SURVEYING, STRUCTURES and STONE MASONRY

2 marks

What is Surveying?

Surveying is the art of determining the relative positions of points on above or beneath the surface of the earth, by means of measurements of distances, directions and elevations.

What are the two major functions of surveying?

1. Determination of relative horizontal and vertical positions for plotting maps.
2. Establishment of marks and lines to control constructions just like land boundaries, foundation location etc. from given maps and drawings.

What are the two primary divisions of surveying?

Geodetic surveying and plane surveying are the two primary divisions of Surveying

Distinguish plane surveying and geodetic surveying

Plane Surveying	Geodetic Surveying
Curvature of the earth is not taken in to consideration	In this curvature of earth is considered.
In plane Surveying, line joining any two points of triangle formed by any three points is considered as straight line and plane triangle are assumed to be plane angles.	In geodetic surveying line joining two points of triangle formed by three points is considered as curved line of spherical triangle and angles of triangle are considered as spherical angles.
This survey is done on smaller area less than 250km2	This survey is done on large area greater than 250 km2
Required accuracy is competitively low.	High accuracy is required
Simple methods and instruments can be used as the required accuracy is low.	Very refined methods and instruments are used.

What is plane surveying?

PLANE SURVEYING is a process of surveying in which the portion of the earth being surveyed is considered a plane. The term is used to designate survey work in which the distances or areas involved are small enough that the curvature of the earth can be disregarded without significant error.

What is geodetic surveying?

GEODETIC SURVEYING is a process of surveying in which the shape and size of the earth are considered. This type of survey is suited for large areas and long lines and is used to find the precise location of basic points needed for establishing control for other surveys. In geodetic surveys, the stations are normally long distances apart, and more precise instruments and surveying methods are required for this type of surveying than for plane surveying.

Classify Surveying based on the purpose?

On the basis of object of survey the classification can be as engineering survey, military survey, mines survey, geological survey and archeological survey.

Classify Surveying based on the instruments used?

Based on the instruments used, surveying may be classified as:

(*i*) Chain survey
(*ii*) Compass survey
(*iii*) Plane table survey
(*iv*) Theodolite survey
(*v*) Tacheometric survey
(*vi*) Modern survey using electronic distance meters and total station
(*vii*) Photographic and Aerial survey

Classify Surveying based on the methods employed?

On this basis surveying is classified as triangulation and traversing survey.

Classify Surveying based on the location?

On this basis survey may be classified as land survey, marine or hydraulic survey and astronomical survey.

Classify Surveying

Surveying may be classified on the following basis:

(*i*) Nature of the survey field
(*ii*) Object of survey
(*iii*) Instruments used and
(*iv*) The methods employed.

What are the Principles of Surveying?

There are two principles of surveying.

1. Working from whole to part

A set of primary control points are established with higher precision to prevent accumulation of errors and to localize minor errors within the frame work of the control points. Minor control points in between the primary control points are then established with less precision.

2. Location of a point by measurement from two control points

The relative position of a point can be fixed with reference to two other points by means of linear and angular measurements. This may be with sufficient number of linear and angular measurements.

What are the two different methods available for locating a point with reference to two known points?

Briefly explain chain surveying?

It is the system of surveying in which sides of the various triangles are measured directly in the field and no angular measurements are taken.
In this surveying, measuring chain and tape are used to take linear measurements. It is simple and quite useful in land surveying. Chain survey is conducted for measuring areas, demarcating the boundaries, dividing the land into plots etc

What are the instruments used in Chain Surveying?

The list of instruments required for chain surveying

1. Chain
2. Measuring tape
3. Ranging rods
4. Arrows
5. Pegs
6. Cross staff

What is cross-staff?

cross staffs used for setting perpendicular offsets. All cross staffs are having two perpendicular lines of sights. The cross staffs are mounted on stand. First line of sight is set along the chain line and without disturbing setting right angle line of sight is checked to locate the object.

What is ranging?

When a survey line is longer than a chain length, it is necessary to align intermediate points on chain line so that the measurements are along the line. The process of locating intermediate points on survey line is known as ranging.

What are the sources of errors in chain surveying

Errors in chaining may be classified as:
(*i*) Personal errors
Wrong reading, wrong recording, reading from wrong end of chain etc., are personal errors.
(*ii*) Compensating errors, and
Incorrect marking of the end of a chain.
Fractional part of chain may not be correct though total length is corrected.
Graduations in tape may not be exactly same throughout.
In the method of stepping while measuring sloping ground, plumbing may be crude.
(*iii*) Cumulating errors.
Bad ranging
Bad straightening
Erroneous length of chain
Temperature variation

Variation in applied pull
Non-horizontality
Sag in the chain,

What is magnetic meridian?
The magnetic north-south direction which is the reference direction is called magnetic meridian
What is true meridian?
The true north-south direction which is the reference direction is called true meridian
What is magnetic bearing?
The angle between the line and the magnetic meridian is called magnetic bearing.
What is true bearing?
The angle between the line and the true meridian is called true bearing.
What is dip?
The vertical angle between the horizontal and the direction shown by a perfectly balanced and freely suspended needle is known as the magnetic dip at that place. Its value is 0° at equator and 90° at magnetic poles.
What is magnetic declination?
The horizontal angle between magnetic meridian and true meridian is known as magnetic declination.
What are the two systems of representing bearing?
Whole circle bearing and reduced bearing
What is Whole Circle Bearing?
Whole circle bearing is the angle of the line measured always clockwise with respect to the meridian.
What is reduced or quadrantal bearing?
The reduced bearings are measured from north or south direction towards east or west. Hence, angles are from 0 to 90°. This system of measuring bearings is used in Surveyor's compass and it is also known as Quadrantal Bearing (**QB**). The bearing measured is designated with letter N or S in the beginning to indicate whether it is from north or south. The letter E or W written after the angle indicates whether the bearing read is towards east or west, respectively.

Convert the following WCB into reduced bearing: 35° , 235° & 335°
N35°E S45°W N25°W
Convert the following reduced bearing into WCB: N35°E , N35°W & S35°E
35° 325° 145°
What is local attraction in a compass surveying?
A freely suspended and properly balanced magnetic needle is expected to show magnetic meridian. However, local objects like electric wires and objects of steel attract magnetic needle towards themselves. Thus, needle is forced to show slightly different direction. This disturbance is called local attraction.
What are the difference between surveyor compass and prismatic compass?

Sr. No.	*Prismatic Compass*	*Surveyors Compass*
1.	Graduation circle is fixed to broad type needle. Hence, it will not rotate with the line of sight.	Graduation circle is fixed to the box. Hence, it rotates with the line of sight.
2.	There is a prism at viewing end.	At viewing end there is no prism. There is only a slit.
3.	Sighting and reading can be done simultaneously.	Sighting and viewing cannot be done simultaneously.
4.	The magnetic needle do not act as an index.	Magnetic needle acts as index while reading.
5.	The graduations are in whole circle bearing.	The graduations are in quadrantal system.
6.	Graduations are marked inverted since its reflection is read through prism.	Graduations are marked directly. They are not inverted.
7.	The reading is taken through a prism.	The reading is taken by directly viewing from top glass.
8.	Tripod may or may not be used. It can be held on a stretched hand also.	Tripod is essential for using it.

How are loads classified?
Dead load, live load, wind load and seismic load.
What is the formula for arriving wind pressure?
$P = 0.6 (k1 \times k2 \times k3 \times V)^2$
Where V is the wind velocity, k1 is impotance factor, k2 is shape, size and height factor, k3 is topography factor.
What is meant by ultimate bearing capacity of the soil?
Ultimate bearing capacity of the soil is the strength limit of soil at which soil crushes with excessive settlement.

What is meant by safe bearing capacity of the soil?
Safe bearing capacity of the soil is the ultimate bearing strength of soil divided by a factor of safety.

What are the functions of foundations?
The main function of foundation is to support and spread the load over a wider area of soil beneath the structures so that the load intensity felt by soil is less than its safe bearing capacity. The other functions of foundation are –
1. To provide even surface for the structure to rest.
2. To give lateral stability to the structure.
3. To ensure safety against undermining and protection against soil movements.

What is shallow foundation? Give examples
If the depth of the foundation is less than the width of the foundation, it is called shallow foundation.
Wall footing, column footing and mat foundations are the examples of shallow foundation.
What is deep foundation? Give examples
If the depth of the foundation is more than the width of the foundation, it is called deep foundation.
Pile foundation, pier foundation and well foundations are examples deep foundation.
What is wall footing?
If the footing under a wall for entire length, it is called wall footing.
When is combined footing is employed?
If the columns are spaced closer enough, footings may overlap. The a common footing supporting the two colums is provided. Such a footing is called combined footing.
What is raft foundation and when is it adopted?
What are the situations under which pile foundation is employed?
What is a pile?
Distinguish between end bearing pile and friction pile?
What are the types of piles?
Sketch the caisson and indicate when such a method of foundation is adopted.
What are the primary functions of walls?
What are the types of walls?
What are the factors that decide the strength of walls?
What are the advantages and disadvantages of stone masonry?
What are the uses of stone masonry?
What are the principles of stone masonry construction?
Explain the following 1. Rubble masonry, 2. Coursed rubble masonry and 3. Ashlar Masonry

10 marks
Explain geodetic surveying and plane surveying with neat sketches.

GEODETIC SURVEYING is a process of surveying in which the shape and size of the earth are considered. This type of survey is suited for large areas and long lines and is used to find the precise location of basic points needed for establishing control for other surveys. In geodetic surveys, the stations are normally long distances apart, and more precise instruments and surveying methods are required for this type of surveying than for plane surveying.

The shape of the earth is thought of as a spheroid, although in a technical sense, it is not really a spheroid. Therefore, distances measured on or near the surface of the earth are not along straight lines or planes, but on a curved surface. Hence, in the computation of distances in geodetic surveys, allowances are made for the earth's minor and major diameters from which a spheroid of reference is developed. The position of each geodetic station is related to this spheroid. The positions are expressed as latitudes (angles north or south of the Equator) and longitudes (angles east or west of a prime meridian) or as northings and castings on a rectangular grid.

PLANE SURVEYING is a process of surveying in which the portion of the earth being surveyed is considered a plane. This survey is good enough for small-scale surveys in limited areas, the curvature of the earth has no effect on the results, thus the computations and results can be referenced to a plane or flat surface.
Plane surveys are used for the determination of legal boundaries, for engineering surveys for the construction of buildings and roads and for small-scale topographic surveys.

Explain principle of Chain surveying and explain technical terms involved with neat sketches.

Chain surveying

Chain surveying is the simplest method of surveying in which only linear measurements are made and no angular measurements are taken. The area to be surveyed is divided into a number of triangles, and the sides of the triangles are directly measured in the field. Since a triangle is a simple plane geometrical figure, it can be plotted from the measured lengths of its sides alone.
In chain surveying, a network of triangles is preferred. Preferably, all the sides of a triangle should be nearly equal having each angle nearly 60° to ensure minimum distortion due to errors in measurements. Generally, such an ideal condition is practically not always possible due to configuration of the terrain and, therefore, attempt should be made to have well-conditioned triangles in which no angle is smaller than 30° and no angle is greater than 120°. The arrangement of triangles to be adopted in the field, depends on the shape, topography, and the natural or artificial obstacles met with.
Chain surveying is recommended where:
• The ground surface is more or less level.
• A small area is to be surveyed.
• A small-scale map is to be prepared
• The formation of well-conditioned triangle is easy.

Technical Terms

Survey Stations

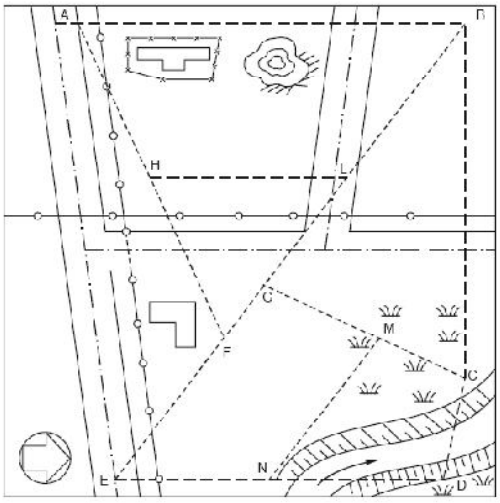
These are important point fixed on ground indicating the starting point and the end point of the survey line. These are also the basic control points of the survey. There can be two types of survey stations.

Main Stations

Main stations are control points at the ends of the chain lines commanding the boundaries of survey.

Subsidiary or Tie Stations

These are stations selected on the main survey lines for running auxiliary lines drawn to locate, measure and plot interior details. (See fig. below)



Main Survey Stations : A, B, C, D, E
Main Diagonal (Base Line) : BE
Subsidiary or Tie Lines : AF, GC
Subsidiary Stations : F, G, H, L
Main Survey Lines : AB, BC, CD, DE, EA
Check Lines : HL, MN

The survey stations are suitably selected with care so that at least main survey stations are mutually visible and survey lines run through as flat ground as possible and are as close to the boundaries as possible. The main survey lines should form well conditioned triangles. These should be as few as possible and suitably selected so as to avoid obstacles in chaining and ranging.

Survey Lines

The lines joining survey stations are the survey lines. The survey lines between main stations are thus called main survey lines or chain lines. The longest of the main survey line is normally called *Base Line* (Line *BE* in Figure) running primarily through the middle of the area to be surveyed. The framework of triangles shall have one or two base lines since the entire survey is built around base line. It shall be measured with higher care and accuracy.

The survey line joining the subsidiary or tie stations on main line is termed *Tie Line*. These are run to account for interior details on the area, e.g. buildings etc.

Apart from main and tie lines, other survey lines are also selected for cross checking the accuracy of survey measurements. Such lines are known as *check lines* or *proof lines*. It is preferable to have at least one check line in each triangle of the framework.

Offsets

The details on ground such as fences, buildings and towers, etc. are to be located with reference to main chain lines by means of lateral measurements. These lateral measurements with reference to the chain line are referred to as offsets. The two types of offsets are exhibited in Figure. These are perpendicular offset PP_1 and the oblique offset *PQ*. *Perpendicular offsets* are the lateral distances taken at right angles (normal) to the chain line. If the inclination of offset line to chain line is anything other than 90^o, the offsets are termed *oblique offsets*.

Ranging

In general, the length of the survey line is many times the chain length. Hence, along the survey lines intermediate points are required to be located to ensure that the survey lines are located and measured in a straight line. The distance can be directly measured by chain and or tape only if its length is more than that of a survey line. In all other cases, intermediate points help in pulling the chain/tape along the proper survey line on the required straight line. This process of locating intermediate points along a straight line is called ranging.

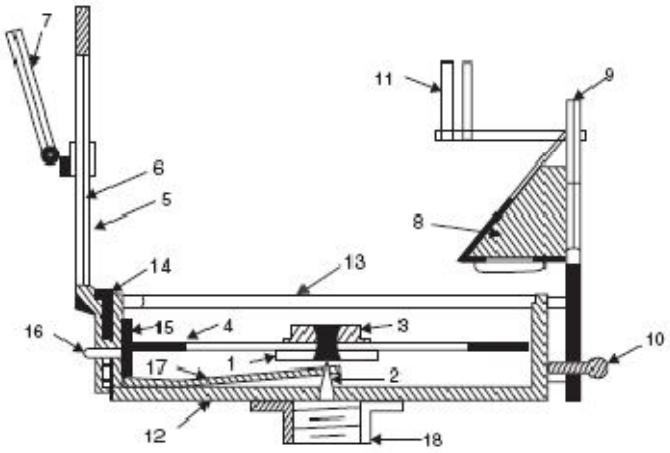
If the end survey stations on the survey line are inter-visible, direct ranging by eyes or line rangers is possible. In case of optical obstructions occurring between end stations, indirect ranging or reciprocal ranging is adopted.

Explain a prismatic compass including description of each part with a neat sketch with labeling the parts.

Figure shows the cross-section of a typical prismatic.

A magnetic needle of broad form (1) is balanced on a hard and pointed steel pivot (2). The top of the pointed pivot is protected with agate cap (3).

An aluminium graduated disk (4) is fixed to the top of the needle. The graduations are from zero to 360° in clockwise direction when read from top. The direction of north is treated as zero degrees, east as 90°, south as 180° and west as 270°. However, while taking the readings observations are at the other end of line of sight. Hence, the readings are shifted by 180° and graduations are marked. The graduations are marked inverted because they are read through a prism.



1. Needle
2. Pivot
3. Agate cap
4. Graduated disc
5. Slit metal frame
6. Horse hair
7. Mirror
8. Reflecting prism with cap
9. Eye vane
10. Focussing stud
11. Dark sunglasses
12. Box
13. Glass cover
14. Lifting pin
15. Light spring
16. Brake pin or knob
17. Lifting lever
18. Support to fit on tripod

The line of sight consists of object unit and the reading unit. Object unit consists of a slit metal frame (5) hinged to the box. In the centre the slit is provided with a horse hair or a fine wire or thread (6). The metal frame is provided with a hinged mirror (7), which can be placed upward or downward on the frame. It can be slided along the frame. The mirror can be adjusted to view objects too high or too low from the position of compass. Reading unit is provided at diametrically opposite edge. It consists of a prism (8) with a sighting eye vane (9). The prism magnifies the readings on the graduation disk just below it. For focussing, the prism is lowered or raised on the frame carrying it and then fixed with the stud (10). Dark sunglasses (11) provided near the line of sight can be interposed if the object to be sighted is bright (*e.g.*, sun).

The bottom of the box (12) which is about 85 mm to 110 mm supports the pivot of needle firmly at its centre. The object vane and the prism are supported on the sides of the box. The box is provided with a glass (13) lid which protects the graduation disc at the same time permit the direct reading from the top. When the object vane is folded on the glass top it presses a lifting pin (14) which activates lifting lever (15) lifts the needle off the pivot. Thus, it prevents undue wear of pivot point. While taking reading, if graduation disc vibrates, it can be dampened with a spring (16). For pressing spring a knob or brake pin (17) is provided on the box. When not in use prism can be folded over the edge of the box. The box is provided with a lid to close it when the compass is not in use. The box is provided with a socket to fit it on the top of a tripod.

Explain each type of shallow foundation with neat sketches.

If the depth of a foundation is less than the width of the foundation. it is called a shallow foundation. Footings (wall footings, column footings), grillage foundation and raft (mat) foundations are shallow foundations.

Footings:

Footing are so named because the entire weight of a building or structure rests on them. These are constructed usually in stone in cement mortar or concrete under the base of a wall or column. The footing foundations are further classified into strip (wall) footings, isolated (spread or pad) footings, combined footings, strap (cantilever) footings. The footings also are provided in steps.

Wall footings or strip footings:

A strip footing is provided for a load-bearing wall. A strip footing is also provided for a row of columns which are so closely spaced that their spread footings overlap or nearly touch each other. In such a case, it is more economical to provide a strip footing than to provide a number of spread footings in one line. A strip footing is also known as continuous footing.

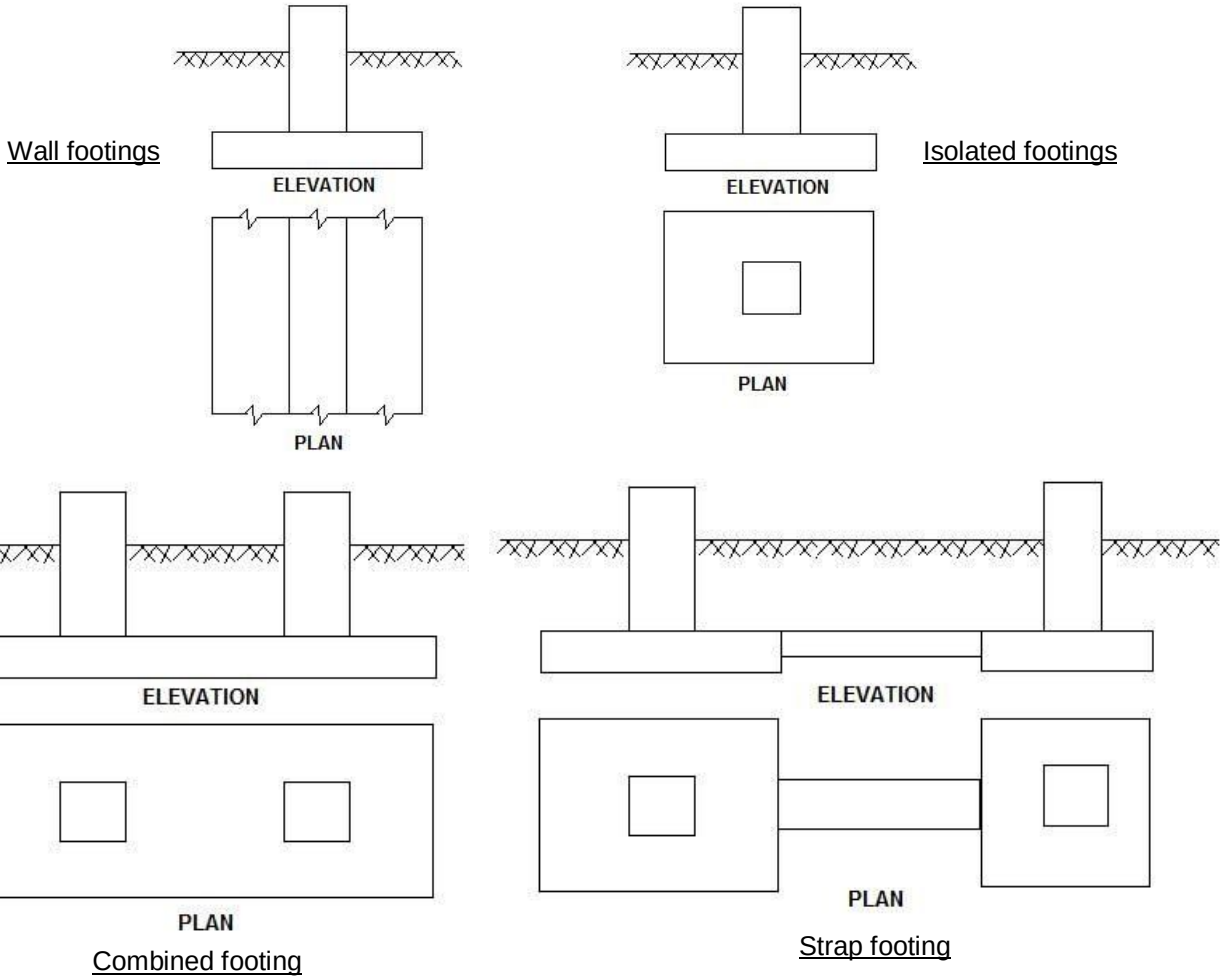
Spread or Isolated Footing:

A spread footing (or isolated or pad) footing is provided to support an individual column. A spread footing is circular, square or rectangular slab of uniform thickness. Sometimes, it is stepped or haunched to spread the load over a large area.

Combined Footing:

A combined footing supports two columns. It is used when the two columns are so close to each other that their individual footings would overlap. A combined footing is also provided when the property line is so close to one column that a spread footing would be eccentrically loaded when kept entirely within the property line. By combining it with that of an interior column, the load is evenly distributed. A combined footing may be rectangular or trapezoidal in plan.

Strap footing:
A strap footing consists of two isolated footings connected with a structural strap or a lever. The strap connects the two footings such that they behave as one unit. The strap is designed as a rigid beam. The individual footings are so designed that their combined line of action passes through the resultant of the total load. a strap footing is more economical than a combined footing when the allowable soil pressure is relatively high and the distance between the columns is large.



Mat or Raft Foundations:
A mat or raft foundation is a large slab supporting a number of columns and walls under the entire structure or a large part of the structure. A mat is required when the allowable soil pressure is low or where the columns and walls are so close that individual footings would overlap or nearly touch each other. Mat foundations are useful in reducing the differential settlements on non-homogeneous soils or where there is a large variation in the loads on individual columns.

Explain each type of deep foundation with neat sketches.

Types of deep foundation:

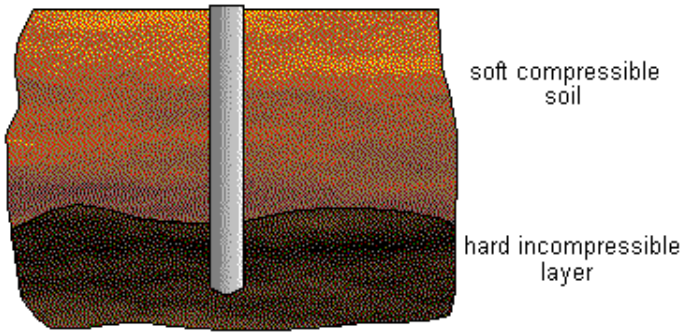
- Pile foundation
- Pier foundation
- Well foundation

Pile Foundation: Piles are relatively long, slender members that transmit foundation loads through soil strata of low bearing capacity to deeper soil or rock strata having a high bearing capacity.

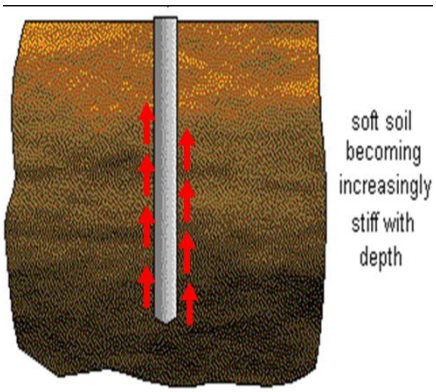
Types of Pile Foundation:

- End bearing pile
- Friction pile
- Compaction pile

End bearing pile: End bearing piles are those which terminate in hard, relatively impenetrable material such as rock or very dense sand and gravel. They derive most of their carrying capacity from the resistance of the stratum at the toe of the pile.



Friction pile: Friction piles obtain a greater part of their carrying capacity by skin friction or adhesion. This tends to occur when piles do not reach an impenetrable stratum but are driven for some distance into a penetrable soil.



Combined end bearing and friction pile : The carrying capacity is derived partly from end bearing and partly from skin friction between the embedded surface of the soil and the surrounding soil.

Pier Foundation : Consists of cylindrical column of large dia. to support and transfer load to the firm strata.

Well or caisson Foundation : Box like structure, circular or rectangular, sunk from the surface of either land or water to the desired depth.

Explain general principles of stone masonry and explain the various types of stone masonry with neat sketches.

General principles of stone masonry construction

1. Stones used for construction should be strong and durable.
2. Stones should be placed in such a way that the load should act perpendicular to the bedding plane.
3. Stones may be dressed (chiseled) to the required shape and size.
4. Under the beams and trusses flat stones should be used for an even distribution of the load.
5. The binding mortar should be of good quality.
6. The construction work should be raised uniformly.
7. The masonry should be cured for a period of two weeks.

Types of stone masonry:

Stone masonry is classified as follows:

Rubble masonry

Random rubble masonry (Coursed and Uncoursed)
Squared rubble masonry (Coursed and Uncoursed)

Dry rubble masonry
Polygonal rubble masonry
Flint rubble masonry

Ashlar masonry

Ashlar fine masonry
Random course ashlar masonry
Rough tooled ashlar masonry
Rock or quarry faced ashlar masonry
Chamfered ashlar masonry
Ashlar facing
Block in course masonry

Random Rubble Masonry, coursed rubble masonry and Ashlar Masonry are explained as follows:

Random Rubble Masonry:

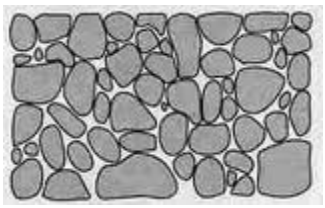
A rubble stone masonry wall is made up of stones as they are collected or as the stone is broken and removed from the quarry. These stones have rounded in natural faces or angular broken pieces. Stones may be dry packed sometimes. Generally, stones in this type of masonry construction are joined with mud mortor ot lime mortar with joint thickness of about 12mm. However, due to the large gap between stone, large quantity of mortar required to fill the gaps.

Coursed rubble masonry:

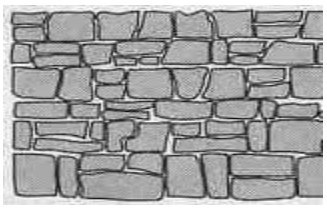
Coursed rubble masonry walls are constructed of quarries stones which are found in layers. It has a fairly uniform thickness. Generally, the stones are hammered as dressed. The stones are arranged in such a manner so that the vertical joints of two adjacent courses do not coincide. Through-stones are used at every 2m distance in each course.

Ashlar masonry:

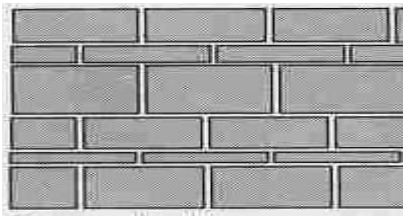
This is constructed with finely dressed stones with uniform and thin joints. By arranging stones in various patterns, different types of appearances can be obtained.Mortar required for this type masonry is very much less compared to other type of stone masonry.



Random Rubble Masonry



Coursed Rubble Masonry



Coursed Ashlar Masonry