UNIT I
SURVEYING AND CIVIL ENGINEERING MATERIALS

Surveying: Objects – types – classification – principles – measurements of distances – angles –leveling – determination of areas – illustrative examples.
Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel sections

1.1Surveying

Surveying is the art of determining the relative position of points on above or beneath the surface of the earth by means of direct or indirect measurements of distances, direction and elevation.

1.1.1object of surveying

The primary object of a survey is the preparation of a plan map. the results of surveys when plotted and drawn on paper, constitute a plan. Therefore a plan is a representation of the ground and the objects upon it some scale as projected on a horizontal plane. If the scale is large, then it is called a plan. if the scale is small, then it is called a map. Example: a plan of a building, a map of India.

Purposes of survey

Following are some of the purposes of survey:

- ✓ To prepare archeological maps, geological maps, military maps etc.
- ✓ To establish boundary points of properties with reference to the available records and demarcate ownership.
- ✓ To measure quantities in cutting or in embankments using contour maps.
- ✓ To lay out th alignment of engineering structures such as roads, railways etc.
- ✓ To plot profile of a structure(eg. irrigation canal) for ascertaining the carrying capacity of canal, capacity of reservoir etc
- ✓ To determine the relative position of desired points with reference to a known bench mark (eg. position of hill stations with reference to mean sea level).
- ✓ To measure distance between various points (eg. distance between two cities).

1.1.2 Primary divisions of surveying

Survey may be primarily divided into following two divisions.

- ✓ Plane surveying: in plane surveying, the mean surface of the earth is considered as a plane and the spheroid shape is neglected as the surveys extend over small areas.
- ✓ Geodetic surveying: in geodetic surveying, the curvature of earth is taken into account and all lying in the surface are curved lines and the triangles are spherical triangles, since large distances and areas are covered.

1.1.3 Principle of surveying

All surveys are based on two fundamental principles they are:

- ✓ Working from whole to part: in order to prevent accumulation of errors and to localize the minor errors, a set of primary central points are established first with higher precision in and around the area to be surveyed. Later on, in between those primary control points, inner control points are established with less precision method. The details are surveyed with the help of these inner control points, adopting any one method of surveying. This principles is known as working from whole to part.
- ✓ Fixing a point with reference to two fixed points: suppose points 'A'and'B'are known on the distance between them is measured

- ✓ . Let it be required to locate or mark a point 'C'. The relative position of the point C is located with reference to the two fixed points A and B by one of the following methods.

  a) Liner measurement
  b) Angular measurement
  c) Both liner and angular measurements

1.1.4 Classification of surveying:

According to the instruments used, the surveying is classifieds follows:

- ✓ chain surveying
- ✓ compass surveying
- ✓ theodolite surveying
- ✓ plane table surveying
- ✓ tachometric surveying etc.

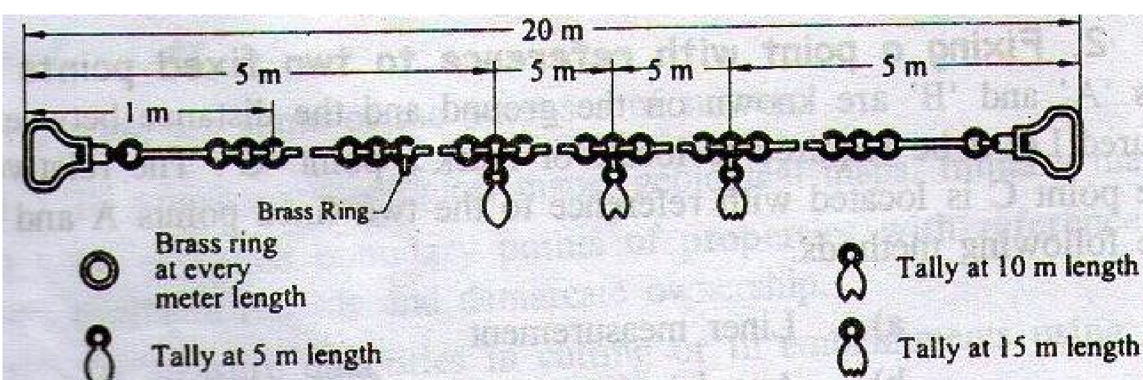
1.1.4.1 Instruments used for chain surveying:

The various instruments used in chain surveying are as follows.

- ✓ chain
- ✓ arrows
- ✓ pegs
- ✓ ranging rods
- ✓ offset rods
- ✓ plumb bob

1. Chain:

Chains are used to measure horizontal distances. Chains are formed of straight links of galvanized mild steel wire called links. The ends of each link are bent into a loop hand connected together by means of three oval rings which afford flexibility to the chain.



20 METER CHAIN

The chain s made of mind steel. The ends of the chin are provided with brass handles for dragging the chain on the ground. the outside of the handle is the zero point or the end point of the chain and the length of the chain measured from the outside of one handle to the outside of the other. The length of a link is the distance between the centers of the two consecutive middle rings.

The end links include the handles. Metallic tags are indicators of the chain to facilitate quick reading of fraction of a chain in surveying measurements. Metric survey chains are available in lengths of 20m and 30m. The 20m chain contains 100 links whereas 30m. Chain contains 150 links. One link of both the type of chain measure 20cm.

2. Arrows:
Arrows or making pins are made of tempered steel wire 4mm in diameter and generally 10 arrows are supplied with a chain. An arrow is inserted into the ground after the chain length is measured on the ground. Usually the length of an arrow is 40cm and one end of it is made sharp and the other end is bent into a circle for facility of carrying.

3. Pegs:
Wooden pegs are used to mark the positions of the stations terminal points of a survey line. They are made of hard timber, generally 2.5cm or 3 cm square and 15cm long, tapered at the end.

4. Ranging Rods
The ranging rods are used for making the positions of stations and for ranging the lines. They are made of ell seasoned straight grained timber teak. They circular in cross section of 3cm diameter and have a length of either 2 or 3cm, lengh being more common. They are shod at the bottom with a heavy iron points. In order to make them visible at a distance, they are pained alternatively black and white or red and white.

5. Offset
Offset rod is similar to that of ranging rod. They are should with pointed iron shoe at one end, ad provided with a notch or a hook at the other for pulling or pushing the chain through a hedges or other obstructions.

6. Plumb Bob
While chaining along sloping ground, a plump is required to transfer the points to the ground. It is also used for accurate centering of the theodolite compass, plane table etc over a station mark and for testing the vertically of ranging poles

7. Cross staff
This is the instrument used for setting out right angles to a chain line. It consists of either a frame or box with two pairs of vertical slits and is mounted on a pole shod for fixing in the ground

- ✓ Open cross staff
- ✓ French cross staff
- ✓ Adjustable cross staff

1.1.4.2 Principle of Chain Surveying
The rectangle is the simplest fig that can be plotted from the lengths of its sided. Based on this, the principle of chain surveying is to divide the area to be surveyed into a network of connected triangles. Hence chain surveying is some times called chain triangulation. The exact arrangement of triangles to be adopted depends upon the shape and configuration of the ground and obstacles met with. When it contains no angle smaller than 30degree greater than 120 degree.

1.1.4.3Advantages and Disadvantages of chain surveying

Advantages:

- ✓ Chain surveying is suitable for fairly level ground
- ✓ It does not require costly equipments
- ✓ It is used for preparing plans of smaller area
- ✓ It is simple

Disadvantages

- ✓ It is cannot used for large areas
- ✓ It is not always accurate

1.1.5Calculation of Areas from offsets to a Base line

The area may be calculated by the rule:

- ✓ Mid-ordinate Rule
- ✓ Average ordinate Rule
- ✓ Trapezoidal rule
- ✓ Simpson's Rule

1.Mid-ordinate rule:

Area = (O1+O2+……….+on)d

O1, O2 = the ordinates at the mid points of each division

n = number of divisions

L = Length of base line= nd

d = Distance of each division

2.Average ordinate Rule

Area = ((O1+O2+……On)/(n+1))L

O1, O2….= Ordinates at the end of each division

3. Trapezoidal Rule

Area= (((O0+On)/2)+(O0+O2+……On-1))d

4. Simpson's Rule

Area = ((d/3) x ((O0+On+4(O1+O3+On-1)+2(O2+O4+….+On-2))

Example: 1

The following perpendicular offsets were taken at 10 meter intervals from a survey line to an irregular boundary line.

3.15m, 4.3m, 8.2m, 5.6m, 6.85m, 7.6m, 4.2m, 5.6m, 4.3m

Calculate the area enclosed between the survey line, the irregular boundary line, and first and last offsets, by the application of

a) Average ordinate rule
b) Trapezoidal rule
c) Simpson's rule

Average
d = the interval between the offset = 10 m
n = number of divisions = 8
n+1 = number of ordinates = 8+1 =9
L= Length of the base line = 8 x 10 = 80m

a) **Average ordinate rule**

Area = ((O1+O2+……On)/(n+1))L
O1, O2….= Ordinates at the end of each division

Area = ((3.15 + 4.3 + 8.2+ 5.6 + 6.85 + 7.6 + 4.2 + 5.6 + 4.3)/(8+1)) x 80
=442.66m2

b) **Trapezoidal rule**

Area= (((O0+On)/2)+(O0+O2+……On-1))d

Area = (3.725 + 42.35) x10 =460.75m2

c) **Simpson's rule**

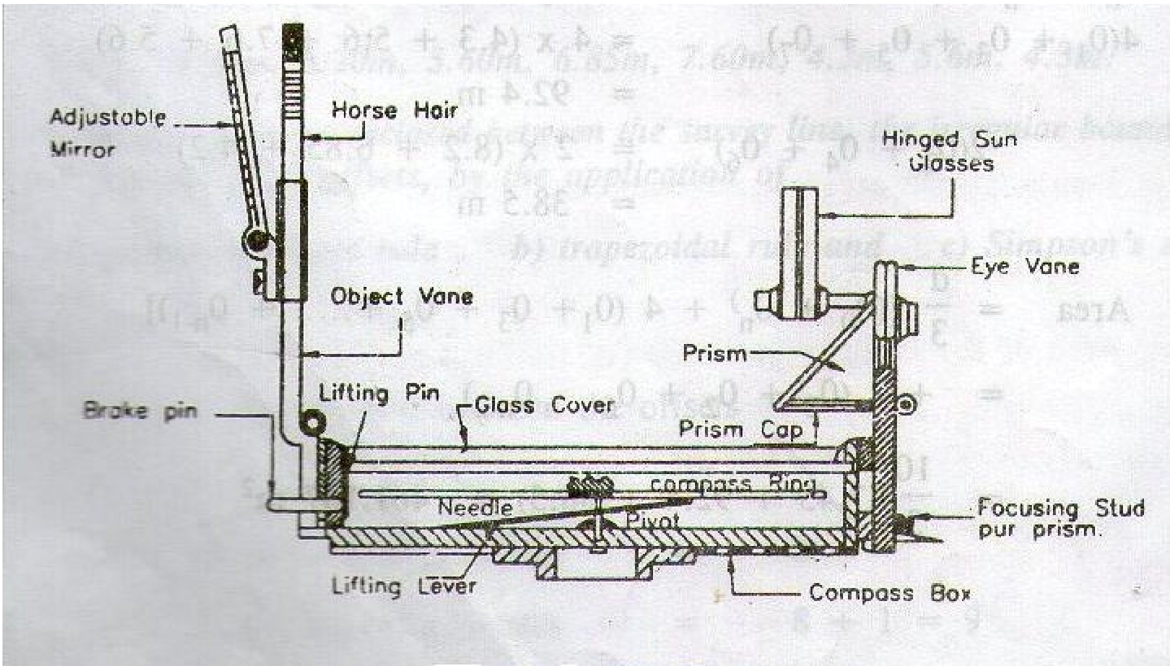
Area= 10/3(7.45 +92.4 +38.5) = 461.167m2

1.1.6 Compass survey

When the area to be surveyed is large, chain and compass surveying is preferable. A compass is used to measure the magnetic bearing of a line. There are two forms of compass that are commonly used. 1. The prismatic compass and 2. The surveyors' compass.

1. The prismatic compass: It is circular in shape and its diameter varies from 85 mm to 110 mm. A pivot is provided at the centre of the box. It carries a magnetic needle. The needle is attached to an aluminum ring which is graduated to 1/2. A light spring break is attached to the inside of the base to damp the oscillations of the needle and bring it to rest before taking a reading.

A reflecting prism facilitates reading of the angles and is protected from moisture and dust etc by a prism cap. The prism base and vertical facts are made convex which magnifies the readings. the object vane is located diametrically opposite to the prism. It is hinged to the side of the box and carries a horse hair. A title reflecting mirror is provided on the side of the object vane to enable bearing of very high or low objects to be taken. A metal cover is provided to enclose the compass and the object vane.



PRISMATIC COMPASS.

2. Surveyor's compass: Surveyor's compass resembles the prismatic compass but with a slight difference. The graduated card is attached to the box and North 90 at south and at East and West interchanged

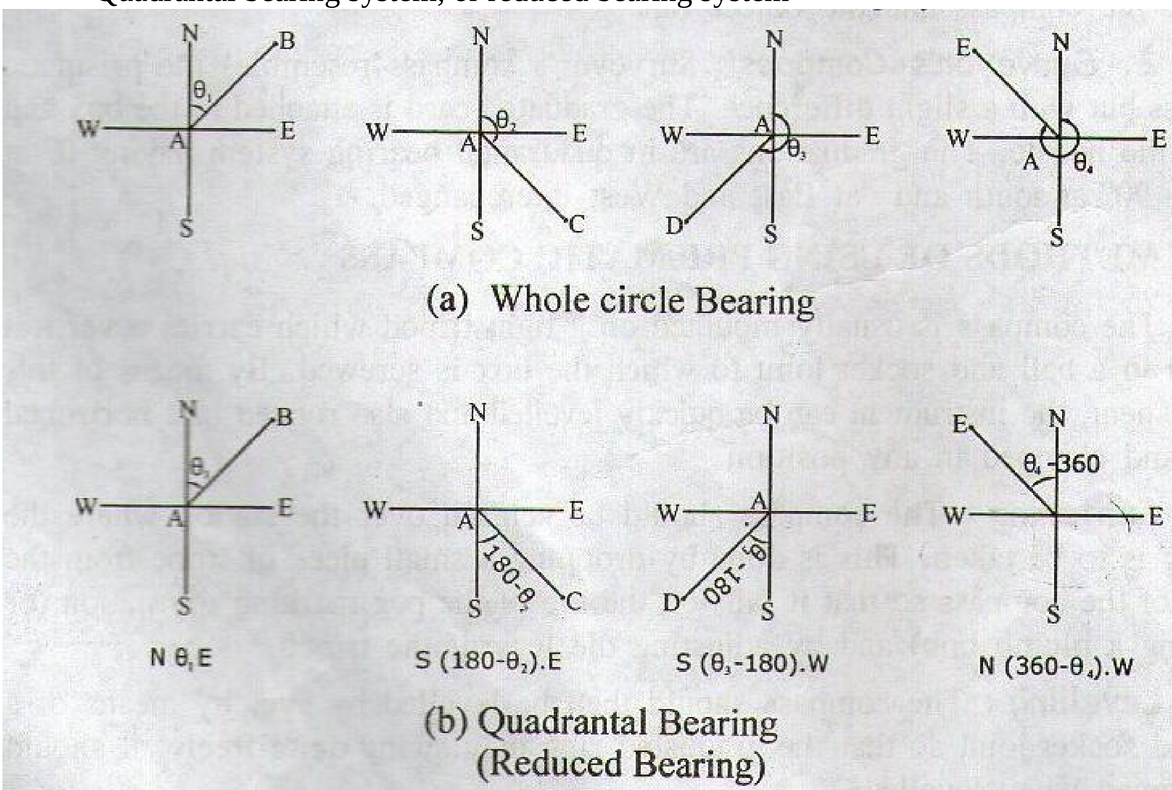
1.1.6.1 Methods of using prismatic compass

The compass is usually mounted on a light tripod which carries a vertical spindle in a ball and socket joint which the box is screwed. By means of this arrangement, the instrument can be quickly leveled and also rotated in a horizontal plane and clamped in any position.
Centering: The compass should be centered over the station where the bearing is to be taken. This is done by dropping a small piece of stone from the centre of the compass so that it falls on the top of the peg marking the station (or by using plumb bob) and by adjusting the legs of the tripod.
Leveling : The compass should then be leveled by eye, by means of a ball and socket joint so that the graduated ring may swing quite freely. It should be clamped when leveled.
Observing Bearing: A ranging rod is kept at the next station.
The compass is turned until the ranging rod at the station is bisected by the hair when looked through the slit above the prism.
When the needle comes to rest, by pressing the knob if necessary, the reading is noted at which the hair line appears to out the image of the graduated ring. The sighting og the ranging rod and the reading is done simultaneously. The reading gives the bearing of the line.
1.1.6.2 bearing of line:
The bearing of a line is the horizontal angle made by the line with a selected reference line called the meridian. There are two types of bearings.
i) Magnetic Bearing: The direction indicated by a freely supported magnetic needle unaffected by local attractive forces, is called the magnetic meridian. The angle between any line and magnetic meridian is called magnetic bearing or simply bearing.

ii) The Bearing: The line joining the geographical north and south poles is known as the true meridian or geographical meridian. The angle between any line and the true meridian is called true bearing of azimuth.

1.1.6.3DESIGNATION OF BEARING

- ✓ The whole circle bearing system
- ✓ Quadrantal bearing system, or reduced bearing system



Whole circle Bearing and Reduced Bearing

- ✓ **The whole circle bearing system:**

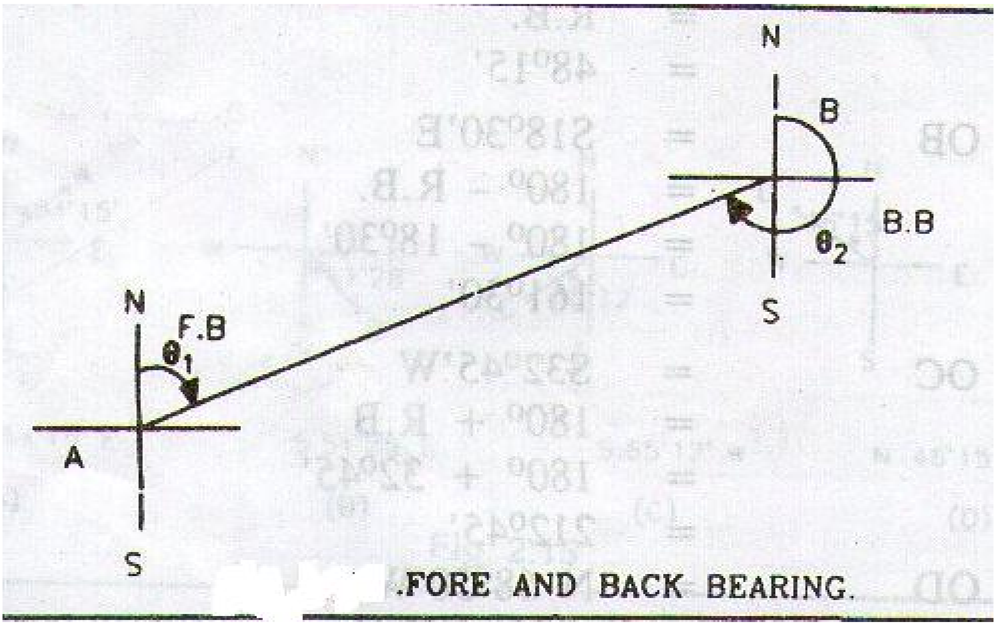
In this system the bearing of a line is measured with north in clockwise direction. The value of the bearing thus varies from 0o to 360o.

- ✓ **Quadrantal bearing system**

In this system the bearing of a line measured from either the north or the south, clockwise or counter clockwise whichever is nearer the line, towards the east or west

1.1.6.4Fore bearing and back bearing

In compass surveying, two bearings are observed for each line, one from each end of the line. The bearing of a line in the direction of the progress of survey is called fore bearing while the bearing measured in the opposite direction is known as back bearing. For e.g. the bearing of line AB taken from the point A is the fore bearing of ine AB and the bearing from point B is back bearing of the line AB.



.FORE AND BACK BEARING.

1.1.7 Theodolite survey

The theodolite is the most precise instrument used for measurement of horizontal and vertical angles. It can also be used for various surveying operations such as establishing grades, setting out curves, extending survey lines, determining differences in elevation etc.
Two categories classified:

- ✓ Transit theodolite
- ✓ Non-transit thedolite

Essential parts of a transit theodolite

Telescope:
A thedolite is provided with a telescope to sight the distant objects clearly. It is mounted on a spindle known as horizontal axis
Two spindles:
There are two spindles with axes one inside the other. The outer axis is hallowed and its interior is ground conical to fit the central vertical axis which is a solid and conical.
Lower plate:
The outer axis is attached to the lower plate also called the scale plate, having its edge beveled. The edge is silvered and graduated form Oo to 360o in the clockwise direction. The lower plate is provided with a clamped tangent screw or the slow motion screw by means of which it can be fixed at any desired position
Upper plate:
The upper plate also called the vernier plate is attached to the inner axis. A clamp and a tangent or slow motion screw are provided for the purpose of accurately fixing the vernier plate to the scale plate. When both plates are clamped together and the lower clamp or loosened, the instrument can be rotated about its outer axis; while if lower plate be clamped and the vernier plate be loosened, the instrument can be rotated about the inner axis. Before either of the tangent screw is turned, the corresponding clamp must be tightened.
Level Tubes:
Two spirit levels called placed at right angles to each other are fixed on the upper surface of the venires plate for leveling in the instrument.

Vertical circle:
The vertical circle and graduated and is attached to the horizontal axis of the telescope and thus it rotates with the telescope. The circle is graduated either continuous from Oo to 90o. By means of vertical clamp and tangential screw, the telescope can be set accurately at any position in vertical plane.

1.1.8 Levelling

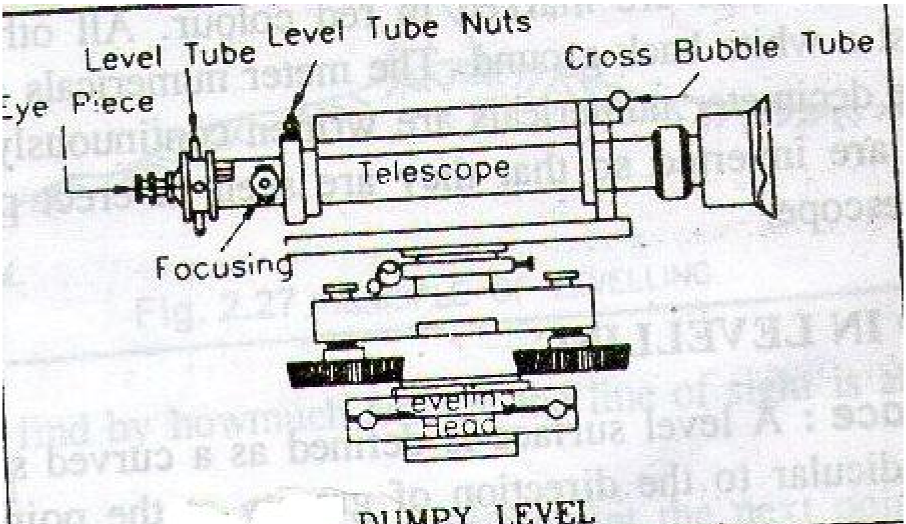
Levelling may be defined as the art of determining the relative height or elevants of points or objects on the earth's surface.

Instruments used for leveling:
- ✓ Level
- ✓ Levelling Staff

Level: The purpose of a level is to provide a horizontal line of sight.

Parts:
- ✓ A telescope to provide line of sight
- ✓ A level tube to make the line of sight horizontal
- ✓ A leveling head to bring the bubble in its centre of run
- ✓ A tripod to support the instrument

Dumpy level:
The telescope is rigidly fixed with the support and therefore, can neither be rotated about the longitudinal axis, nor can it be removed from its support. A long bubble tube is attached to the top of the telescope. The leveling head generally consists of two parallel plates with either three foot screws of four foot screws. The upper plate is known as tribrach and the lower plate is known as trivet which can be screwed on a tripod



DUMPY LEVEL