GOVERNMENT POLYTECHNIC FOR GIRLS

AHMEDABAD

COURSE: ADVANCE CONSTRUCTION TECHNOLOGY

COURSE CODE : 3350605

TOPIC: PILE FOUNDATION

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FOUNDATION

FOUNDATION AND ITS NECESSITY:

It is the lowest part of a structure below the ground level which is in direct contact with the ground and transmits all the loads to the ground.

Mejority of structures fails due to failure of their foundation.

Purpose of foundation :

1. To distribute the weight (load) of the structure over large area so as to bring down the intensity of load at its base below the Safe Bearing Capacity (S.B.C.) of sub-soil.
2. To support the structures.
3. To distribute the non-uniform load of the superstructure, uniformly to the sub soil.
4. To provide a level and hard surface for concreting and masonry work.
5. To take the structure deep into the ground and thus increase its stability, preventing overturning.

- To load the sub-stratum evenly and thus prevent unequal settlement.

SHALLOW FOUNDATION AND DEEP FOUNDATION :

Shallow foundation : If depth of footing (D) is less than equal to width of footing (B), it is called as shallow foundation.

$D<B$

Deep foundation : If depth of footing is more than the width of footing, it is called Deep Foundation.

$D>B$

Shallow foundation	Deep foundation
1. If depth of footing is less than or equal to the width of footing, it is called shallow foundation. 2 Shallow foundation is provided when bearing capacity of soil is more and required bearing capacity is available at shallow depth. 3. It is provided when load of the structure is less. 4. It is suitable when timbering to the trenches is possible. 5. It is suitable when ground Water Table (W.T.) is low. 6. It is suitable when top layers of soil are non - uniform and unstable. 7.It is suitable when dewatering of foundation is not required. 8. Types of shallow foundations are, - Spread footing - Combined footing - Raft foundation - Grillage foundation	1. If depth of footing is more than the width of footing, it is called deep foundation 2. Deep foundation is provided when bearing capacity of soil is low or desired bearing capacity is available at more depth. 3. It is provided when load(weight)of the structure is more. 4.It Is suitable when timbering to the trenches is costly or impossible. 5. It is suitable when ground water table is high. 6. It is suitable when top layers of soil are non-uniform and unstable. 7. It is suitable when dewatering of foundation trenches is costly and difficult. 8. Types of deep foundations are uniform and stable. - Pile foundation - Cassion or well foundation - Coffer dams.

SITUATIONS DEMANDING USE OF PILE FOUNDATIONS :

Pile foundations are preferred in the following situations :

1. The load of the superstructure is heavy and its distribution is uneven.
2. The top soil has poor bearing capacity.
3. The subsoil water is high so that pumping of water from the open trenches for the shallow foundations is difficult and uneconomical.
4. There is large fluctuations in subsoil water level.
5. Where timbering to the trenches is difficult and costly.
6. The structure is situated on the sea shore or river bed, where there is danger of scouring action of water.
7. Canal or deep drainage lines exist near the foundations.

CLASSIFICATION OF PILES BASED ON THEIR FUNCTION OR USE :

Based on the function piles are classified as,

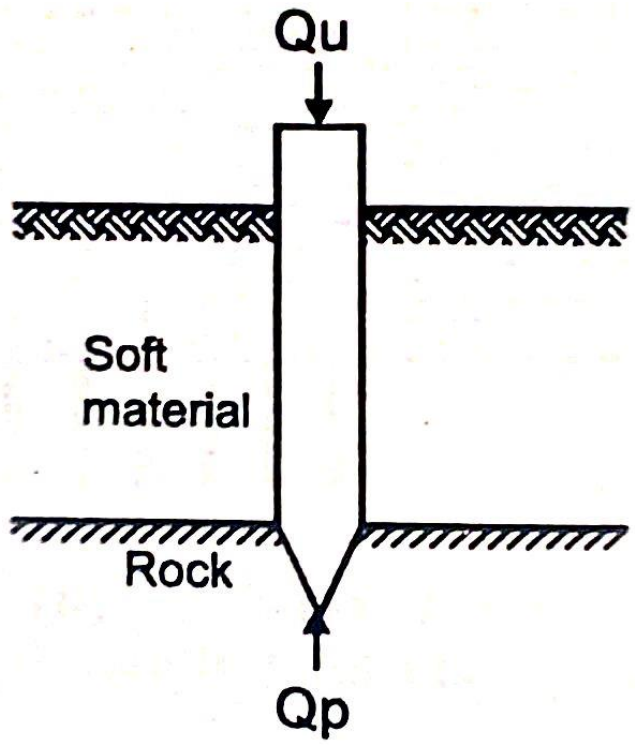
1. Friction pile
2. End bearing pile
3. Compaction pile
4. Tension pile
5. Anchor pile
6. Fender pile
7. Better pile
8. Sheet pile

1. END BEARING PILES.

These piles penetrate through the soft soil and their bottoms or tips rest on a hard stratum. These piles act as columns.

The soft material surrounding the pile provides some lateral support.

For end bearing pile Qu = Qp.



2. FRICTION PILE.

When loose soil extends to a great depth, piles are driven up to such a depth that frictional resistance developed at the sides of the piles equals the load coming on the piles. Friction piles are used when a hard stratum is available at a greater depth. For friction pile,

Qu = ultimate load

Qs = skin friction

The total frictional resistance can be increased in following ways :

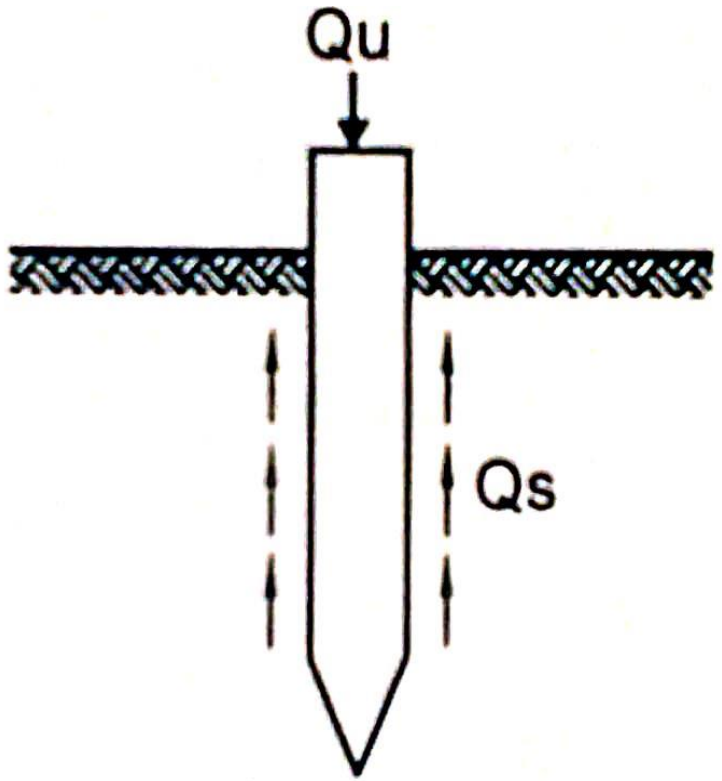
(1) By increasing the length of pile

(2) By increasing the diameter of pile

(3) By making the surface of the pile rough.

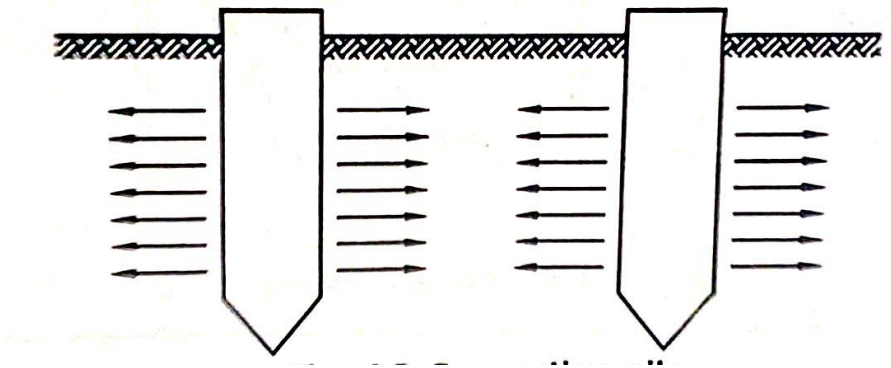
(4) By placing the piles closely

(5) By grouping the piles.



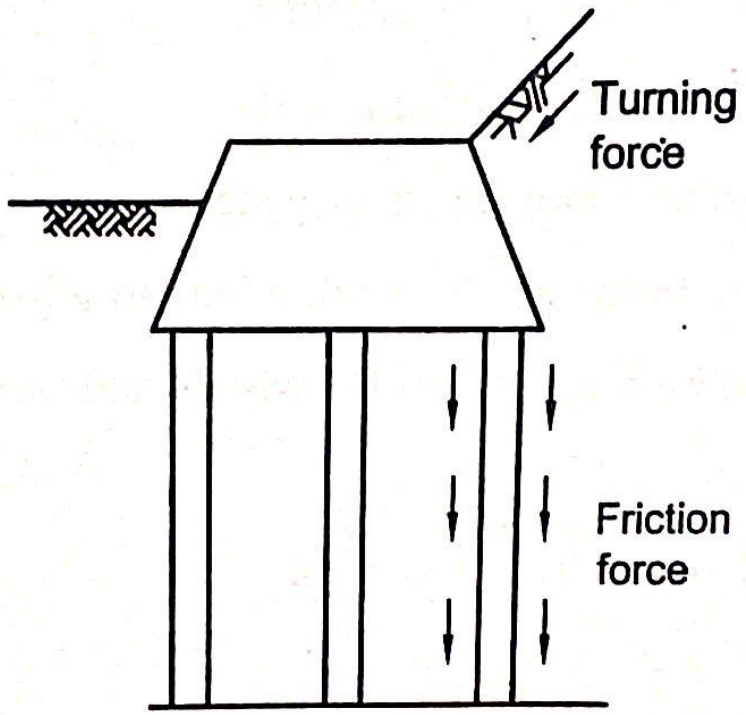
3. Compaction pile

When piles are driven in loose granular soil with the aim of increasing the bearing capacity of soil, the piles are termed as compaction piles. These piles themselves do not carry any load.



4. Tension pile :

These piles anchor down the structures subjected to uplift due to hydrostatic pressure or e to overturning moment.
It is also called uplift pile.

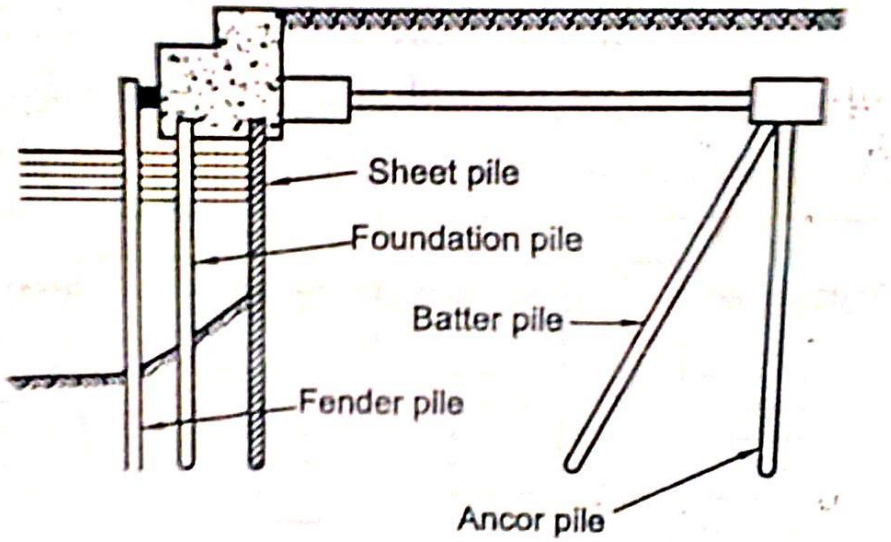


5. Anchor Pile :

Anchor piles provide anchorage against horizontal pull from sheet piling or other pulling forces.

6. Fender pile :

Fender piles are used to protect water front structures against impact from ships or other floating objects.



Fender Pile , Better Pile.

7. Better pile :

They are used to resist large horizontal forces or inclined forces.

8. Sheet pile :

They are used as bulk heads or as impervious cutoff to reduce seepage and under hydraulic structures.

Sheet piles are used for the following purposes.

(1) To isolate foundations from adjacent soils.

(2) To prevent underground movement of water.

(3) To prevent the transfer of machine vibrations to adjacent structures

(4) To construct retaining walls in docks, wharfs and other marine structures.

(5) To protect river banks.

(6) To retain sides of foundations trenches.

(7) To work as cutoff walls under dams.

(8) To confine the soil and thereby increase the bearing capacity of soil.

(9) To construct caissons for water-intake structures.

Based on the material, types of sheet piles are:

1. Concrete sheet piles
2. Steel sheet piles
3. Timber sheet piles

End bearing pile	Friction pile
1.The bottom end of the pile rest on hard strata. 2 Load is transferred at the tip of the pile. 3. It is suitable when hard strata is available at shallow depth. 4. Pile does as a column. 5. End bearing piles are normally driven in vertical direction. 6. Dimensions of pile are determined from load on pile and its material. 7.The length of pile must be equal to the depth of hard strata from ground surface.	1. When loose soil expends to a great depth, the bottom end of the pile does not reach up to the hard strata 2. Load is transferred to the soil surrounding the pile by friction between soil and the pile material. 3. It is suitable when loose soil expends to a great depth. 4. Pile does not act as a column. 5. Friction piles may be driven in vertical or inclined direction. 6. Dimensions of pile are determined from load on pile and the roughness of pile surface. 7. The length of pile can be reduced by increasing the diameter of pile or by increasing the roughness of surface of the pile.

SHEET PILES

Sheet piles are thin piles, made of plates of concrete, timber or steel, driven into the ground for either separating members or for stopping seepage of water. They are not meant for carrying any vertical load. Therefore, sheet piles are also termed as non-load bearing piles. Sheet piles are used for the following purposes :

(1) To isolate foundations from adjacent soils.
(2) To prevent underground movement of water.
(3) To prevent the transfer of machine vibrations to adjacent structures.
(4) To construct retaining walls in docks, wharfs and other marine structures.
(5) To protect river banks.
(6) To retain sides of foundations trenches.
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Based on the material, types of sheet piles are:

1. Concrete sheet piles
2. Steel sheet piles
3. Timber sheet piles

Concrete sheet piles

Concrete sheet piles are reinforced, precast units. The width of each unit may vay from 50 cm to 60 cm and thickness varies from 2 cm to 6 cm.

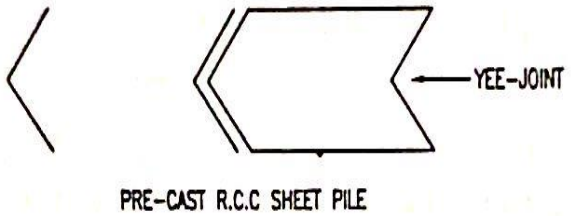
The reinforcement is in the form of vertical bars and hoops. For important works, Pre-stressed precast concrete piles are used.

Pre-cast RCC sheet piles are used for permanent works such as bulk heads, cut-off walls, retaining walls, wharf walls, ete.

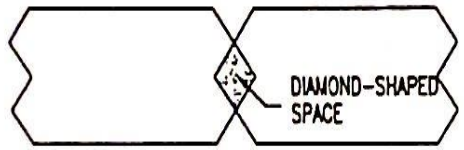
In order to make them water tight, they are placed in such a way that grooves are formed and these grooves are then filled by cement mortar in proportion (1: 3) under pressure.

Figure shows, V-joint, diamond shaped joint, tongue and semicircular groove.

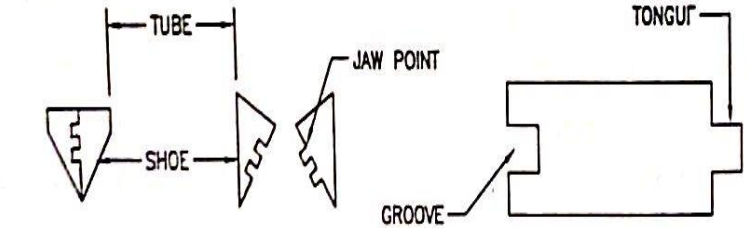
The feet of the piles are shaped obliquely and bevelled so as to facilitate driving. Metal shoes are provided at the bottom of the piles, if they have to pass through hard strata.

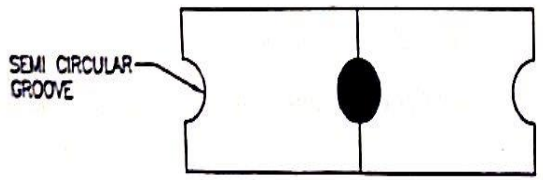


PRE-CAST R.C.C SHEET PILE



PRE-CAST R.C.C SHEET PILE





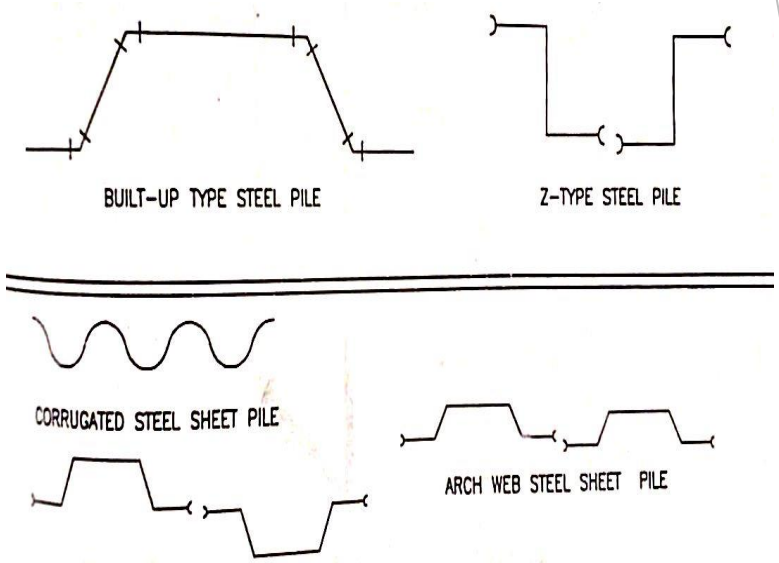
PRE-CAST R.C.C. SHEET PILE

Steel sheet piles :

Steel sheet piles are most commonly used.

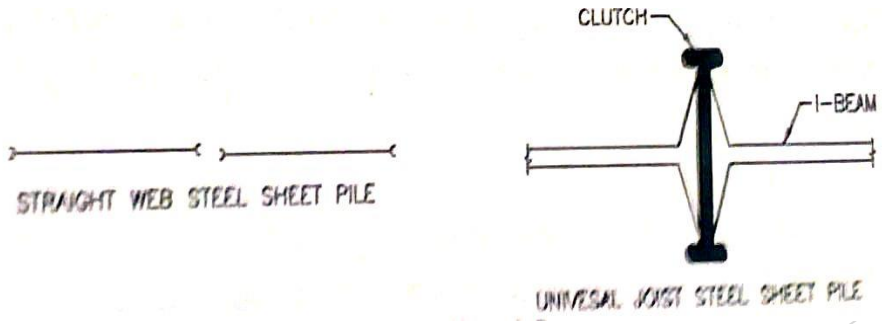
- They are trough shaped and when driven the piles are interlocked with alternate ones reversed.
- They are generally made from steel sheets 20 to 30 cm wide and 4 to 5 m long.
- Steel sheet piles are strong and durable and can be easily driven without appreciable distortion. They provide a fairly water tight enclosure and hence, they are widely used in the construction of cofferdams.

They are also used for permanent works in marine structures.



Different types of steel sheet piles :

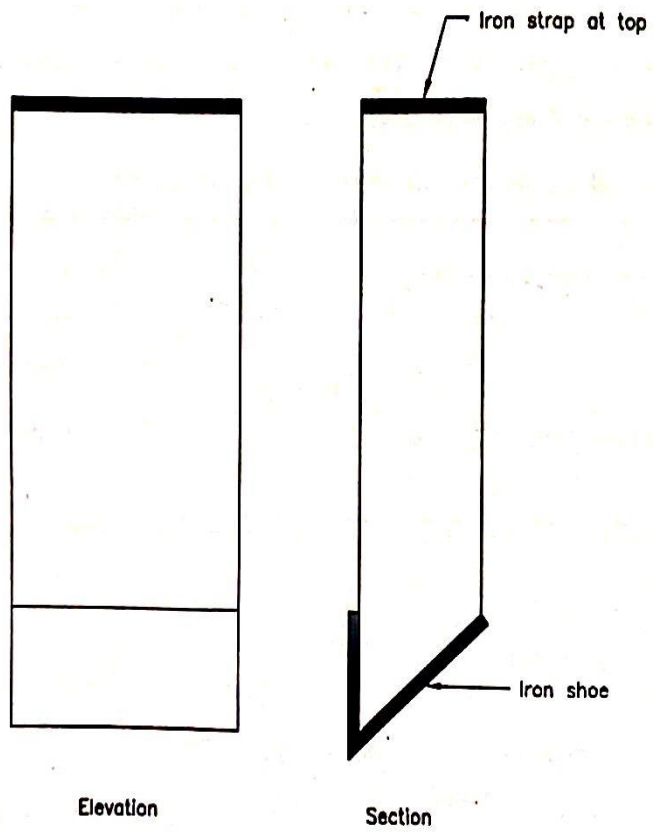
1. Arch web steel sheet pile
2. Built up type steel sheet pile.
3. Z-Type steel sheet pile.
4. Corrugated steel sheet pile.
5. Deep arch web steel sheet pile.
6. Universal joint steel sheet pile .



Universal joint steel sheet piles consists of I-beams connected by standard clutches lockbars. The clutch is also of l-beam. But its flanges are curved so as to accomodate the flanges of I-beams.

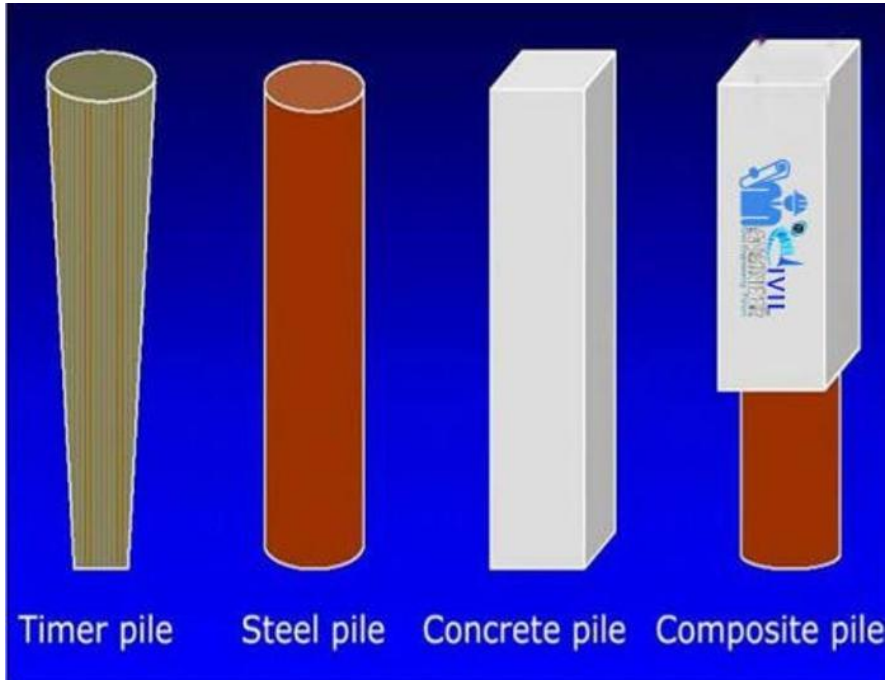
TIMBER SHEET PILES

- Timber sheet piles are commonly used for temporary works such as cofferdams.
- The width of the sheet may vary from 225 to 280 mm, while thickness should not be less than 50 mm.
- They may be jointed by either butt or V-joints. Their feet are bevelled and sometimes shod with sheet iron.

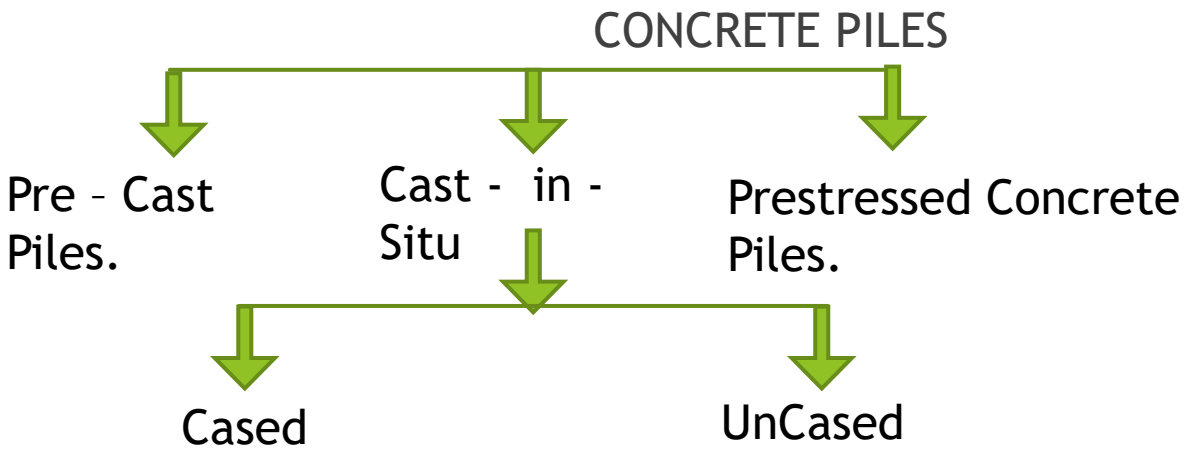


CLASSIFICATION OF PILES BASED ON MATERIALS :

- Based on the material piles are classified as,
  1. Concrete piles.
  2. Steel piles.
  3. Timber piles
  4. Composite piles.
  5. Sand piles



CONCRETE PILES.



- Raymond Piles
- Mac Arthur Piles
- Monotube Piles
- BSP base driven Piles
- Swage Piles
- Button bottom Piles

- Simplex Piles
- Franki Piles
- Vibro Piles
- Pedestal Piles
- Pressure Piles

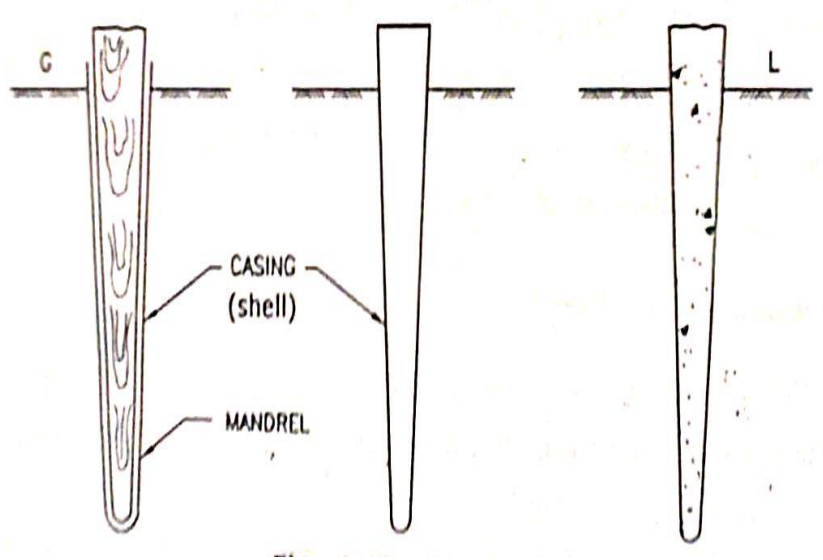
1. Cast-in-situ concrete Piles :

In this type of concrete Piles, a bore is dug into the ground by inserting a casing. This bore is then filled with cemet concrete after placing reinforcement, if any. The casing may be kept in position or it may be withdrawn. The piles with casing are known as cased cast-in-situ concrete Piles and those without casing are known as uncased cast-in-situ concrete piles.

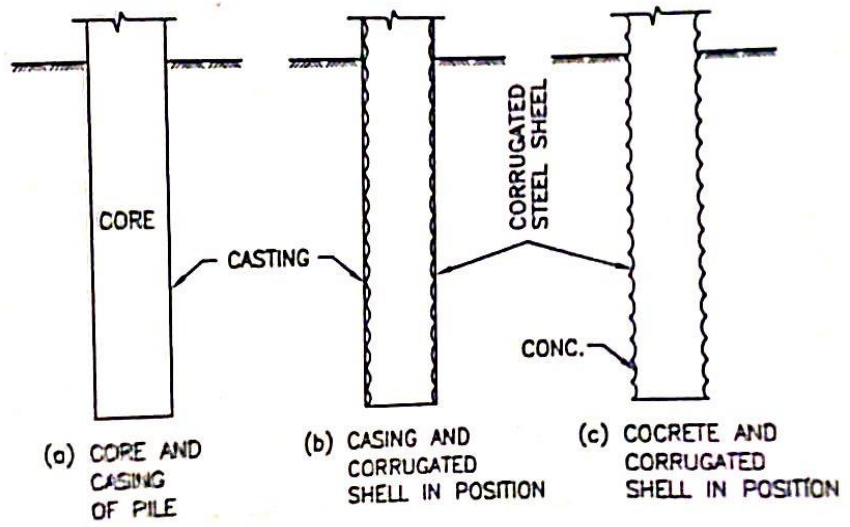
- **Raymond Piles :**

  The Raymond standard pile is used primarily as a friction pile. It is provided with uniform taper of 1 in 30 resulting in shorter piles.

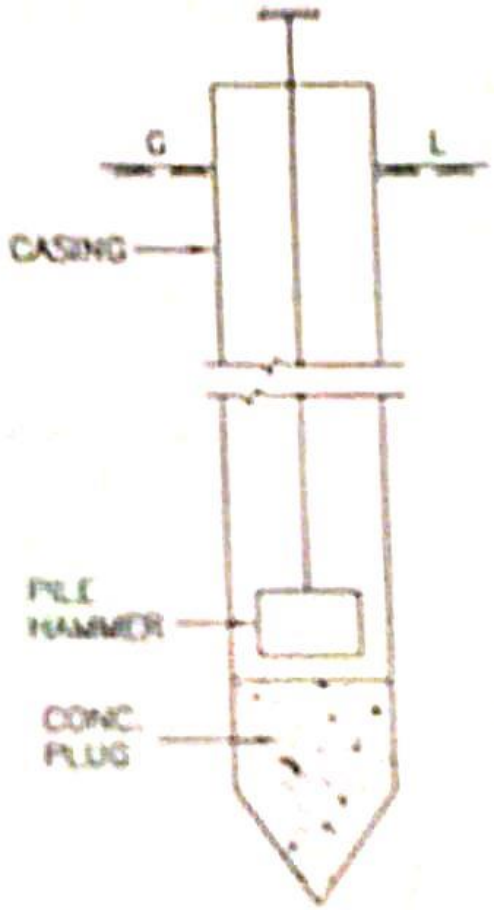
- The lengths of piles vary from 6 to 12 m. The diameter of piles vary from 40 to 60 cm at the top and 20 to 30 cm at the bottom.
- The Pile consists of a thin corrugated shell (casing) closed at the bottom. The steel shell is reinforced with spirally wound hard drawn wire on 8 cm pitch.
- The shell is driven into the ground with a collapsible steel mandrel or core in it having the same taper.
- When the Pile is driven to the desired depth mandrel is mechanically collapsed and withdrawn, leaving the shell inside the ground.The shell is inspected internally by ng the light from a mirror or flash light or drop light.
- The shell is gradually filled with concrete up to the top.



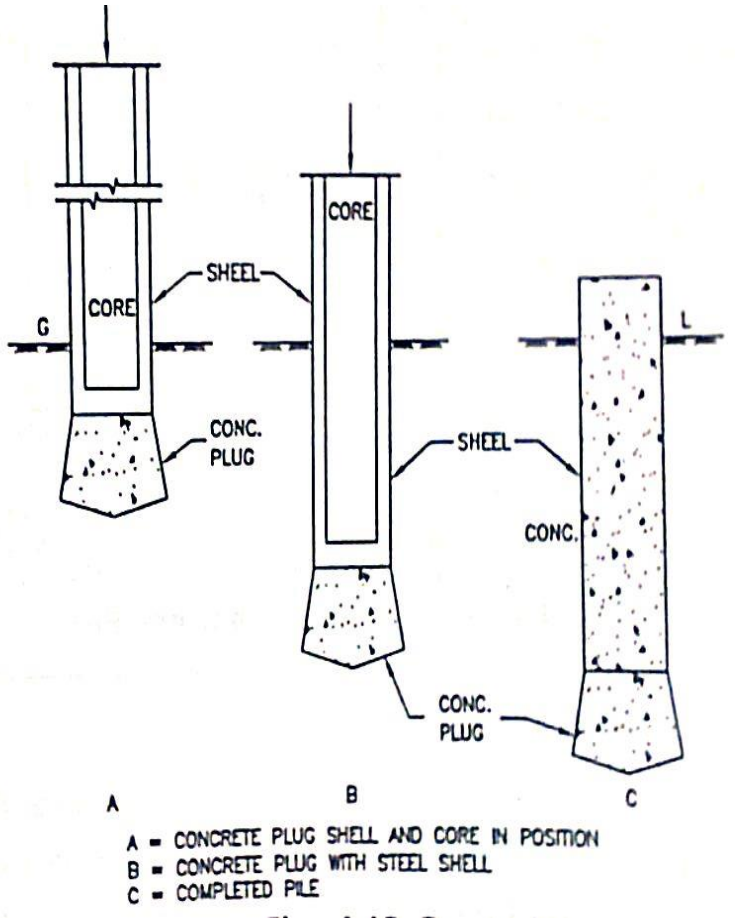
- **Mac Arthur Piles :**
- Mac Arthur is a pile of uniform diameter, using the corrugated steel shell which remains in place, as in Raymond Piles.
- A heavy steel casing with a core is driven into the ground as shown in Fig. When the desired depth is reached, the core is withdrawn and a corrugated steel shell is placed in the casing.
- Finally, concrete is placed in the shell, by gradually compacting it, and withdrawing the steel casing.



- **BSP-base driven Piles :**
- This pile consists of a helically welded shell of steel plate. A concrete plug is provided at the bottom of the shell.
- Driving is done by allowing Pile hammer to fall on the concrete plug.
- The casing is driven to the desired depth and then it is filled with concrete.



- **Swage Piles :**
- Swage Piles are used with advantage in some soils where the driving is very hard or where it is designed to leave water tight shell, for some time before filling the concrete.
- In the first stage, a steel shell is placed on a precast concrete plug, and a steel core which is not long enough to reach the plug is inserted in the plug.
- In the second stage, as the pipe is driven over the plug until the core reaches the plug, the pipe is swaged out by the taper of the plug thus forming a water tight joint.
- In the third stage, the pipe is driven to a specified depth. The driving force is practically exerted by the core on the plug and the pipe is pulled down rather than driven.
- In the fourth stage, after the pipe was reached the desired depth, the core is removed and the pipe is filled with concrete.



Button – bottom – Piles :

These piles are used in locations where increase in the end bearing area is desired. The pile uses a concrete plug, of the shape of button. This button forms an enlarged hole in the soil during driving.

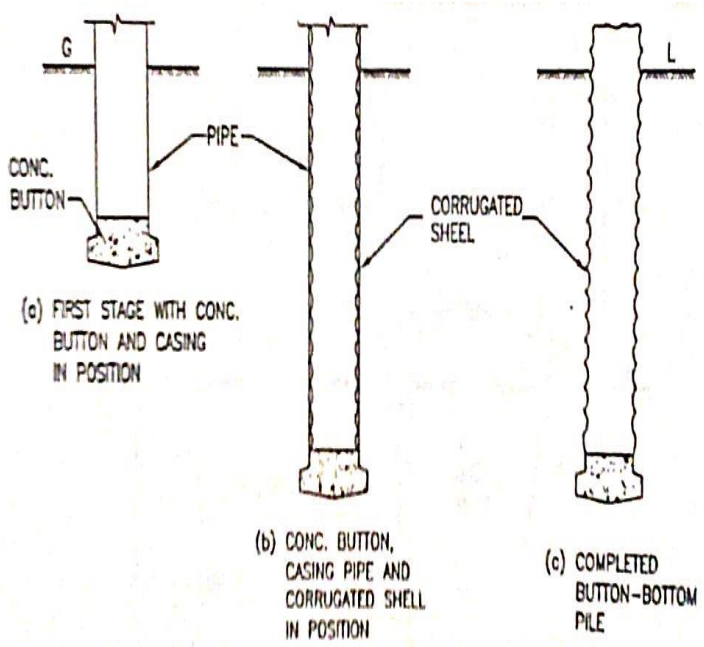
There piles have been used upto lengths of about 23 m, and for loads up to 50 tonnes.

In the first stage, a steel pipe with 12 mm thick walls is set on the concrete button. The concrete button has a diameter about 25 mm larger than the pipe.

In the second stage, the pipe and button are driven to a specifid depth.

In the third stage, a corrugated steel shell is inserted in the pipe, resting on the button.

In the fourth stage, the casing is withdrawn leaving the button in place, and the shell is filled with concrete. Reinforement may be used if necessary.



- **Uncased cast-in-situ concrete Piles :**

  These piles do not use casing and hence are cheaper. However, great skill is required in their construction. These piles are used only where it is certain that neither soil nor water will fall into the hole, or squeeze into and reduce the size of the hole, and also where adjacent piles will not damage the green concrete. It is essential to have close installation inspection, since no inspection is possible after they are installed.

- **Advantages of uncased piles :**

(i) They do not require storage space.
(ii) They do not require cutting off excess lengths or building up short lengths.
(iii) They do not require special handling equipment.
(iv) The concrete is not liable to damage from driving.

The common types of uncased cast-in-situ concrete piles are :

1. Simplex Piles
2. Franki Piles
3. Vibro Piles
4. Pedestal Piles
5. Pressure Piles

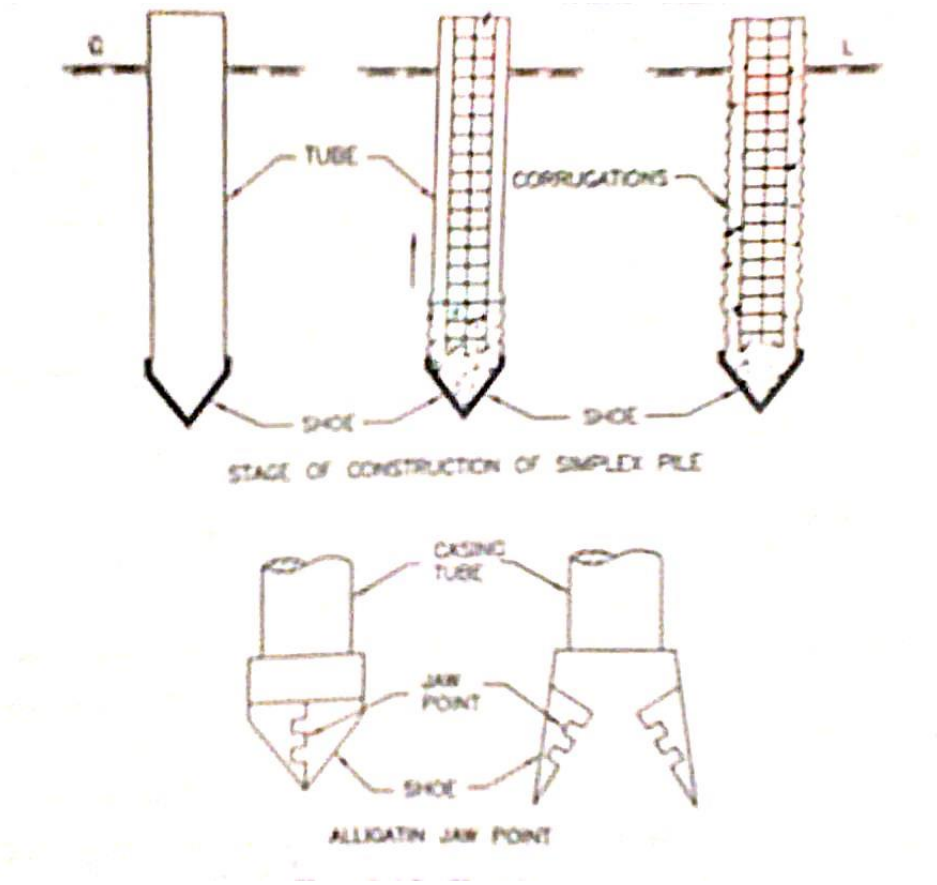
- **Disadvantages of cast – in – situ concrete piles:**

1. It is difficult to maintain reinforcement in correct position during construction of pile.
2. For an unreinforced pile, a slight movement of earth may break the pile.
3. These piles cannot be constructed under water
4. The dry ground may absorb water from wet concrete, making the pile structurally weak.
5. If the concrete is not well rammed, voids will remain in the concrete, making the concrete weak.
6. It is not possible to have a proper control over the composition and design of these piles.

1 . Simplex Piles:

Simplex piles can be driven through soft or hard soils. In this type of pile, tube fitted with a cast iron shoe is driven into the ground up to the desired depth. Reinforcement, if necessary is put inside the tube, concrete is then poured into the tube, and the tube is slowly withdrawn, without concrete being tamped, leaving behind the cast iron shoe.

In this type of piles, if tamping of concrete is done at regular interval as the tube is withdrawn, we get the **simplex tamped pile.**



STAGE OF CONSTRUCTION OF SIMPLEX PILE

ALLIGATIN JAW POINT

2. Franki Piles :

In this type of pile, a plug of dry concrete gravel is formed on the ground by heavy removable pipe shell.

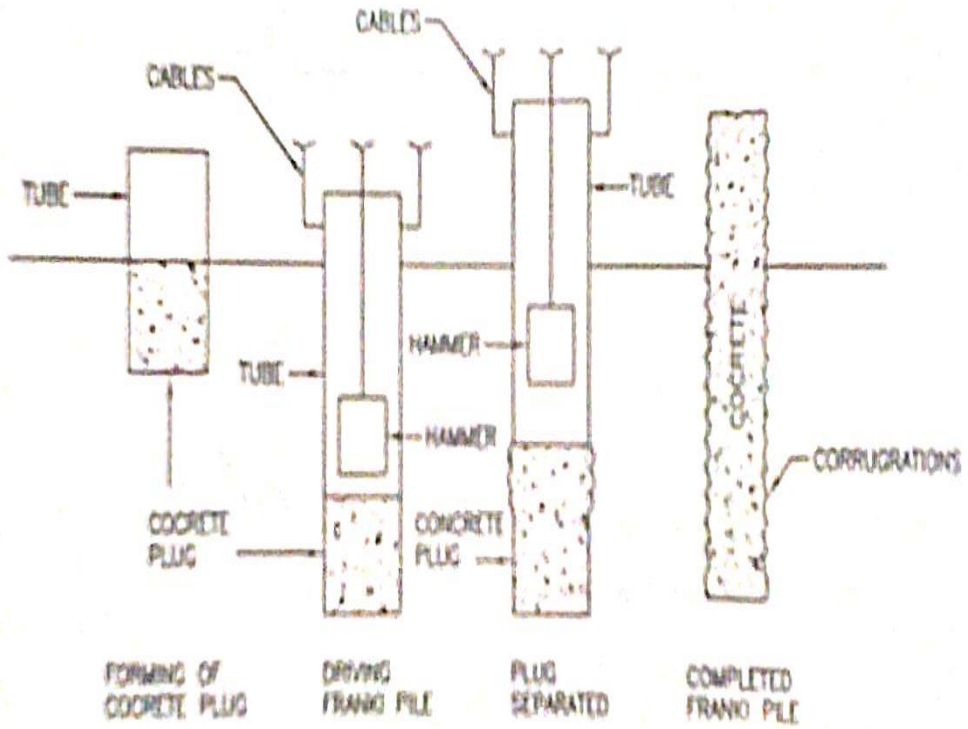
A diesel operated drop hammer of 20 to 30 kN weight is driven on the concrete plug. This results in the formation of a dense plug that penetrates the ground and drages the tube with it on account of friction developed between the tube and the concrete plug.

When the tube has reduced the desired depth, the tube is held in position by cables. (leads) and the hammer is applied to the concrete plug, forcing it down and outward. This results in the enlargement of the base into the mushroom shape.

If required a fresh charge of semi-dry concrete is not to enlarge the bulb.

In the next stage, the shaft is formed by introducing successive charges of concrete, ramming each in turn, and withdrawing the casing gradually about 300 mm at a time. Corrugations will be formed on the surface of a completed pile.

The pile diameter in Franki piles vary from 50 cm to 60 cm, while the enlarged base may have a diameter of about 90 cm. The pile has a load carrying capacity of 60 tonnes (660 kN) to 90 tonnes (900 KN).



3. Vibro Piles :

These piles are used where the ground is soft, thus offering little frictional resistance to the flow of concrete. Both 'Standard' and expanded piles are formed by the vibro- process.

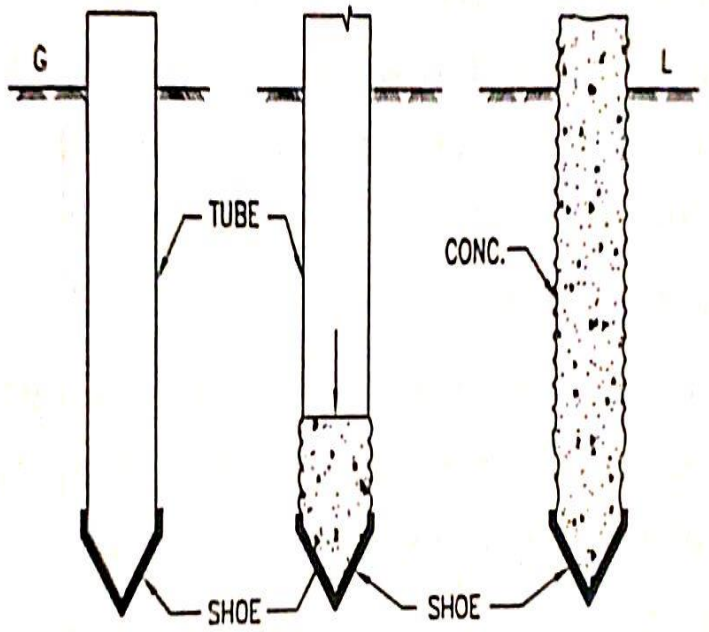
These piles are formed by driving a steel tube and shoe, filling with concrete, and withdrawing the steel tube.

Standard vibro piles are made in size of 35, 45 and 50 cm diameter for loads of 60 to 70 tonnes. They can be formed in the lengths of 25 m and over.

A steel tube fitted with a cast iron shoe is driven in the ground by 2 to 2.5 tonnes hammer operated by steam or compressed air delivering up to 40 blows per minute, with a stroke of about 1.4 m.

When the shoe and the tube has reached the desired level, the tube is filled with concrete (usually 1:2:4 mix). The withdrawal of the tube and the ramming of the concrete are effected by hammer operating at 80 blows per minute.

Finally, the steel tube is completely withdrawn leaving the shoe in place and thus pile is formed with corrugations all along its height.



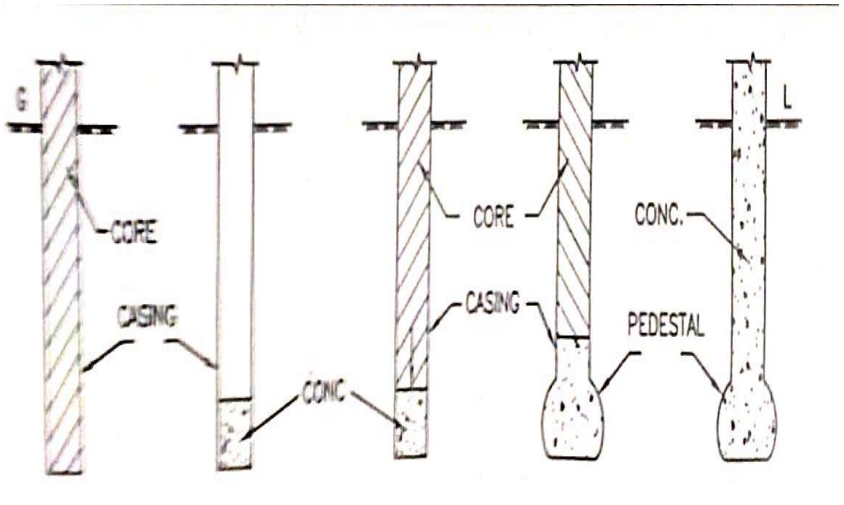
4. Pedestal Piles :

This type of piles are used where thin bearing stratum is reached with reasonable depth. The pedestal of the pile gives the effect of spread footing on this comparatively thin bearing.

The core and casing are driven together into the ground, till they reach the desired level.

The core is taken out and a charge of concrete is placed in the tube.

The core is again placed in the casing to rest on the top of poured concrete. Pressure is applied on the concrete through the core, and as the same time, the casing withdrawn. The process is repeated till the casing is completely removed. The finished pile is shown in Fig.



5. Pressure piles :

These are formed with the help of a casing tube, boring auger and compressed air equipment. These piles are especially suitable for those congested sites where heavy vibrations and noise are not permissible.

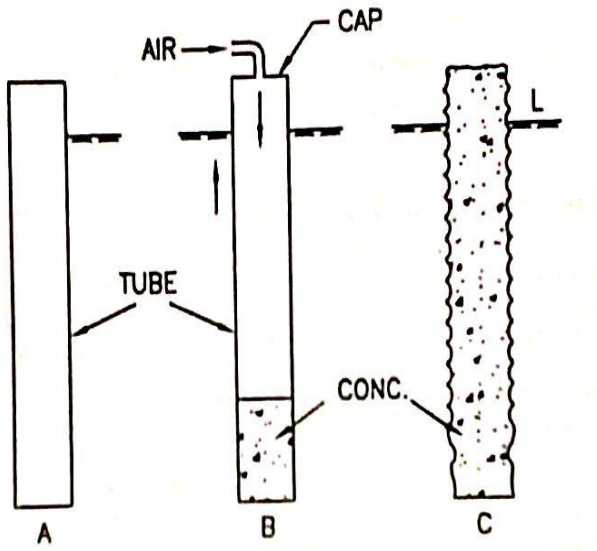
A hole is bored into the ground by means of an auger and as the boring proceeds, the hole is lined by a steel tube.

When the tube reaches the required depth, the boring tool is withdrawn. The reinforcement, if any is then placed in the tube.

In the second stage, a layer of concrete is laid and pressure cap is provided at the top of the tube.

Compressed air is then admitted through the air pipe and winch is applied to raise the tube. Thus, the tube is lifted slightly and at the same time concrete is forced into the surrounding ground by compressed air.

The process is repeated till the pile is completed. Care should be taken to see that some portion of concrete remains at the bottom of tube when lifting of tube is stopped to receive a new layer of concrete.



A = CASTING DRIVEN
B = CONCRETE POURED AND CONSOLIDATED BY PRESSURE AND CASING TUBE WITHDRAWN
C = COMPLETED PILE

Advantages and Disadvantages of cast-in-situ concrete piles :

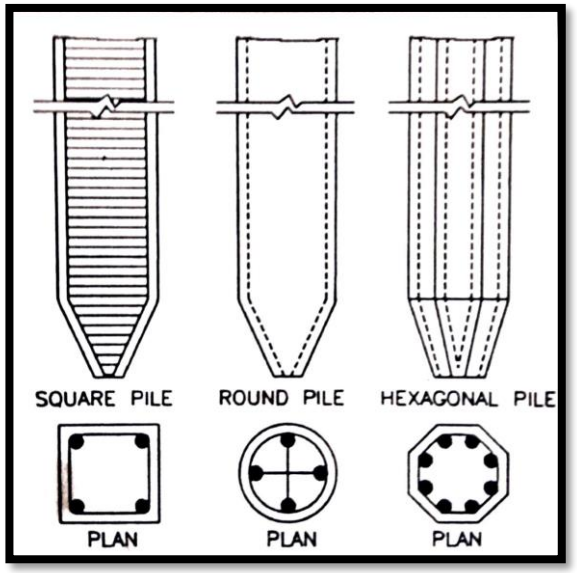
1. Light weight shells are used in cast-in-situ concrete piles. These shells are easy to handle and to drive in the ground.
2. No extra reinforcement is required to resist the stresses developing during handling and driving operations.
3. There is no wastage of material as the pile of required length is only constructed. It also eliminates the problems of lengthening or shortening of the pile.
4. The piles are sound in construction as they are not driven into the ground by a hammer. The danger of breaking of pile is also eliminated.
5. Extra cost of transportation of pile is eliminated.
6. If the need arise, additional piles may be constructed quickly.

Disadvantages of cast-in-situ concrete piles:

1. It is difficult to maintain the reinforcement in correct position during construction of pile.
2. For an unreinforced pile, a slight movement of earth may break the pile.
3. These piles cannot be constructed under water.
4. The dry ground may absorb water from wet concrete, making the pile structurally weak.
5. If the concrete is not well rammed, voids will remain in the concrete, making the concrete weak.
6. It is not possible to have a proper control over the composition and design of these piles.

Pre-cast Concrete Pile :

- Precast concrete piles are those which are manufactured in a factory or at a place away from the construction site, and then driven into the ground at the place required. Naturally, these piles require heavy pile driving machinery.
- Precast Piles may be square, octagonal or circular in cross section, and may be tapered or parallel sided longitudinally. Because of driving stresses and handling stresses (ie. transportation and lifting) the precast concrete piles are usually reinforced.
- The size of pile may vary from 30 cm to 50 cm in cross sectional dimension, and up to 20 m or in length. The reinforcement may consist of longitudinal steel bars of 20 mm to 40mm in diameter, 4 to 8 nos. with lateral ties of 6 to 10 mm diameter at 100 mm c/c spacing for top and bottom 1 m length and 300 mm c/c spacing for the middle length. A concrete cover of at least 50 mm is provided.
- The grade of concrete should be M20.



- Procedure for forming precast concrete Piles:

1. The formwork for the Pile is prepared and it is coated with soap solution or oil to prevent adhesion.
2. The cage of reinforcement is prepared as per design and this cage is then placed in the formwork. A concrete cover of at least 50 mm is provided.
3. A concrete of grade M20 is prepared with proportion 1:1.5:3. The size of coarse aggregate varies from 10 mm to 25 mm.
4. The concrete is laid in the formwork and well compacted using vibrators.
5. The forms are removed after 3 days and the piles are kept in the same position for about 7 days or so.
6. The piles are then shifted to a curing tank and after a period of about three or four weeks, they become ready for use.

- Advantages of precast concrete piles :

1. They can be cast well before the commencement of the work resulting in rapid execution of work.
2. The position of reinforcement in pile is not disturbed from its original position.
3. Their construction can be well supervised and any defect detected can be rectified before use.
4. They can be driven under water.
5. The driving of adjacent Pile does not produce adverse effect upon the already driven piles.
6. The piles can be loaded soon after they have been driven to the desired depth.
7. Any number of piles can be manufactured at a convenient place and this may prove to be economical.
8. These piles are highly resistant to biological and chemical actions of the subsoil.

- Disadvantages of Precast concrete piles :

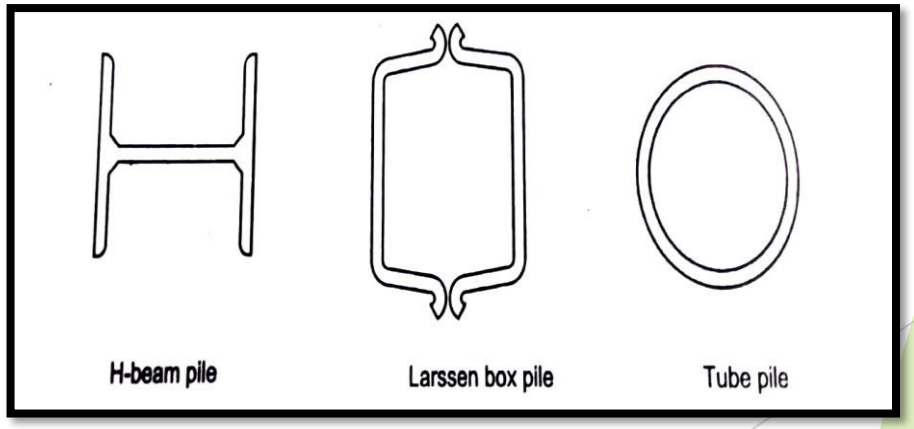
1. These piles are heavy. Therefore they require special equipments for handling and transportation.
2. If sufficient care is not taken, these piles may break during transport or driving.
3. They require heavy pile driving equipment.
4. Extra reinforcement is required to bear handling and driving stresses. Hence these piles are costly.
5. The length of the pile is restricted since it depends upon the transport facilities.
6. It is difficult to increase the length of the pile previously estimated on the basis of bore holes.
7. If the pile is found to be too long, during driving, it is difficult and uneconomical to cut the pile.
8. These piles are not available at short notice. Hence delay of work will occur for emergency projects.

- **Sheet Piles :**
- The types of steel piles commonly used are :

1. H-piles
2. Box piles
3. Tube piles

- **H-piles :**

These piles are usually of wide flange section. They are suitable for trestle type structures in which the piles extend above ground level and also act as columns. Since they have small cross sectional area, therefore, they can be easily driven in soils in which it will be difficult to drive ordinary displacement piles. They are used as long piles with high bearing capacity.



- **Box piles :**

They are rectangular or octagonal in form filled with concrete. These piles are used when it is not possible to drive H-piles into hard strata.

- **Tube piles :**

In this type, tubes or pipes of steel are driven into the ground. Concrete is filled inside the tube piles. Because of their circular cross section, these piles are easy to handle and easy to drive in.

- The advantages of steel piles are :

1. These piles can easily withstand the stresses due to driving.
2. These piles can resist lateral forces in a better way.
3. These piles can be easily lengthened by welding and can also be cut off easily.
4. The bearing capacity of these piles is comparatively high.
5. These piles can take up impact stresses.
6. The only disadvantage of steel piles is their corrosion.

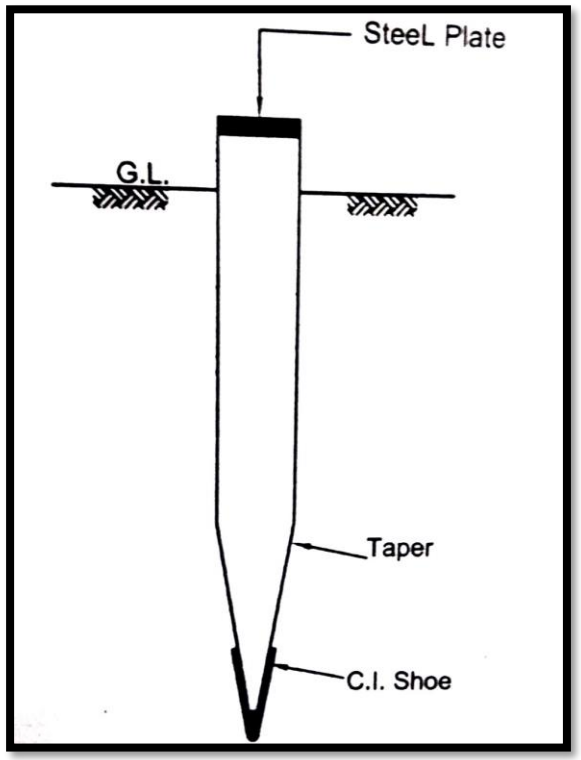
- Disadvantages:

1. Corrosion is the only drawback of steel piles. When steel piles are exposed to air or when they are subjected to alternate drying or wetting, corrosion takes place.
2. To prevent corrosion, steel piles may be coated with anti-corrosive paints or they may be encased with cement concrete. But, it may increase the cost of pile.

Timber Piles:

These piles are prepared from trunks of trees. They may be circular or square. They are 30 to 50 cm in diameter with a length not exceeding 20 times its top width.

At the bottom, a cast-iron shoe is provided and at the top a steel plate is fixed. If a group of timber piles is driven, the top of each pile is brought at the same level and then a concrete cap is provided to have a common platform. They have small bearing capacity and are not permanent unless treated.



- Advantages :

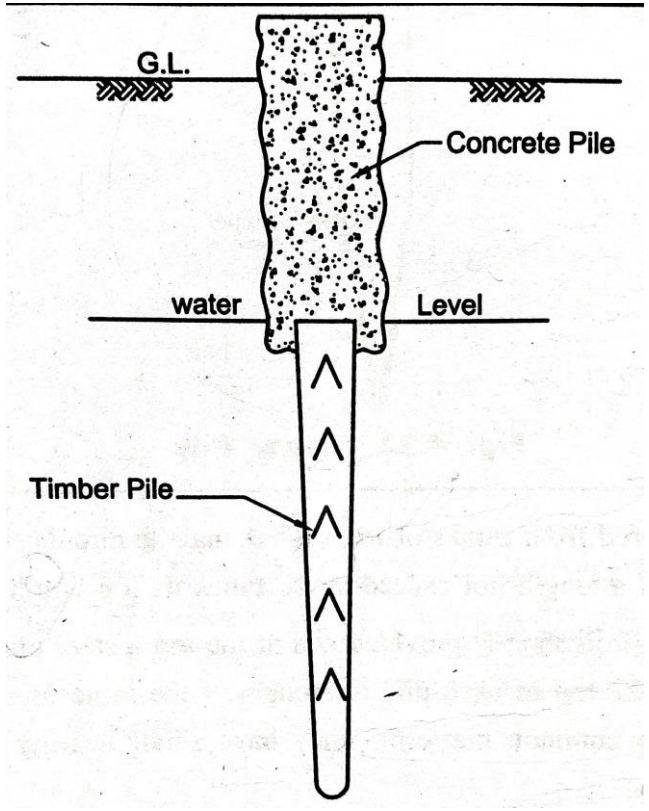
1. Where timber is available easily, these piles prove to be economical.
2. The length of timber piles can be adjusted either by cutting or lengthening without much extra cost.
3. These piles can be removed easily, if necessary.
4. Skilled supervision is not required in the construction of timber piles.
5. These piles do not require heavy equipment for driving.

- Disadvantages :

1. These piles deteriorate due to the action of soil or salty water or insects.
2. These piles can not take heavy loads.
3. These piles can not be driven into hard ground.
4. They are less durable.

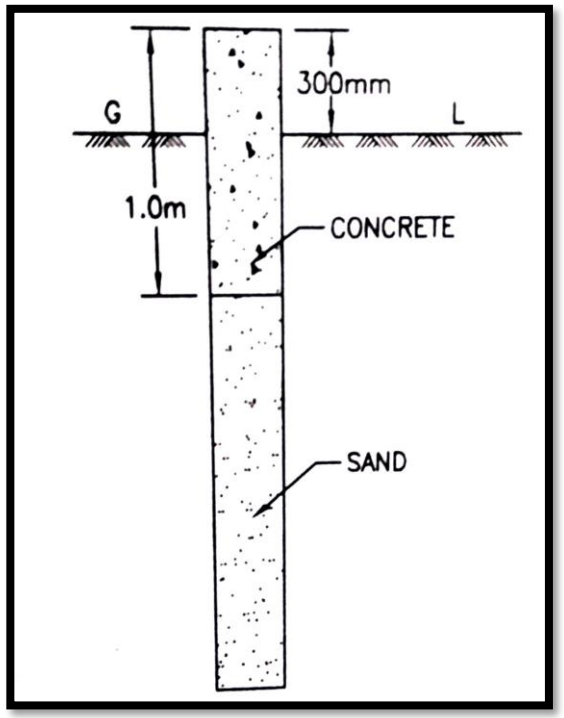
- **Composite Piles :**
- This is a type of construction in which piles of two different materials are drive one over the other, so as to enable them to act together to perform the function of a single pile.
- In this combination, advantage is taken of durability of concrete piles and the cheapness of timber piles. The timber pile is terminated just at the lowest level of ground water table.
- Advantages of composite piles :

1. They are economical.
2. They are easy to construct.
3. They are suitable for ground conditions in which other types of piles will be unsuitable.



Sand piles :

- These piles are formed by making holes in the ground and then filling them with sand. If sand is kept confined, it possesses great crushing strength and becomes incompressible.
- A bore hole of required diameter, usually 30 cm is formed either by driving a wooden pile or by an anger or by forcing a pipe with closed end.
- The hole is then filled with sand and it is well rammed. The sand to be used should be moist at the time of placing.
- The top of sand pile is filled with concrete to prevent the sand ejecting upwards due to lateral pressure.
- Sand piles are spaced at 2 to 3 m, usually under the columns of the structure. A load test should be carried out to determine bearing capacity of a sand pile. A properly constructed sand pile resting on a firm strata can take up a load of 100 tonne/m2 or more.
- The length of sand pile is kept about 12 times its diameter. The diameter of sand pile depandss upon the load acting on the pile.

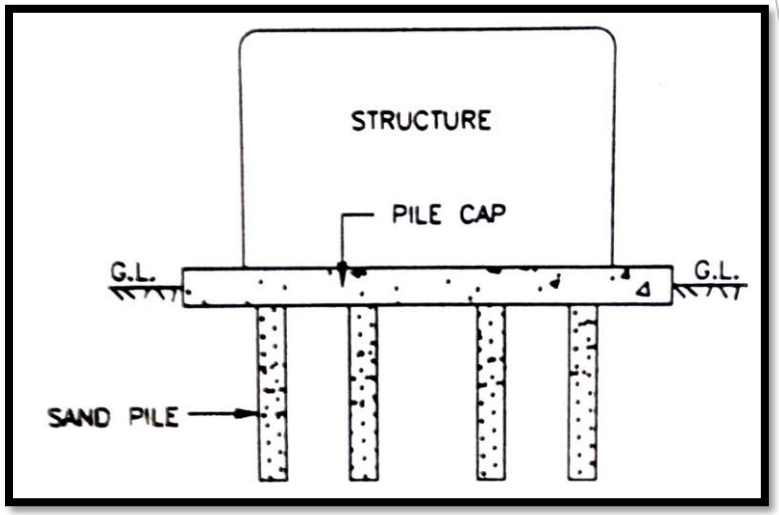


- **Advantages** :

1. These piles are economical for small buildings and for embankments of roads.
2. They are easy to construct.
3. It is possible to use gravel in place of sand. Such piles are known as gravel piles.
4. Sand piles can be used irrespective to any position of water table.

- **Disadvantages** :

1. Sand piles are not suitable for loose or wet soils.
2. Sand piles are not suitable where there is danger of scour.
3. Sand piles cannot be adopted in regions subjected to frequent earthquakes.



Sand pile group

FACTORS AFFECTING THE SELECTION OF TYPE OF PILES :

The following factors should be considered while selecting type of Pile :

1. Nature of Structure
2. Loading conditions
3. Availability of funds
4. Availability of materials and equipments
5. Type of soil and its properties
6. Ground water table
7. Self weight of Pile.
8. Durability of Pile.
9. Cost of pile
10. Maintenance Cost
11. Length of Pile required
12. Number of Piles required
13. Case study of adjacent buildings
14. Facilities available for Pile driving
15. Difficulties in Pile driving
16. Adaptability to varying lengths
17. Presence of acids and other materials in the soil that would injure the Pile.
18. Erosion of soil near the structure.

- Some of the factors are discussed below :

1. Nature of Structure :

- For the structures on land, the driven and cast in - place Piles are usually the cheapest for moderate loadings and unhampered site conditions.
- For the foundations of wharf - structures and jetties on sea shore, the driven Piles or driven and cast - in - place cased piles arae preferred.
- In case of Piling is to be done very near to some existing structure, open ended tube piles or H-pile may work out to be good choice.
- Piles used to support marine structures or structure above open water should be precast type.
- The Jacked piles are suitable for under-pinning existing structures.
- For very heavy structures, large diameter bored piles are the most economical type.

2. Ground conditions :

- If the subsoil consists of silt on alluvium for appreciable depth, the pile will act as a friction pile. Depending upon the load, suitable pile such as Vibro pile. Vibro expended pile or a tapered pile may be used in such conditions.
- In case the ground is very weak or loose and it is intended to use cast - in - situ Pile, casing will be required to prevent the inflow of soil into the pile hole. In adverse conditions, where the ground water flow is strong, pile with permanent casing should be used. Alternatively, Precast Piles may be used.
- In case the soil strata is comparatively firm uncased cast in - situ piles or precast pile may be selected.
- For reducing the length of pile in the firm strata, pedestal pile will be more effective.
- In situations where it is necessary that the pile should penetrate into rock for some depth, H-piles may work out to be a good selection.
- In case the soil is firm clay, drilled piles with or without enlarged base, may work out to be an economical choice. 3.

3. Durability :

- In situation where there is possibility of the soil being chemically aggressive, high quality precast concrete piles should be selected.
- Timber piles may work out to be economical if they are used for the foundation of timber trestles structures with moderate loads or if the piles are to be used for protecting concrete docks, etc.
- Timber piles are not suitable for marine conditions as they are likely to be affected by borers or insects.

4. Cost Consideration :

- While selecting a particular type of pile, the cost of pile, cost of driving, cost of maintenance of pile and availability of fund should given due consideration.

THANK YOU

COUTRESY. DR.R.P.RETHALIYA SIR