SURVEYING-1

DEFINITION OF SURVEYING

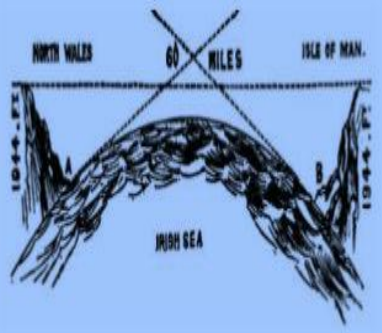
Surveying is the art and science of determining the relative positions of various points or stations on the surface of the earth by measuring the horizontal and vertical distances , Angles and taking the details of these points and by preparing a map or plan to any scale.

★Measurements taken in Horizontal and Vertical planes

PRIMARY DIVISIONS OF SURVEYING

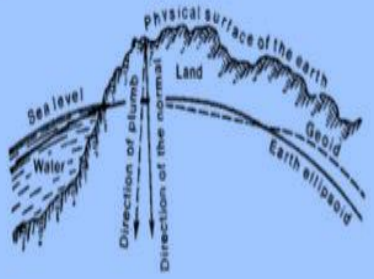
PLANE SURVEYING

- Type of surveying in which earth surface is considered as a plane and the curvature of the earth is ignored.
- In such surveying the line joining any two stations is considered to be straight.



GEODETIC SURVEYING

- Type of surveying in which the curvature of the earth is taken into consideration.
- The line joining any two stations is considered as curved line.

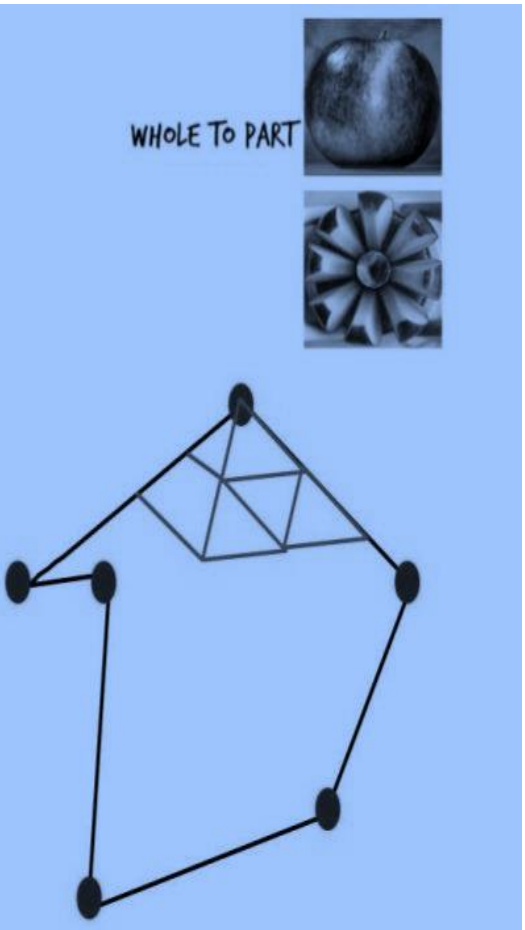


FUNDAMENTAL PRINCIPLES OF SURVEYING

Principle: 1	Principle: 2
WHOLE TO PART	LOCATE A POINT BY ATLEAST TWO MEASUREMENTS
Always work from whole to part	Locate a new station by at least 2 measurements whether linear or angular from fixed reference points.

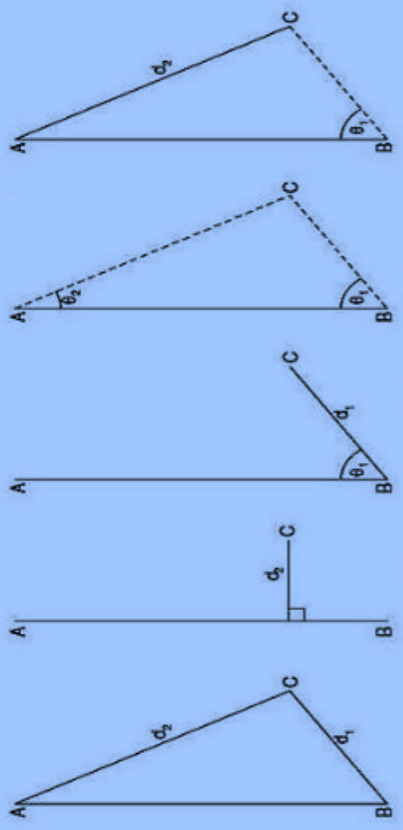
Principle: 1

- In surveying large areas, a system of control points are identified and they are located with high precision.
- Then secondary control points are located using lesser precise methods.
- The details of the localized areas are measured and plotted with respect to the secondary control points.
- This is called working from whole to part.
- This principle in surveying helps in localising the errors.
- If the surveying is carried out by adding localized areas errors accumulated and may become unacceptable when large area is covered.



Principle: 2

- Control points are selected in the area and the distance between them is measured accurately. The line joining these two points is plotted to the scale on drawing sheet.
- Now the desired point(new station) can be plotted by making suitable measurements from the given control point.
- The new stations are located by linear or angular measurements or by both.

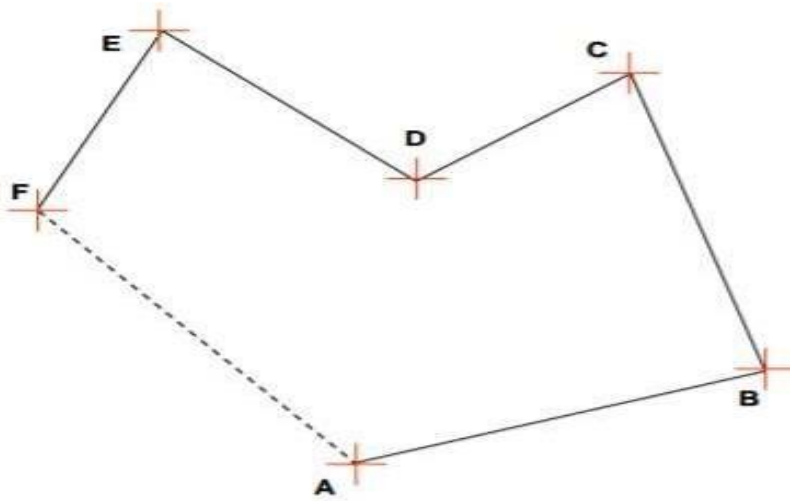


Purpose of Surveying in the field of Civil Engineering

- To determine the relative positions of the existing futures of the ground.
- To layout our marked positions of proposed structures on the ground.
- To determine areas, volumes and other related quantities.
- To prepare a map of a country of detailed out location of cities, towns, villages and major roads.
- To prepare the engineering detailed plans and sections of various sections such as roads, railways, bridges, dams and other structure.
- To prepare a topographical map showing details of hills, valleys and river

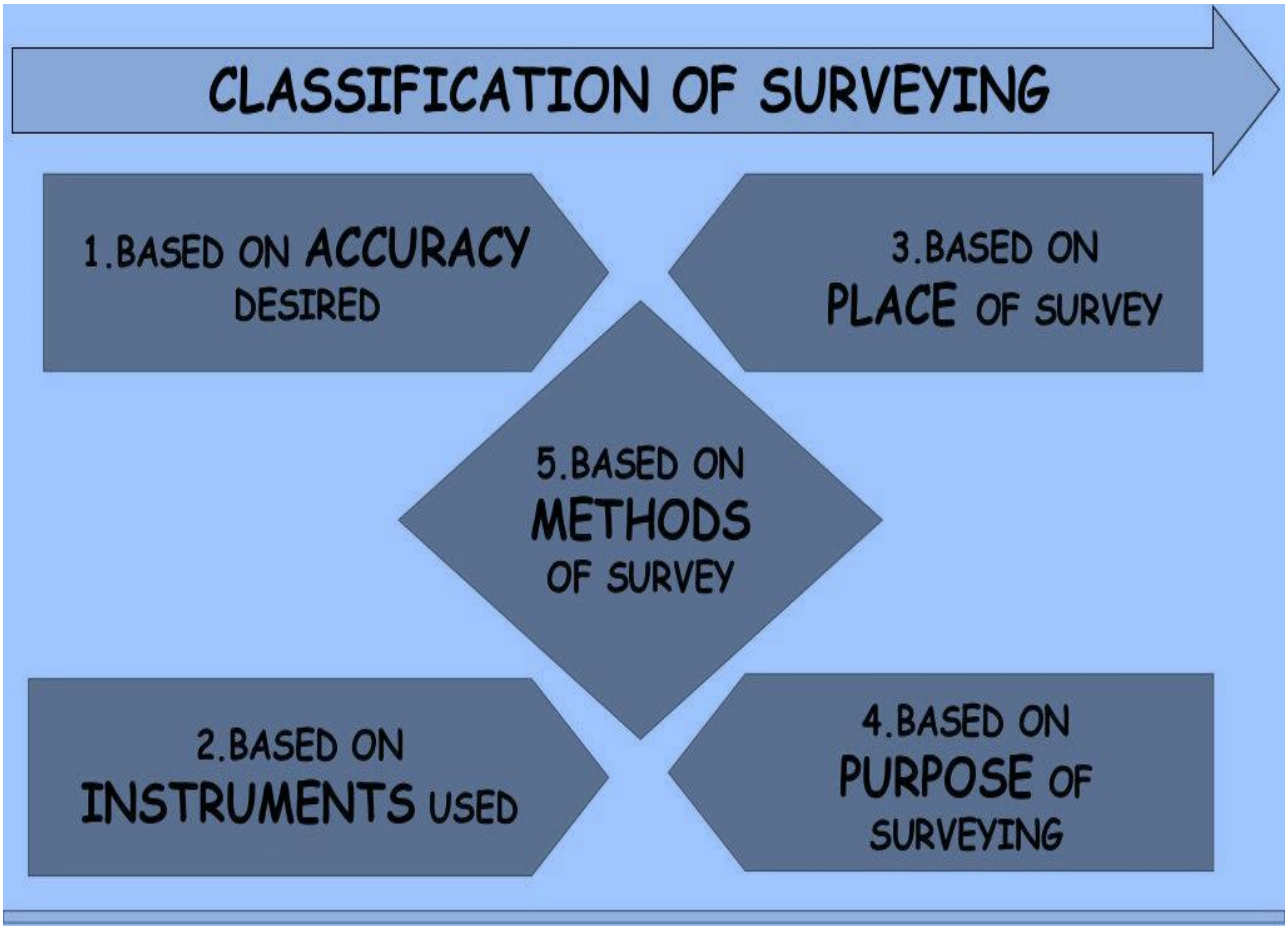
Measurements

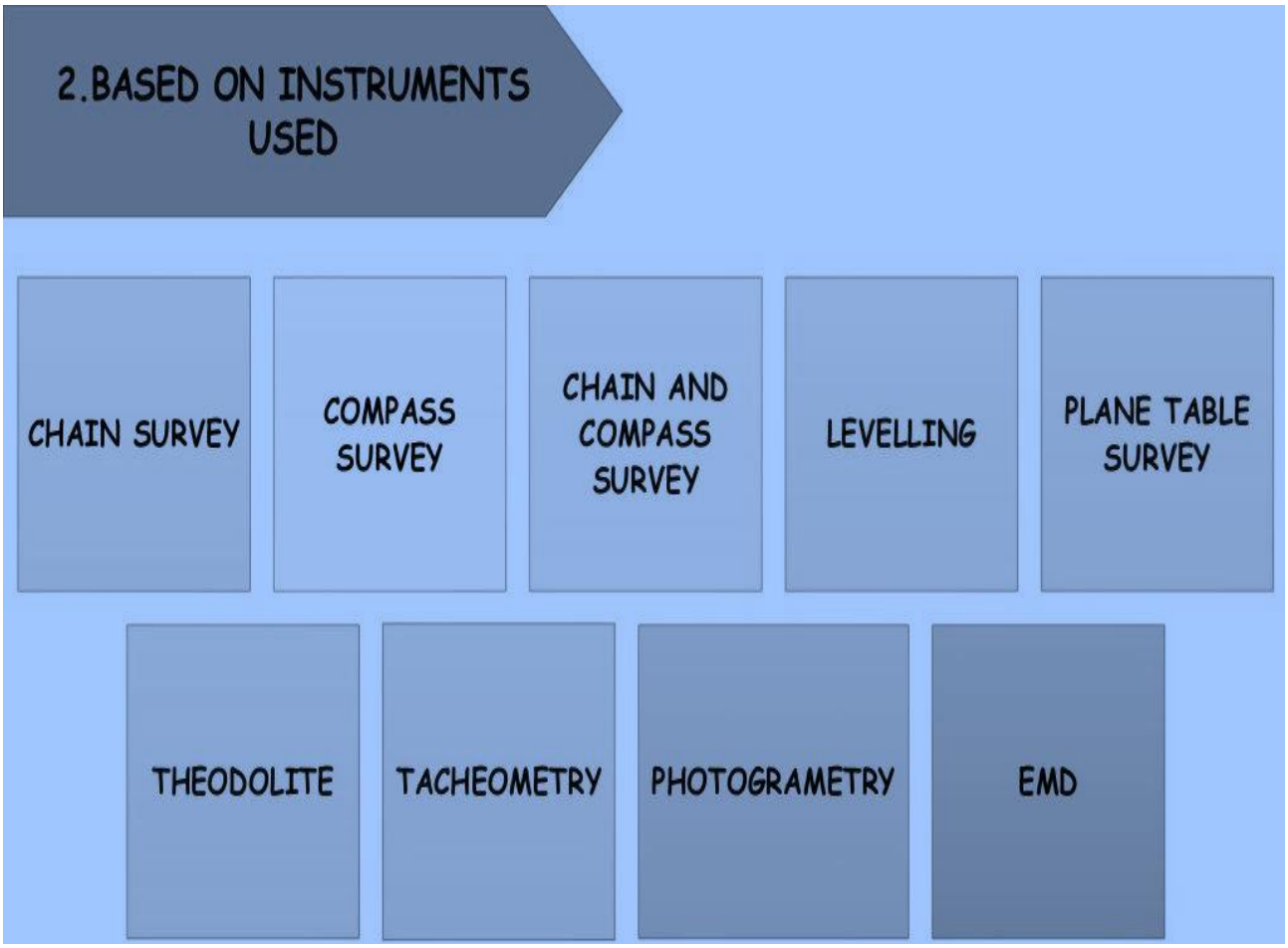
- Linear Measurement
- Angular Measurement



BASIC INSTRUMENTS USED IN SURVYING

1. Chain
2. Tape
3. Pegs
4. Arrows
5. Alidade
6. Level Staff
7. Dumpy Level
8. Plane Table
9. Auto Level
10. Tripod Stand


CLASSIFICATION OF SURVEYING
1.BASED ON ACCURACY DESIRED
3.BASED ON PLACE OF SURVEY
5.BASED ON METHODS OF SURVEY
2.BASED ON INSTRUMENTS USED
4.BASED ON PURPOSE OF SURVEYING


2.BASED ON INSTRUMENTS USED
CHAIN SURVEY
COMPASS SURVEY
CHAIN AND COMPASS SURVEY
LEVELLING
PLANE TABLE SURVEY
THEODOLITE
TACHEOMETRY
PHOTOGRAMETRY
EMD

Chain surveying

OBJECTIVE: Study of various instruments used in chain surveying and their uses

INSTRUMENTS:

1) Chain or tape
2) Arrows
3) Ranging rods
4) Cross staff
5) Offset rods
6) Pegs
7) Plumb bob

PURPOSE OF CHAIN SURVEYING

Chain surveying is the type of **surveying** in which only linear measurements are made in the field. The main principle of **chain surveying** or **chain** triangulation is to providea frameworkconsist of number of well- conditioned triangles or nearly equilateral triangles. It is used to find the area of the field.

PRINCIPLES OF CHAIN SURVEYING

The main principle of chain surveying or chain triangulation is to provide a framework consist of number of well-conditioned triangles or nearly equilateral triangles. It is used to find the area of the field.

ADVANTAGES:-

- Chain surveying is the simplest and commonest method used in serving exercises
- The equipment used to conduct chain survey are simple to use
- The equipment in the chain survey can easily be replaced for example measuring road can be replaced with measuring tape.

DISADVANTAGE:-

- Simple chain survey cannot be conducted in built up areas and large areas
- It is time consuming
- Chain survey becomes more complicated method when there are raised points in between areas to be surveyed

OPERATION IN CHAIN SURVEYING

- **Ranging**
- **Chaining**
- **Offsetting**

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. There are two methods of ranging viz., direct ranging and reciprocal ranging.

Direct Ranging

If the first and last points are intervisible this method is possible. The intervisible stations A and B in which an intermediate point C is to be located. Point C is selected at a distance slightly less than a chain length. At points A and B ranging rods are fixed. The assistant holds another ranging rod near C. Surveyor positions himself approximately 2 m behind station A and looking along line AB directs the assistant to move at right angles to the line AB till he aligns the ranging rod along AB. Then surveyor instructs the assistant to mark that point and stretch the chain along AC.

INDIRECT OR RECIPROCAL LEVELLING

Due to intervening ground, if the ranging rod at B is not visible from station A, reciprocal ranging may be resorted. Figure 12.19 shows this scheme of ranging. It needs two assistants one at point M and another at point N, where from those points both station A and station B are visible. It needs one surveyor at A and another at B. To start with M and N are approximately selected, say M1 andN1. Then surveyor near end A ranges person near M to position M2 such that AM2N1 are in a line. Then surveyor at B directs person at N, to move to N2 such that BN2M2 are in a line. The process is repeated till AMNB are in a line.

OFFSET

The lateral measurement taken from an object to the chain line is known as 'offset'. Offsets are taken to locate objects with reference to the chain line. They may be of two kinds.

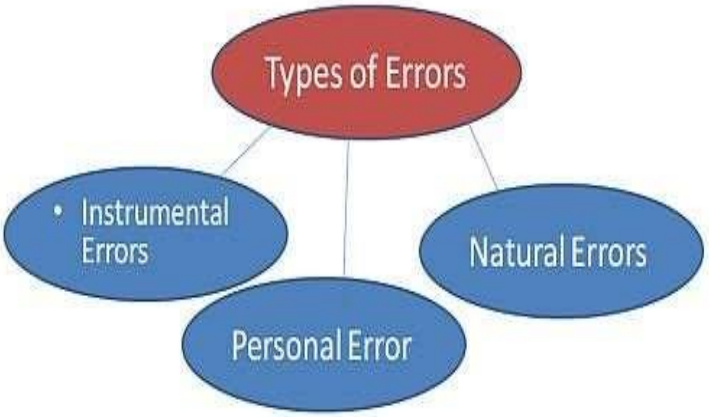
1. Perpendicular offset and

2. Oblique offset.

OBSTACLES

- Type # 1. Chaining Free, VisionObstructed
- Type # 1. Chaining Obstructed, VisionFree
- Type # 3. Chaining and Vision Both Obstructed

ERRORS IN CHAIN SURVEYING



- **PersonalErrors**

  Wrong reading, wrong recording, reading from wrong end of chain etc., are personal errors. These errors are serious errors and cannot be detected easily. Care should be taken to avoid such errors.

- **Compensating Errors**

  These errors may be sometimes positive and sometimes negative. Hence they are likely to get compensated when large number of readings are taken. The magnitude of such errors can be estimated by theory of probability. The following are the examples of such errors:

  (i) Incorrect marking of the end of achain.

  (ii) Fractional part of chain may not be correct though total length iscorrected.

  (iii) Graduations in tape may not be exactly samethroughout.

  In the method of stepping while measuring sloping ground, plumbingmay be crude.

- **CumulativeErrors**

  The errors, that occur always in the same direction are called cumulative errors. In each reading the error may be small, but when large number of measurements are made they may be considerable, since the error is always on one side. Examples of such errors are:

  (i) Badranging
  (ii) Bad straightening
  (iii) Erroneous length of chain
  (iv) Temperature variation
  (v) Variation in appliedpull
  (vi) Non-horizontality
  (vii) Sag in thechain

CORRECTIONS IN CHAIN SURVEYING

1. Correction for Absolute Length

If Ca is the correction for absolute length or the actual length, then it is given by:

Ca = Lc/l

Where, L = Measured length of the line; c = Correction per tape length; l= designated length of the tape or the nominal length.

2. Correction for Temperature

The correction for temperature Ct is given by the formula:

$$C_t = \alpha(T_m - T_\alpha)\, L$$

Where, α = Coefficient of Thermal Expansion;

Tm is the mean temperature in the field during measurement; To is the temperature during the standardization of the tape; L = Measured length;

3. Correction for Pull or Tension

The correction for pull or tension is given by the formula:

$$\mathrm{Cp} = \frac{(P - Po)L}{AE}$$

Where, P = Pull applied during the measurement; Po= Standard Pull; Both P and Po are measured in Newtons;L = measured length;A =Area of cross-section in cm^2; E = Young's modulus in N/cm^2.

4. Correction for Sag

Stretching the tape between two supports make the tape to form a horizontal catenary. Hence, the horizontal distance becomes greater than the distance along the curve. Hence,

Sag Correction = Horizontal distance – length along the horizontal catenary

5. Correction for Slope or Vertical Alignment

The slope correction or correction due to vertical alignment is given by the relation:

$Cv = 2L \sin^2(x/2)$

Or

$$\text{Total Slope Correction} = \sum \frac{h^2}{2L}$$

Where, h = The difference in elevation between the ends; x = slope measured;

Compass Surveying

- Chain surveying can be used when the area to be surveyed is comparatively small and is fairly flat.
- But when the area is large, undulated and crowded with many details, triangulation (which is the principle of chain survey) is not possible. In such an area, the method of traversing is adopted.

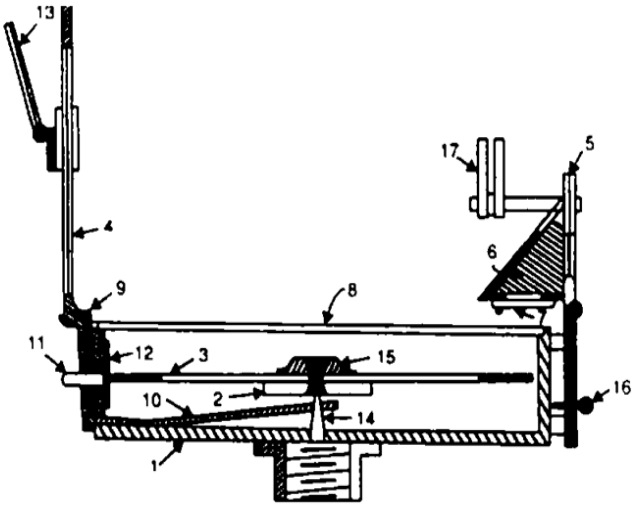
Principle of Compass Surveying

- **The Principle of Compass Survey is Traversing**; which involves a series of connected lines the magnetic bearing of the lines are measured by prismatic compass and the distance (lengths) of the are measured by chain. Such survey does not require the formulation of a network of triangle.
- Compass surveying is recommended when the area is large, undulating and crowded with many details.
- Compass surveying is not recommended for areas where local attraction is suspected due to the presence of magnetic substances like steel structures, iron ore deposits, electric cables conveying currents, and so on.

Types and Uses of Compass

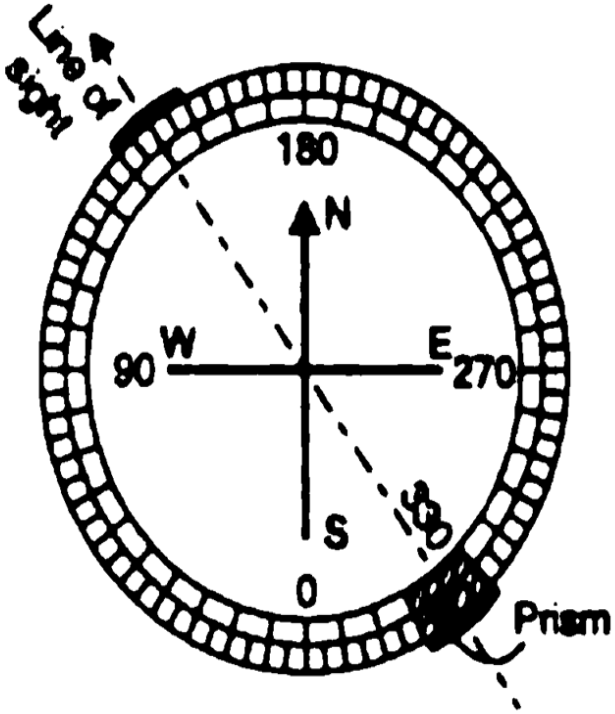
- **Compass:** A compass is a small instrument essentially Consisting of magnetic needle, a graduated circle, and a line of sight. The compass can not measure angle between two lines directly but can measure angle of a line with reference to magnetic meridian at the instrument station point is called magnetic bearing of a line. The angle between two lines is then calculated by getting bearing of these two lines.
- There are two forms of compass available:
- **The Prismatic Compass**
- **The Surveyor's Compass**

Prismatic compass

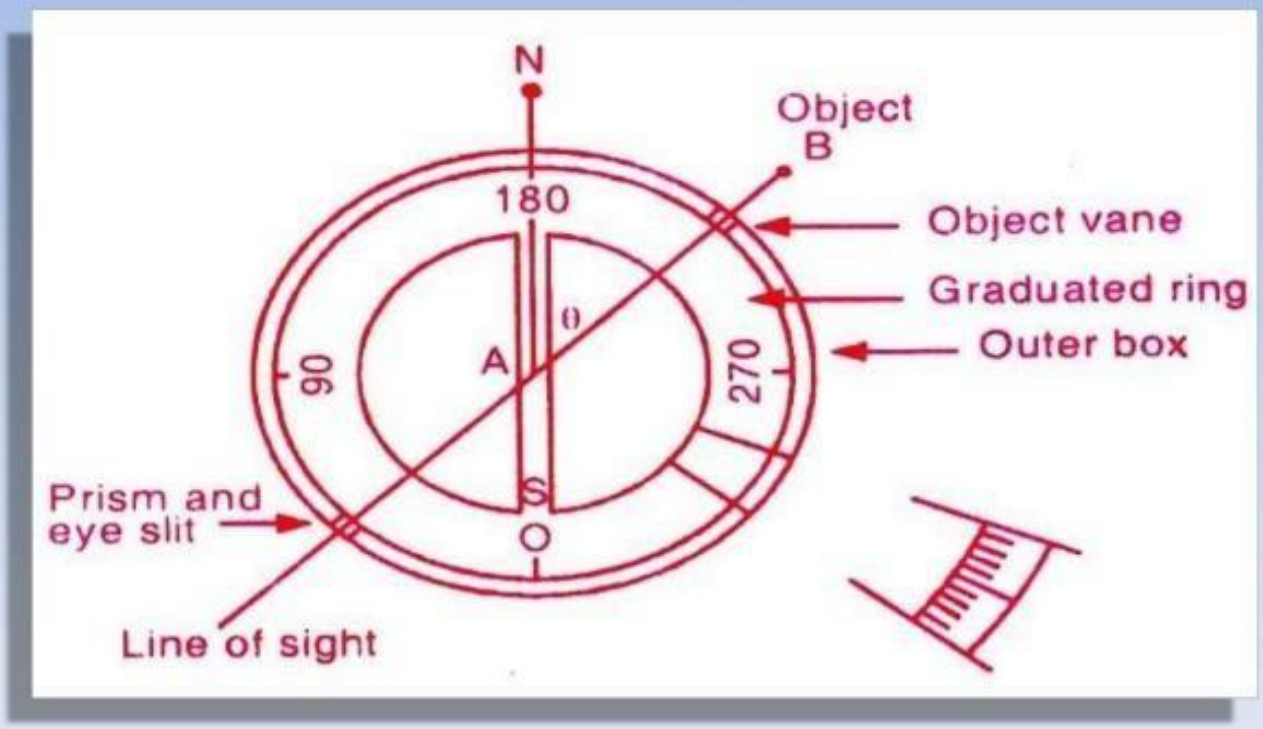


1. Box
2. Needle
3. Graduated ring
4. Object vane
5. Eye vane
6. Prism
7. Prism cap
8. Glass cover
9. Lifting pin
10. Lifting lever
11. Brake pin
12. Spring brake
13. Mirror
14. Pivot
15. Agate cap
16. Focusing stud
17. Sun glass

FIG. 5.12. THE PRISMATIC COMPASS.



Bearing


N
Object
B
180
Object vane
Graduated ring
Outer box
θ
A
90
270
S
O
Prism and
eye slit
Line of sight

Designation of Bearings

- The bearing are designated in the following two systems.
- Whole Circle Bearing System (W.C.B)
- Quadrantal Bearing System (Q.B.)

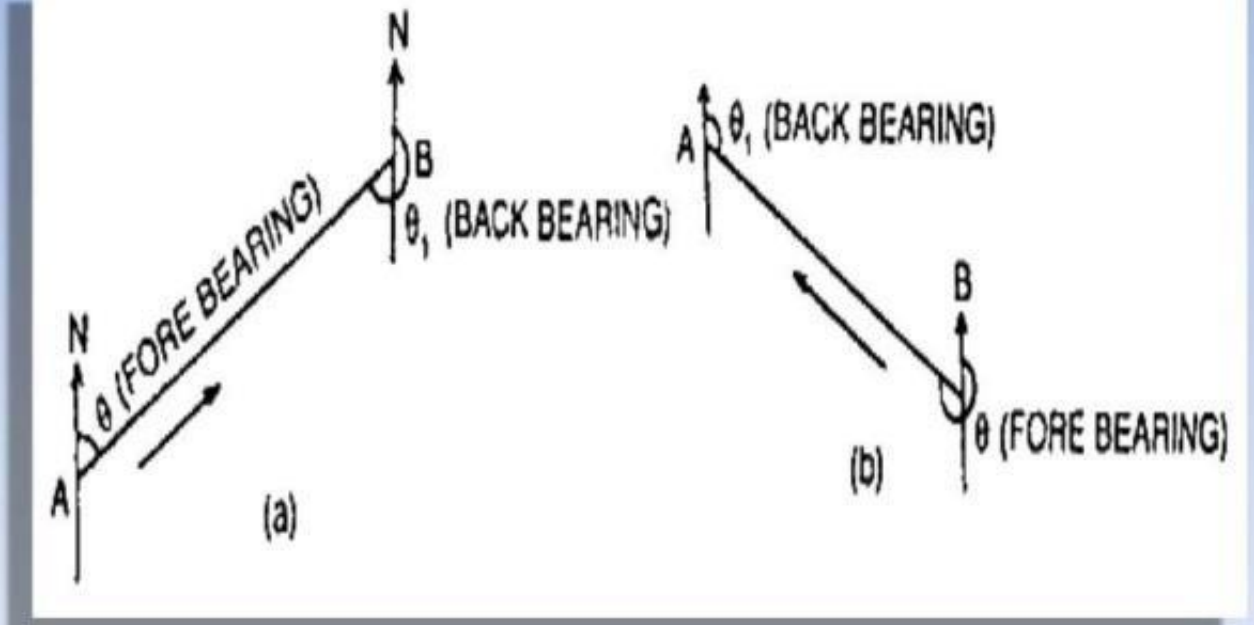
Reduced Bearing (RB)

- When the whole circle bearing of a line is converted into quadrantal bearing it is termed as 'Reduced Bearing'. Thus, the reduced bearing is similar to the quadrantal bearing. It's value lies between 0^0 to 90^0, but the quadrants should be mentioned for proper designation.

Fore Bearing and Back Bearing

- The bearing of a line measured in the forward direction of survey line is called the 'Fore Bearing' (FB) of that line.
- The bearing of the line measured in the direction opposite to the direction of the progress of survey is called the 'Back Bearing' (BB) of the line.

Fore Bearing



Local Attraction

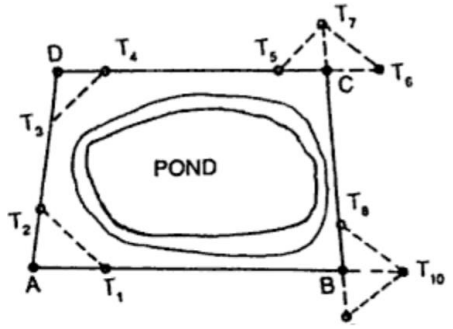
- may be **constant** or **may vary** depending upon the surrounding magnetic influences
- draws the needle **away** from the magnetic meridian

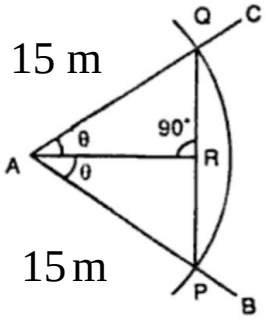
Magnetic Declination

- The horizontal angle between the magnetic meriadian and true meridian is known as 'Magnetic declination'
- When the north end of the magnetic needle is pointed towards the west side of the true meridian the position is termed as 'Declination West (ϴW).
- When the north end of the needle is pointed towards east side of the true meridian the position is termed as 'Declination East (ϴ E)

Methods of traversing

- **<u>Chain traversing:</u>**





Let $\angle PAR = \theta$

Then $\angle BAC = 2\theta$

Here $AP = AQ = 15$ m

In triangle PAR,

$$\sin\theta = \frac{PR}{AP} = \frac{2PR}{2AP} = \frac{PQ}{30}$$

$$\therefore \quad \theta = \sin^{-1}\frac{PQ}{30}$$

- **<u>Compass traversing:</u>**Fore bearings and back bearings between the traverseleg are measured
- **<u>Theodolite traversing:</u>**Horizontal angles between the traverse legs aremeasured. The length of the traverse legs are measured by chain/tape or by stadia method
- **<u>Plane table traversing:</u>**Plane table is set at every traverse station in clockwiseand anticlockwise direction and the circuit is finally closed. During traversing the sides of the traverse are plotted according to any suitable scale.

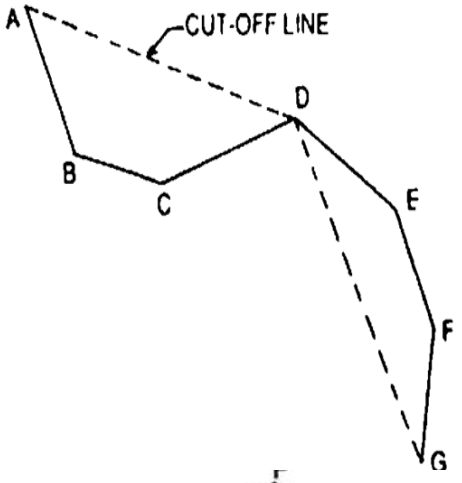
Checks on traverse: Closed traverse

- **Check on closed traverse:**
  - Sum of the measured interior angles (2n-4) x 90°
  - Sum of the measured exterior angles (2n+4) x 90 °
  - The algebric sum of the deflection angles should be equal to 360°. Right hand deflection is considered +ve, left hand deflection –ve

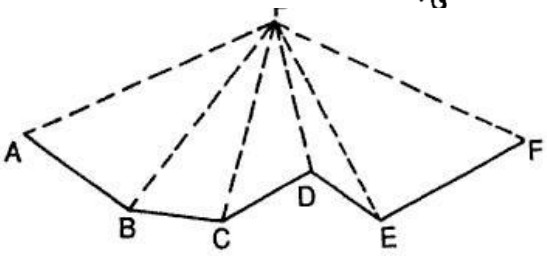
- **Check on linear measurement**
  - The lines should be measured once each on two different days (along opposite directions). Both measurement should tally.
  - Linear measurement should also be taken by the stadia method. The measurement by chaining and stadia method should tally.

Checks on traverse: Open traverse

- Taking cut-off lines: measured the bearings and lengths of cut off lines after plotting and tally with actual values.



- Taking an auxiliary point: Take P permanent point as auxiliary point measured bearings and lengths of P from each traverse point. If survey is accurate, while plotting all the measured bearing of P should meet at P.



Problems:

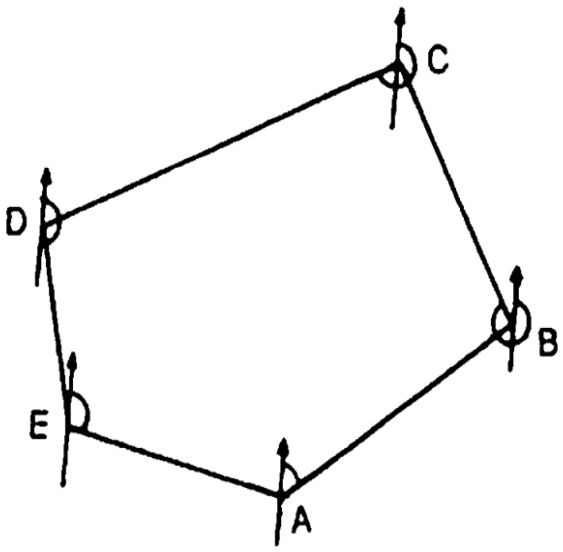
- **Convert the following WCBs to QBs**
  - (a) WCB of AB = 45°30’
    (Ans 45°30’)
  - (b) WCB of BC = 125°45’
    (Ans 180- 125°45’ = 54° 15’)

- **Fore bearing of the following lines are given. Find back bearing**
  - AB=S 30°30’ E
  - BC=N 40°30’ W
- The magnetic bearing of a line AB is 135°30’ what will be the true bearing, if the declination is 5°15’ W.

Problems

Problem 5 A closed traverse is conducted with five stations A, B, C, D and E taken in anticlockwise order, in the form of a regular pentagon. If the FB of AB is 30°0′, find the FBs of the other sides.

$$\text{Interior angle of pentagon} = \frac{(2N - 4) \times 90^\circ}{5} = \frac{540^\circ}{5} = 108^\circ$$



FB of AB = 30°0′

FB of BC = BB of AB + ∠B
= (30°0′ + 180°0′) + 108°0′
= 210°0′ + 108°0′ = 318°0′

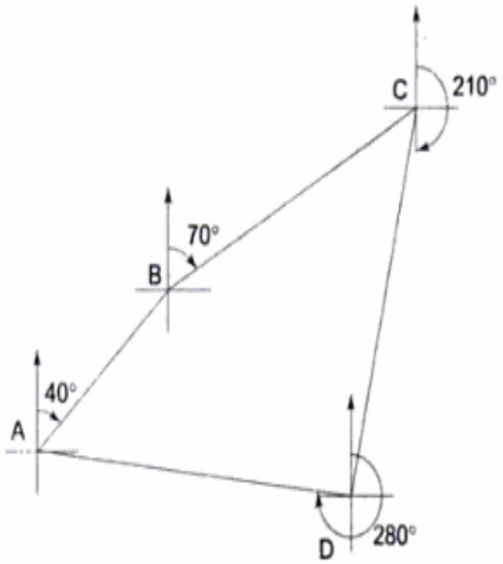
FB of CD = BB of BC + ∠C
= (318°0′ – 180°0′) + 108°0′
= 138°0′ + 108°0′ = 246°0′

FB of DE = BB of CD + ∠D
= (246°0′ – 180°0′) + 108°0′
= 66°0′ + 108°0′ = 174°0′

FB of EA = BB of DE – exterior ∠E
= (174°0′ + 180°0′) – (360°0′ – 108°0′)
= 354°0′ – 252° = 102°0′

Example 3.2 Determine the value of included angles in a closed compass traverse ABCD (Fig. 3.11) conducted in clockwise direction, given the following fore bearings of the respective lines.

Line	F.B.
AB	40°
BC	70°
CD	210°
DA	280°



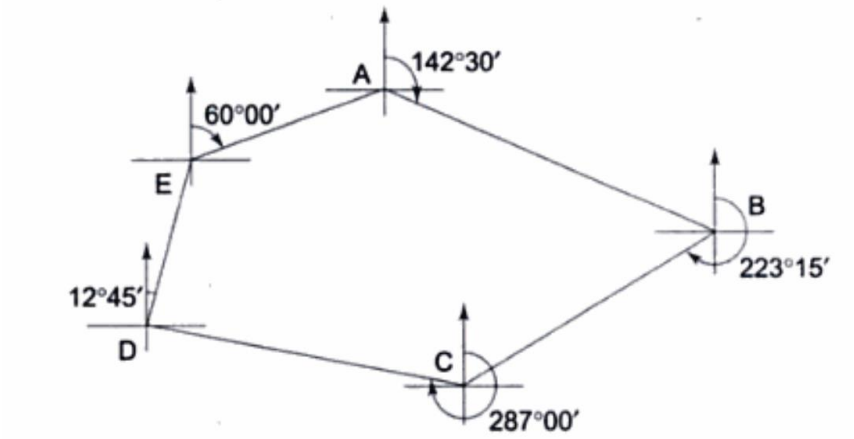
Example 3.3 Following are the bearings taken in a closed compass traverse.

Line	F.B.	B.B.
AB	S37°30′E	N37°30′W
BC	S43°15′W	N44°15′E
CD	N73°00′W	S72°15′E
DE	N12°45′E	S13°15′W
EA	N60°00′E	S59°00′W

Compute the interior angles and correct them for observational errors.

Solution Refer to Fig. 3.12. Convert the quadrantal bearings to whole circle bearings.

Lines	F.B.	B.B.
AB	142°30′	322°30′
BC	223°15′	44°15′
CD	287°00′	107°45′
DE	12°45′	193°15′
EA	60°00′	239°00′



MADE BY:-

SUNITA

(GUEST FACULTY IN CIVIL ENGINEERING)

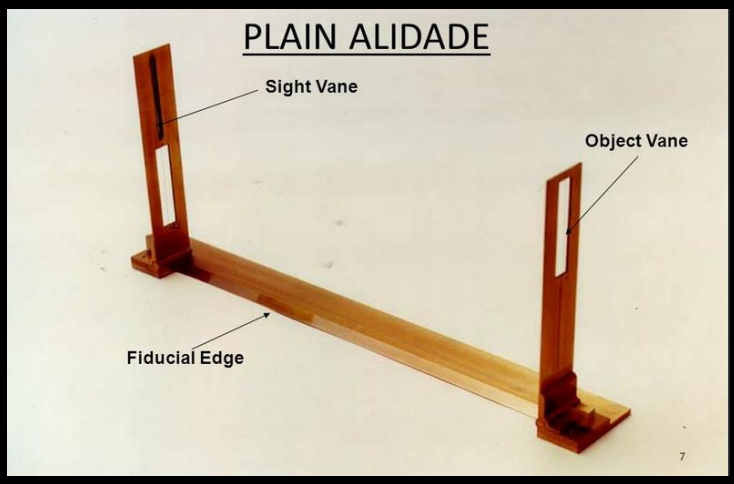
Plane Table Surveying

Plane Table Surveying

- Plotting of the plan and field observations can be done simultaneously
- Geometrical conditions of site are manuscript in the map sheet using plane table and alidade after that topographic details are arranged on the map.
- Best fitted for small-scale surveying
- Surveying industrial areas where compass survey fails to perform
- Used to fill in details between stations fixed by triangulation method or theodolite traversing method.

Instruments used

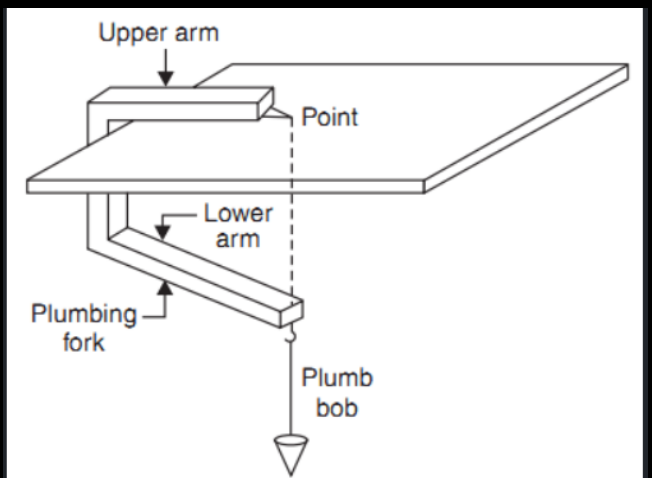
- **Drawing Board**
  - The board may be mounted on a tripod with a leveling head or a ball-and-socket arrangement in such a fashion that it can be leveled and revolved about a vertical axis and may be clamped in any position.
- **Alidade**
  - The alidade is a ruler with a sight line attached and is used on the plane table for bisecting the object, drawing rays, direction lines, etc.



- **One of the sight vanes is provided with a narrow rectangular slit. While other is provided with a central vertical hair or wire.**

Instruments used

- Trough compass
- Plumbing fork or U-frame
- Spirit level
- Plumb bob
- Ranging rods
- Drawing sheet



Instruments used : Spirit level

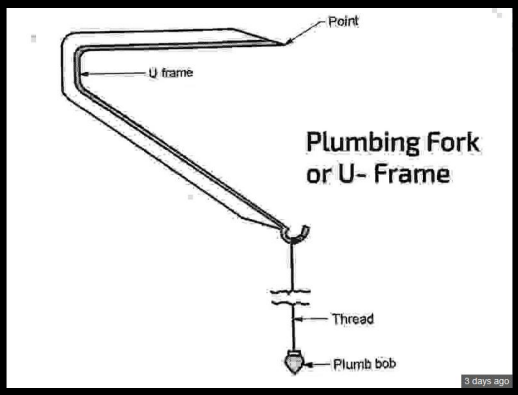
- A spirit level is required to ensure levelling the table surface.
- The spirit level can be place in two perpendicular directions and levelled.

Instruments used : Magnetic needle

- A magnetic needle in a rectangular box is generally used.
- By turning the box placed on the table, the needle is made to read zero.
- A line drawn along the edges of the box gives the magnetic meridian

Instruments used : Magnetic needle

- A folded frame with a hook and a plumb bob at the lower limb makes up the plumbing fork.
- The upper frame is placed on the sheet with its pointed end at a point marked as station.
- The tripod legs are adjusted to bring the plumb bob over the station mark.



Procedure

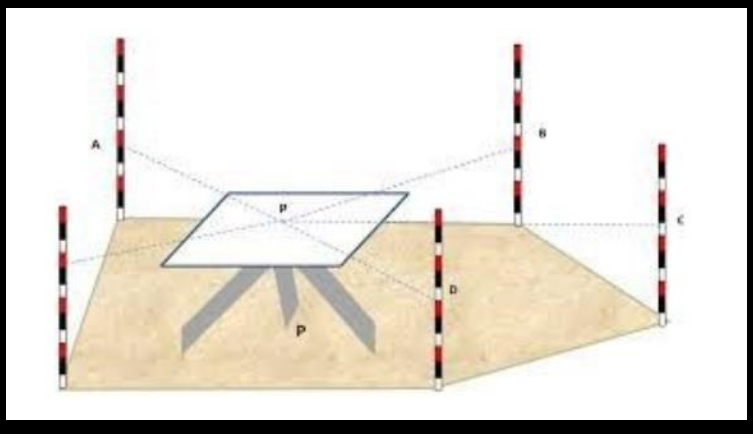
- **Fixing of Plane Table**
- **Leveling of Plane Table → spirit level**
- **Centering of Plane Table →** plumbing fork
- **Orientation of Plane Table →** compass or back sighting

Methods of Plane Table Surveying

- **Radiation**

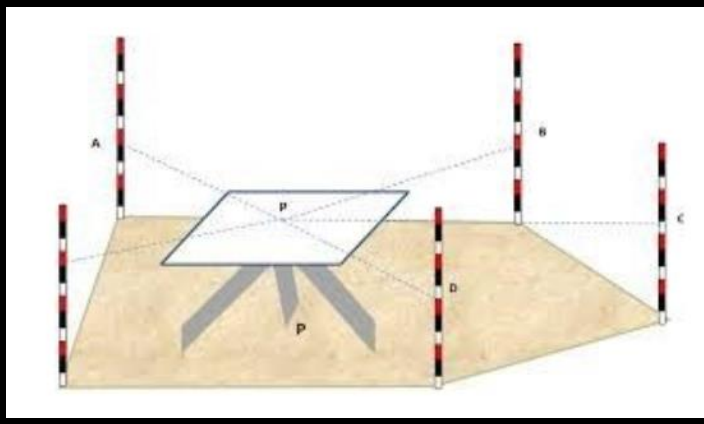
This method is only effective if the whole surveying is to be done from one single station i.e. the table will be in such a position from where all the other points of the field are easily visible.

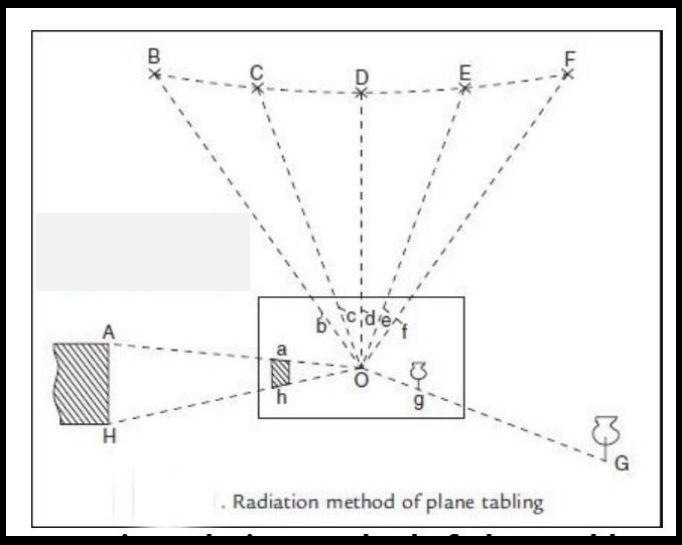
i. A point P is to be selected in such a fashion that all the other points (A B C D E) are seen easily from P
ii. Centering, leveling, and orientation must be done prior to surveying
iii. At first, by putting the alidade on point P a line of sight for station A is to be drawn.



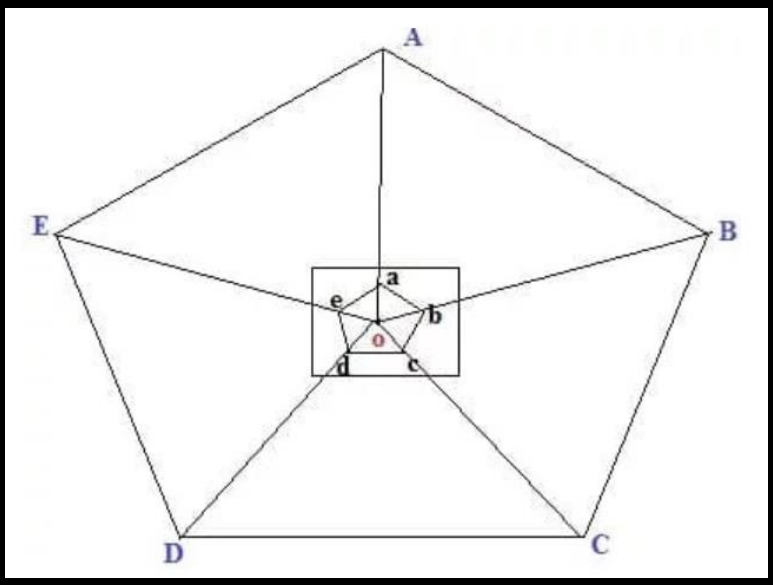
Methods of Plane Table Surveying

iv. After measuring the distance of PA on field, the measurement needs to be put on paper to a suitable scale.
v. Similarly, points b, c, d, and e are obtained on paper by drawing lines of sight for stations B, C and D and measuring the distances PB, PC, PD and PE on ground respectively.
vi. Points a, b, c, d, and e are joined on paper, as shown in the figure.





. Radiation method of plane tabling



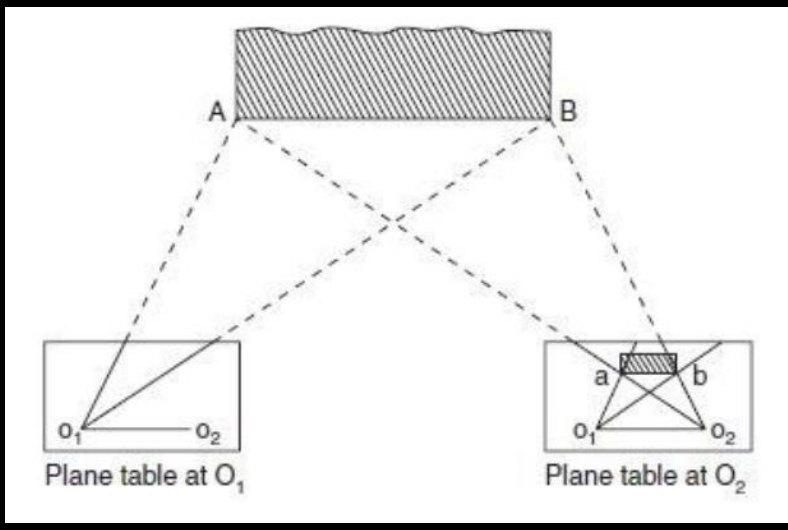
Methods of PT : Intersection

In case of a mountainous terrain or rough surface where distances cannot be taken physically, it is best to use intersection method.

i. Two stations O1 and O2 are selected so that the points to be located on paper are easily seen from them.

ii. The baseline (o1o2) is plotted on the paper.

The table can be centered and leveled at station O1 and then after orienting at station O2, the distance O1 O2 can be accurately measured and put up to some scale on the paper. The line o1o2 can be drawn to some scale on the paper and then the board can be adjusted from station O1 by back sighting at station O2.

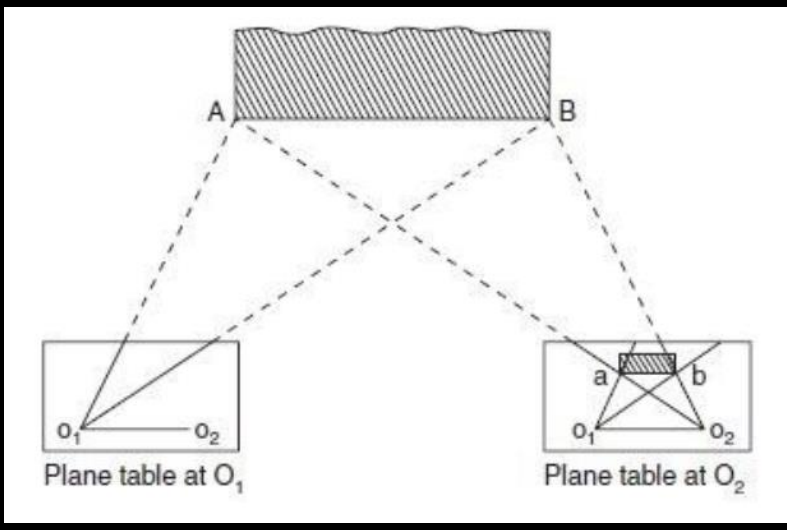


Methods of PT : Intersection

iv. From station O1, rays for stations A, B are drawn

v. Now moving the table to the new station and orienting it again the rays of stations A, B are drawn etc.,

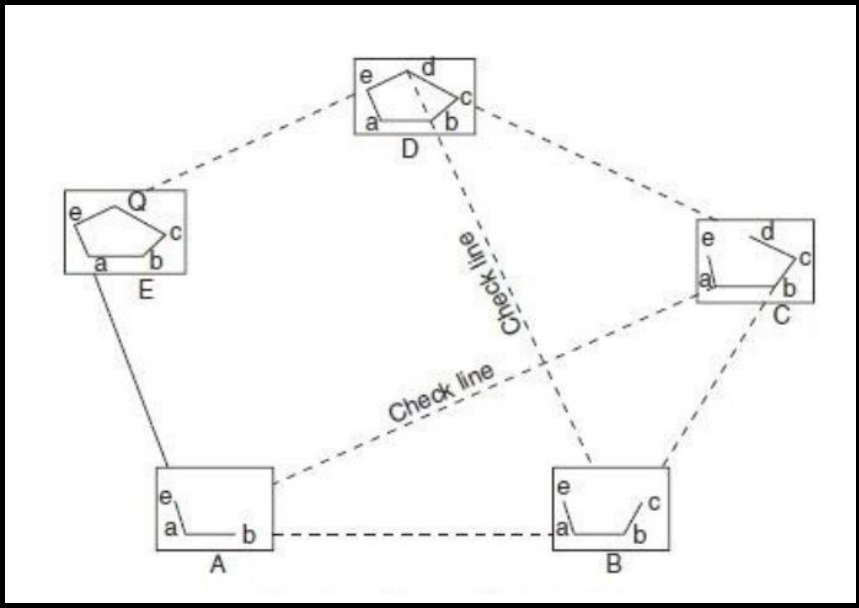
vi. The intersection of rays from stations O1 and O2 will give points a, b etc. on paper, as shown in the figure.



Methods of PT : Traversing Method

- It is used for running survey lines between stations, which have been previously fixed by other methods of survey, to locate the topographic details.

i. The plane table is fixed at a location (say A)
ii. From that point, a sight is taken toward B and the distance AB is measured.
iii. The plane table is shifted to station B and sighted toward A (this is called back sighting). Distance BA was measured.

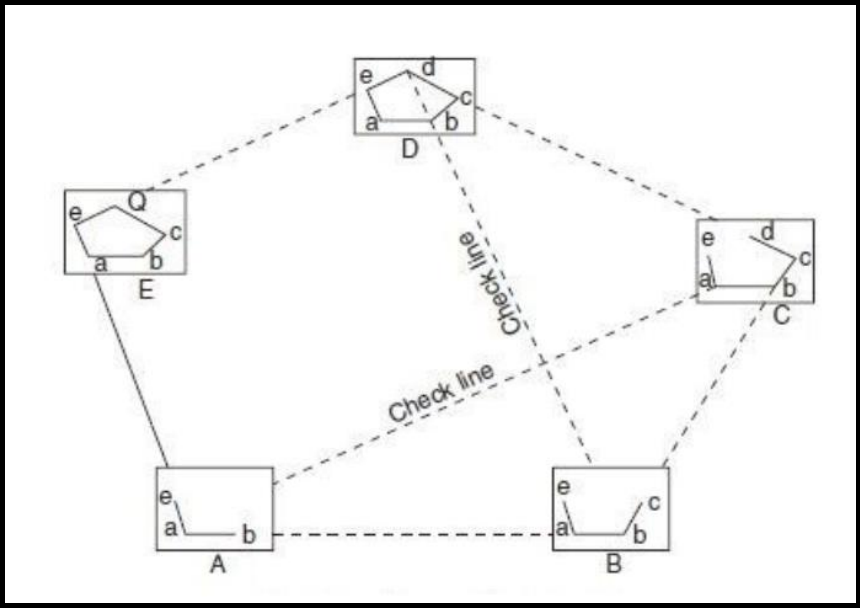


Methods of PT : Traversing Method

- It is used for running survey lines between stations, which have been previously fixed by other methods of survey, to locate the topographic details.

iv. The average distance between AB and BA are plotted to suitable scale on the drawing paper.

v. Then the point C is sighted from B and the distance was measured. This process is repeated for all the stations.



Resection Method

- Resection is a method of orienting the table.
- The objective is to plot the station occupied by the table rather than plotting other points.
- After resection, the station occupied by the table is obtained on the sheet in correct orientation.
- The two-point and three-point problems are resection methods.

Three point problem

- Given three visible stations and their plotted positions, to plot the station occupied by the table with the table correctly oriented.
- 1.Mechanical method (Tracing paper method)
- 2.Graphical method (Bessel's method)
- 3.Trial and error method

Mechanical method

1.The table is placed at P and levelled. A tracing paper is fixed on the map and a point p is marked on it.

2. With the alidade centred on P, the points A, B, C are bisected and the rays are drawn. The rays will not pass through the points a,b,c.

3. Now the tracing paper is removed and moved over the map such a way that , the three rays at a time pass through the positions a, b, c.

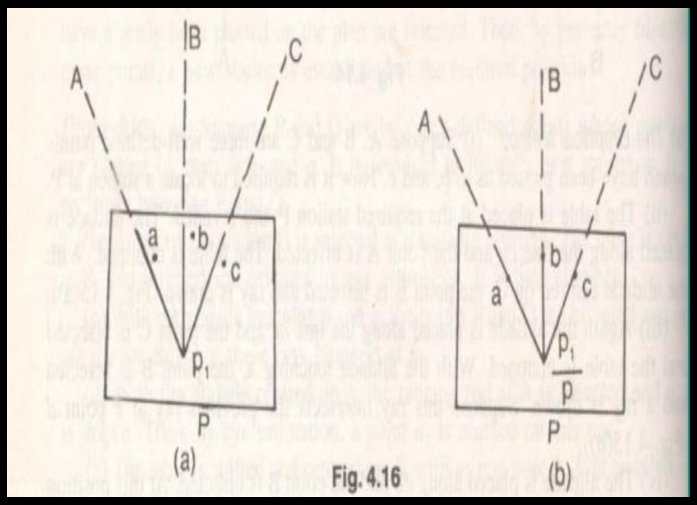


Fig. 4.16

Mechanical method

4. The point p is picked with a pin to give a impression pon the map. pis the required point on the map. The tracing paper is removed.

5. Alidade is centred on pand the rays are drawn towards A, B, C. These rays must pass through the points a,b,c.

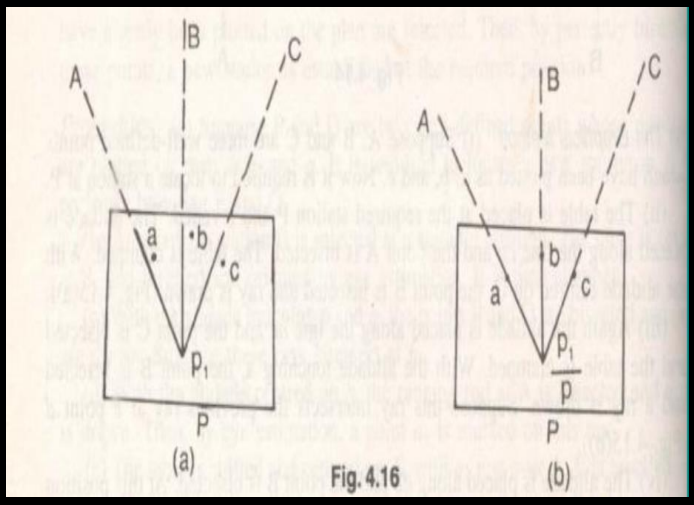


Fig. 4.16

General Instructions while Plane Table Surveying:

- The points A, B, C etc. on the ground should be denoted by the corresponding small letters a, b, c, etc. when plotted on the sheet.
- The table should be turned only when it is to be oriented. After performing the orientation, it must be kept clamped in position.
- The table should be kept clamped in position while the objects are sighted. Only the alidade should be moved on the table to bisect the objects.
- While the sights are being taken, the drawing edge of the alidade must be set touching the plotted station-point on the sheet and not the other edge.
- The lines should be drawn as fine as possible and with a good quality hard pencil.

Errors in Plane Tabling Surveying

- Instrumental errors.
- Errors of manipulation and sighting.
- Errors of Plotting.

Instrumental Errors:

(i) The surface of the board not being a perfect plane.

(ii) The fiducially edge of the alidade not being a straight line.

(iii) The sights of the alidade not being perpendicular to its base.

(iv) The fittings of table and tripod being loose.

(v) The defective trough compass

Errors of Manipulation and Sighting

(i) The board not being horizontal.
(ii) The table not being accurately centered.
(iii) The table not being correctly oriented.
(iv) The table not being properly clamped.
(v) The objects not being correctly sighted.
(vi) The alidade not being correctly centered on the station-pointing the paper.
(vii) The rays not being accurately drawn through the station point.

Errors of Plotting

(i) By using a good quality paper and stretching it properly on the board.
(ii) By constant care in drawing and in the use of scales.