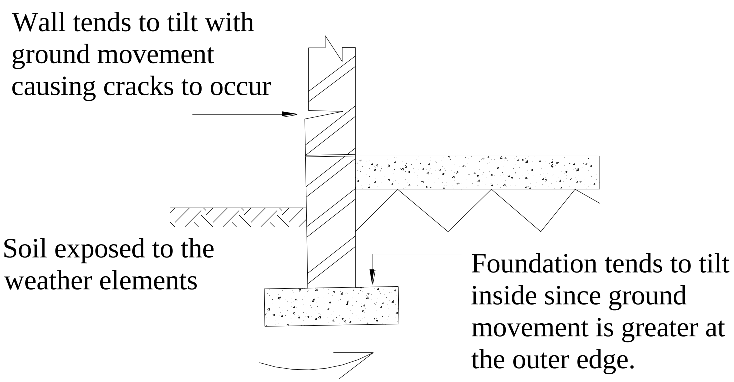


Fig 3.2a Foundation failure

c) *Damage by trees*. Damage to a buildings foundation by trees can be in two ways.

I. *Direct physical contact*. The roots of a tree may grow into the foundation and then directly fracture it.

II. *Shrinkage*. This is most evident in long periods of dry weather. The roots of broad-leaved trees such as oak, may extract water from the soil causing the ground (especially clay) to shrink because of the reduction in moisture content. This will cause the surface near the foundation to crack due to subsoil contraction and this movement in turn cracks the foundation and the building. **See fig 3.2b**

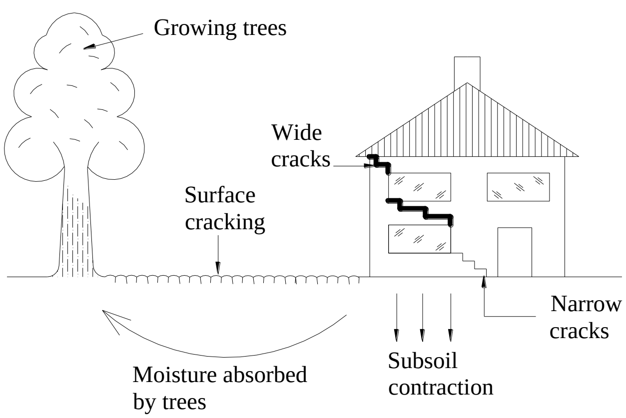


Fig 3.2b Subsoil shrinkage

III. *Surface heave*. This is the opposite of shrinkage and it occurs during the wet weather. It's caused by the previous removal of moisture- dependant trees that would have drained and balanced the subsoil conditions. The moisture will flow to the surface causing subsoil expansion and this movement will lead to cracks in the foundation. **See fig 3.2c**

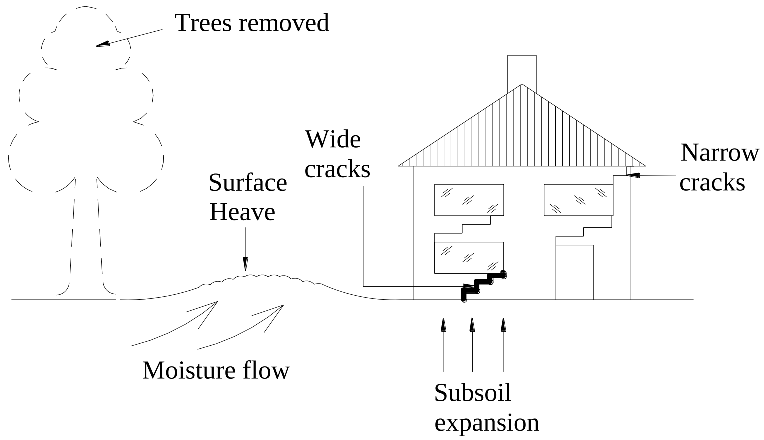


Fig 3.2c Surface heave

Damage of the foundation by trees can be avoided in the following ways;

ii) Using deep strip or short bored pile foundations instead of the traditional strip foundation
iii) Buildings on shallow foundations should not be closer to trees
iv) Constant pruning of growing trees is often necessary to restrict their height and avoid risk of damage to buildings.
v) Adequate time should be allowed after felling trees on a new site to allow time for the ground to regain its water content accompanied by surface heave.
vi) Foundations may be incorporated with an absorbing layer or compressible filler to resist ground movement.

Underpinning

This is the process of providing new, permanent support beneath a structure without the need to remove it. It's applied to structures whose support has suffered damage and distortion.

To prevent fracture, damage or settlement of the wall(s) being underpinned the work should always be carried out in short lengths called legs or bays. **See fig 3.3a**

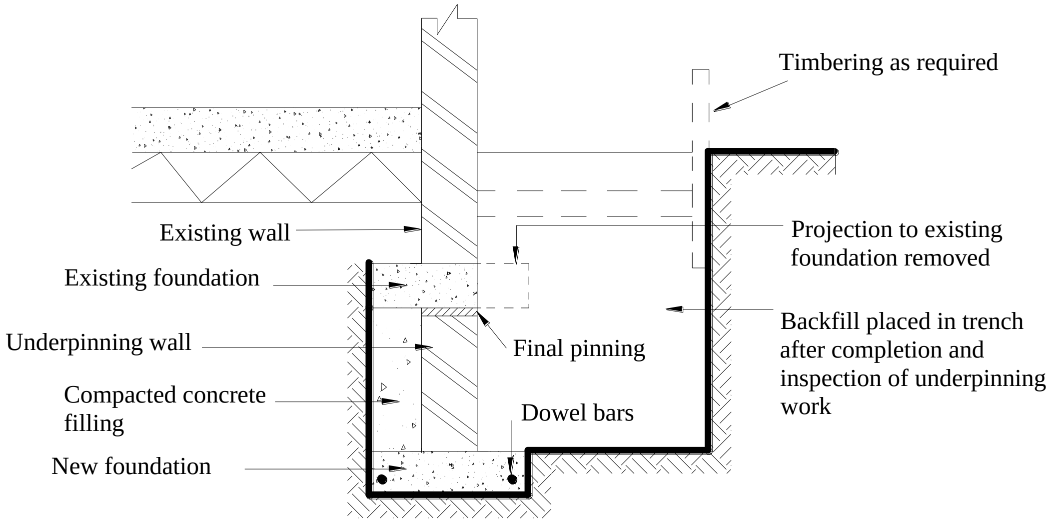


Fig 3.3a Underpinning

Reasons for underpinning

An underpinning operation may be necessary for one or more of the following reasons:

a) *Uneven settlement.* This could be cause by uneven loading of the building, unequal resistance of the soil action, tree roots or cohesive soil settlement.
b) *Increase in loading.* This could be due to the addition of an extra storey or an increase in imposed loadings such as that which may occur with a change of use.
c) *Lowering of adjacent ground.* Usually required when constructing a basement adjacent to existing foundations.

Precautions before underpinning

Before any form of underpinning work is commenced the following precautions should be taken:

a) Notify adjoining owners of proposed works giving full details and temporary shoring or tying.
b) Carry out a detailed survey of the site, the building to be underpinned and any other adjoining or adjacent building structures. A careful record of any defects found should be made and where possible agreed with the adjoining owners before being lodged in a safe place.
c) Indicators or 'tell tales' should be fixed over existing cracks so that any subsequent movements can be noted and monitored.
d) If settlement is the reason for the underpinning works a thorough investigation should be carried out to establish the cause and any necessary remedial work put in hand before any underpinning works are started.
e) Before any underpinning work is started the loads of the building to be underpinned should be reduced as much as possible by removing the imposed loads from the floors and installing any props and/or shoring where needed.
f) Any services that are in the vicinity of the proposed underpinning works should be identified, traced, carefully exposed, supported and protected as necessary.

EXERCISE

1(a) Explain briefly why a foundation is necessary in the field of building construction.

(b) What type of foundation would you recommend for each of the following?

(i) Clay soil (ii) Man made ground

(iii) Sloppy ground (iv) Firm soil (v) Column support.

(c) Draw an annotated diagram of a Strip foundation for soft ground.

(d) State any five foundations, where each is suitably used and why

2(a) What is a foundation?

(b) State any five factors that may influence the choice of a foundation.

(c) Give any five examples of foundations and state where they can be used.

(d) Distinguish between the following terms.

(i) Back filling and made ground
(ii) Bearing capacity and bearing pressure
(iii) Settlement and ramming