UNIT-2

Surveying and Positioning

Surveying is the science of determining the relative positions of points on, above beneath the surface of the earth by means of direct or indirect measurements of distance, direction and elevation.

AIM / OBJECT of SURVEYING:-

Surveying is the first step for execution of any civil Engg. structure which may be any building, dam, tunnel, roads etc.

Object of surveying is the demarcation of boundaries of land and prepare map and plan.

Primary Division of Surveying:-

① Plane Surveying:- Surveying in which, surface of the earth is assumed as a plane and the curvature of the earth is ignored are known as plane surveying.

As the plane surveying extended only over the small areas, the line connecting two points is treated as straight lines.

② Geodetic Surveying :- In this type of surveying, curvature of the earth is taken into account and a very high standard of accuracy is maintained.

As the surveys extended over large areas, the line joining any two points on the surface of the earth are treated as arcs.

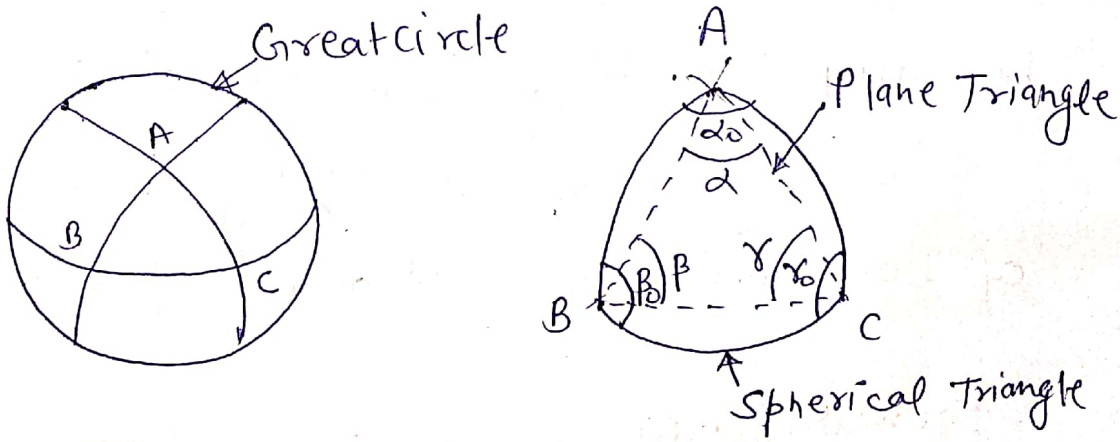

Fig. Plane and Geodetic Surveying

Classification of Survey based upon :-

1. Nature of the field survey
   - (i) Land surveying
     - (a) Topographical Survey
     - (b) Cadastral Survey
     - (c) City Survey
   - (ii) Hydrographic Survey
   - (iii) Aerial Survey
2. Purpose of Survey
   - (i) Engg. Survey
   - (ii) Military Survey
   - (iii) Mine Survey
   - (iv) Geological Survey
   - (v) Archaeological Survey
3. Instrument Used
   - (i) Chain survey (L and A) (ii) Compass Survey (Direction + Area)
   - (iii) Theodolite Survey (H and V angles)
4. System of Survey
   - (i) Triangulation Survey (Δ)
   - (ii) Traverse Survey (chain, tape, compass etc.)

Fundamental Principles of Surveying:-

(1) Always Work from the whole to the Part:-

In case of closed traverse survey, the surveyor should establish firstly the large framework and afterwards, we should established the small framework.

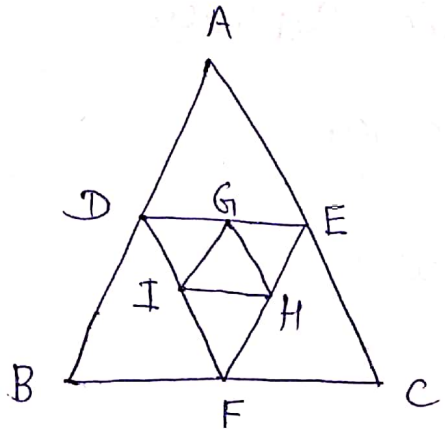

Fig.

(2) Location of a Point by Measurement from Two Control Points:-

Two points of reference A and B are selected and the length AB is accurately measured on the field. Thus line AB can be plotted to a suitable scale on the paper. Now the position of any point "C" can be

determined by following different methods :-

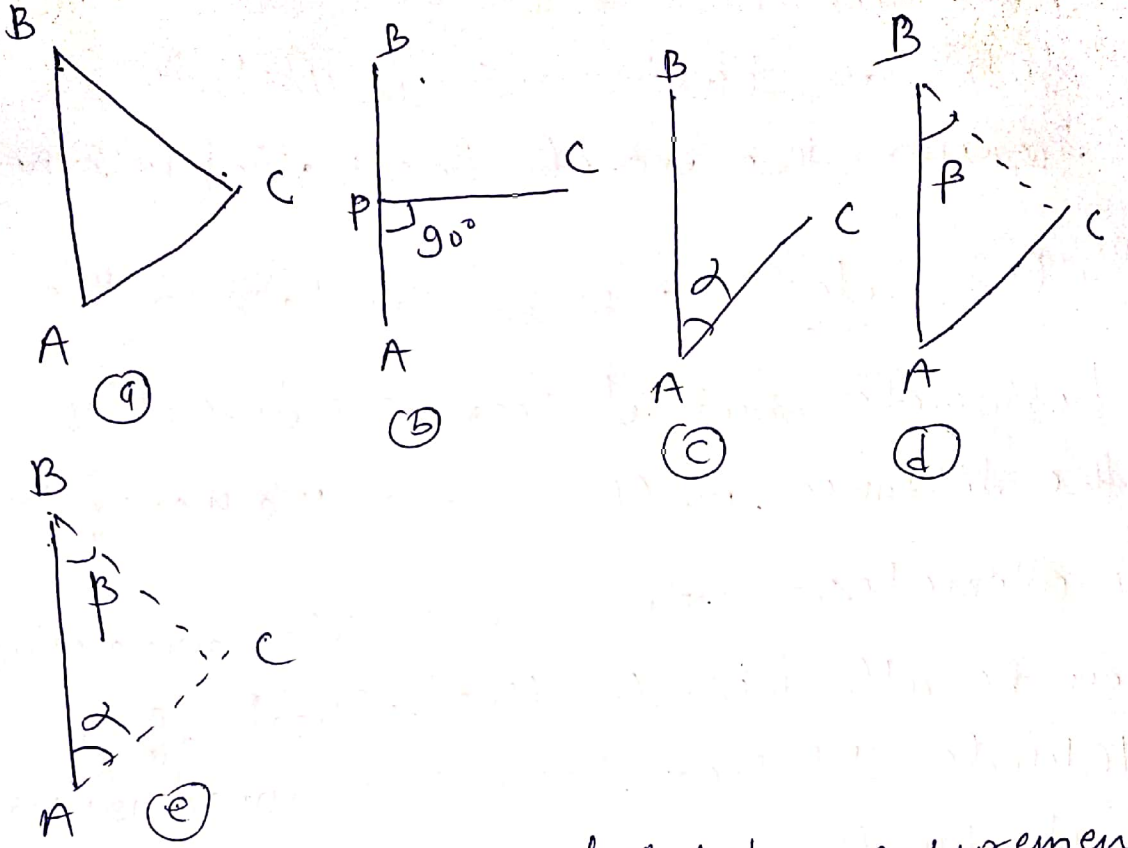

Fig Location of a point by measurement from two control points

Different methods of Linear Measurements :-

(1) Direct Measurements
(2) Optical Measurement
(3) Electronic method

(1) Direct Measurements :-

(i) Pacing :- In this method, distance can be measured by counting the no. of paces, walked by a man.

(ii) Passometer :- The counting of no. of paces for a long distance is difficult so as an instrument is used to register the no. of paces called passometer.

(iii) Pedometer :- It is similar to the passometer, but it registers directly the distance walked not the no. of paces.

(iv) Odometer :- It is a simple device which can be attached to the wheel of the vehicle. It registers the no. of revolutions made by the wheel. The distance covered is equal to the product of the revolutions and the circumference of the wheel.

(v) Perambulator :- It is a wheel fitted with a fork and handle. The wheel is graduated and shows a distance per revolution. There is a dial which records the no. of revolution. Thus the distance can be computed.

(vi) Speedometer :- It is a simple device which gives the distance directly travelled by the vehicle.

(vii) Chaining :- In chaining, distances are measured with the help of chain or tapes.

(2) Optical Measurements :-

In this method, observations are taken through the telescope and calculations are done for the distance.

(3) Electronic Methods :- In this method, ~~observations are taken through~~ distances are measured with electronic instruments. Principle behind these instrument is propagation, reflection and reception of either radio or light waves.

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Instruments used for Linear Measurements :-

(i) chain (ii) Tape (iii) Arrow (iv) Pegs
(v) Ranging Rods (vi) offset rods (vii) Plumb bob

(1) Chain :-

Chain consists of ano. large links made up of galvanised mild steel wire of 4mm dia. Large links are connected to each other by three small circular ringl. These connecting links provide flexibility to the chain

Types of Chains :-

1. Metric Chain :- These are generally 5m, 10m, 20m and 30m in length, having 25, 50, 100 and 150 links respectively. The length of each link is 200mm

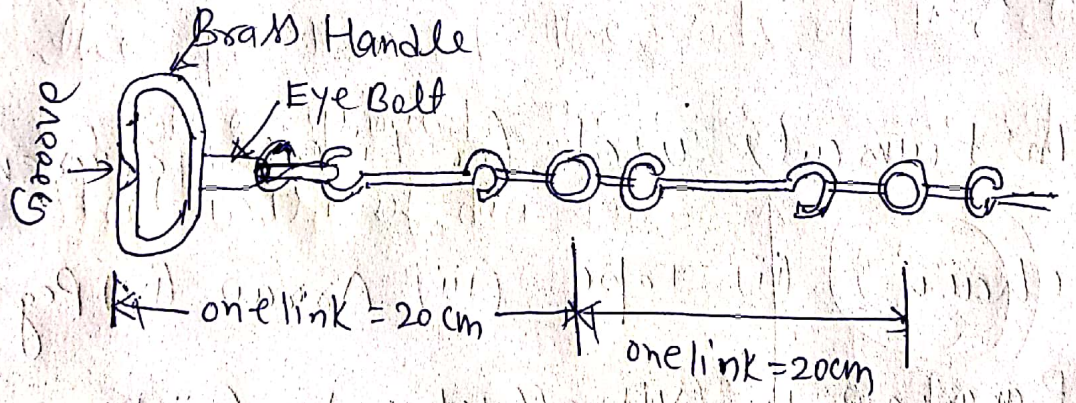


Fig. Metallic Chain

One meter = 1 Brass Ring,
5, 10, 15, 20 m tallies

(2) Gunter's or Surveyor's chain :- It is 66 ft long and it is divided in to 100 links. Each link having length of 0.6ft.

(3) Engineer's chain :- It is 100ft long and it is divided in to 100 links. Each link having length of 1 ft.

(4) Revenue chain :- It is 33ft long and consists of 16 links, each link being $2\frac{1}{16}$ ft long.

(II) Tapes :-

(1) Cloth Tape :- These are made up of cloth. They are generally 10m to 30m in length and 12mm to 15mm in width. It may gets shrunk and stretched.

(2) Metallic Tape :- A cloth tape is reinforced with brass or copper wires is called a metallic tape. These are generally in 10m, 15m, 20m, 30m and 50m in length.

(3) Steel Tape :- Steel tapes are made up of steel strip having width varying from 6 mm to 10mm. These are available in lengths of 1m, 2m, 5m, 10m, 20m, 30m and 50m. These tapes are more durable and accurate than the metallic tape.

(4) Invar Tape :- Invar tapes are made up of an alloy of steel (64%) and nickel (36%). It is 6mm in width and it is available in 10m, 20m, 30m, 50m and 100m lengths. It having very low co-efficient of thermal expansion of about 0.000000122 per °C.

(iii) Arrows :- Arrows are used to mark the position of the ends of the chain on the ground. These are made up of steel wire of dia. 4mm.

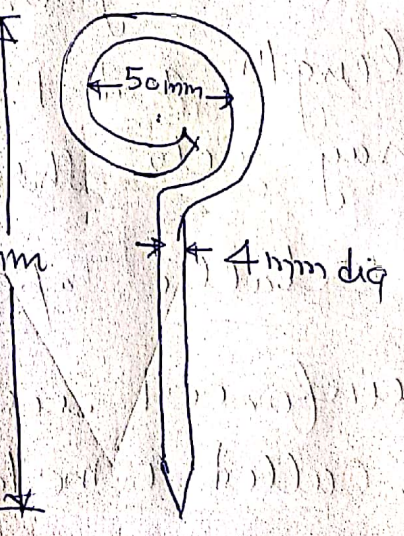


Fig. Arrows

(iv) Pegs :- These are made up of Wood. These are used to mark the positions of the end points of survey lines. The most commonly used section are 25mm x 25mm and 150mm long.

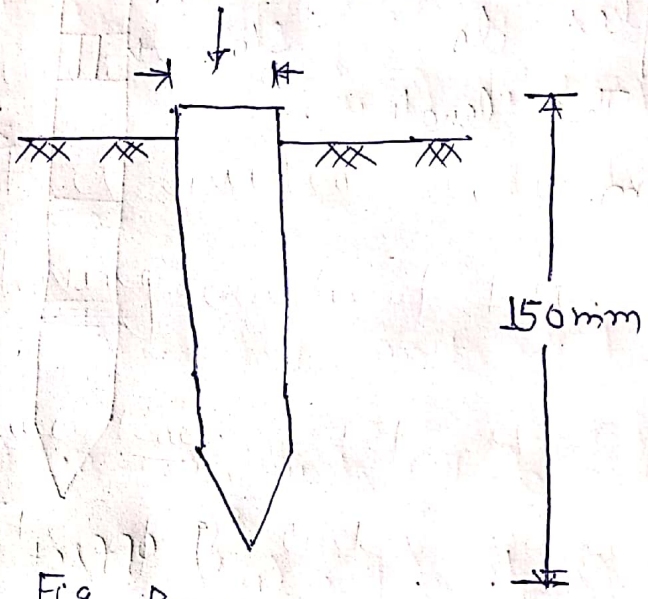


Fig. Pegs

(v) Ranging Rods :- Ranging rods are used to fix up the intermediate points on an survey line. They are of circular cross-section with dia. 3cm and lengths 2m and 3m.

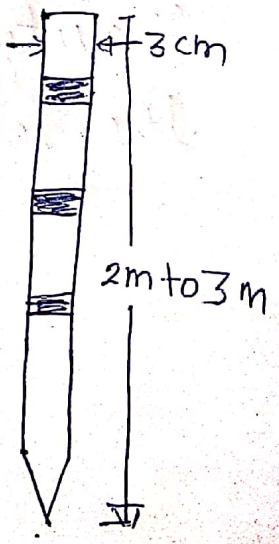


Fig. Ranging Rod

(vi) Offset Rods :- Offset rods are used for setting out right angles to the survey line. The two short slots are made up at right angles to each other. The length of rod is 3m.

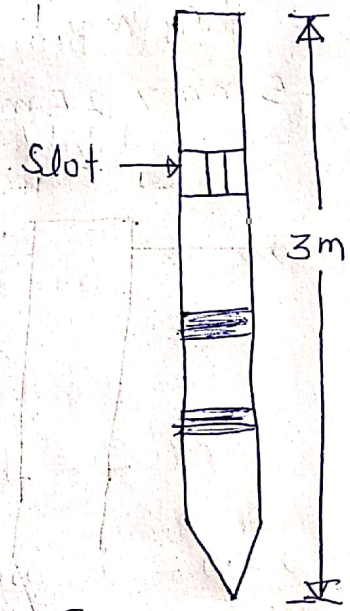


Fig. Offset Rod

(vii) Plumb Bob :- A plumb bob consists of a string attached at the top of the metal bob. As freely suspended plumb bob always points towards the gravity it indicate the direction of the vertical line.

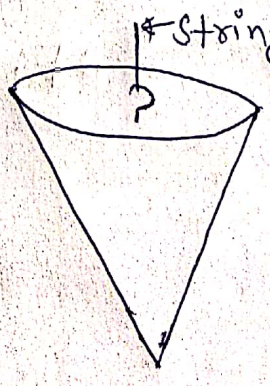


Fig. Plumb bob

Testing and Adjustment of Chain or Chain corrections :-

i) True length of Line (TL) $= \frac{L_1}{L} \times$ Measured Length of Line

ii) True area of a land (TA) $= \left(\frac{L_1}{L}\right)^2 \times$ Measured Area

iii) True Volume (TV) $= \left(\frac{L_1}{L}\right)^3 \times$ Measured Volume

Where,

L = True length of the chain

L_1 = Incorrect length of chain

$L_1 = L + e$, if chain is long

$L_1 = L - e$, if chain is short

e = Elongation or shortening of the chain

Q.1 The length of a line was measured with 20m chain and it worked out to be 580m. After measuring the length, it was found that the chain was 0.06m too long. What is the true length of the line.

Soln:- Given:

Length of the chain, $L = 20m$

Elongation of the chain, $e = 0.06m$

Measured length of the line $= 580m$

True length of line $= ?$

$L_1 = L + e = 20 + 0.06 = 20.06m$ (∵ chain is long)

True length of line $= \frac{L_1}{L} \times$ Measured length of line

$= \frac{20.06}{20} \times 580$

$= 581.74m$ Ans.

Q.2. The length of a line was measured with 20m chain and it work out to be 700m. After measuring the length, it was found that the chain was 0.08m too short. What is the true length of the line?

Soln. Given:

Length of the chain, $L = 20m$

Measured length of Line $= 700m$

Shortening of chain $e = 0.08m$

$\therefore L_1 = L - e = 20 - 0.08 = 19.92m$

True length of line $= ?$

$$\text{True length of line} = \frac{L_1}{L} \times ML$$

$$= \frac{19.92}{20} \times 700$$

$$= 697.20\ m \quad \text{Ans.}$$

Q.3. A distance of 5000m was measured by a 20m chain having actual length of 19.8m. Calculate correct distance measured state whether the correction is positive or negative?

Soln. Given:-

$ML = 5000m$

$L = 20m$, $L_1 = 19.8m$

$L_1 = L \pm e$

$\Rightarrow 19.8 = 20 - e$ (chain is short)

$\Rightarrow \boxed{e = 0.2m}$

$$TL = \frac{L_1}{L} \times ML$$

$$= \frac{19.8}{20} \times 5000$$

$$= 4950m$$

∴ Correction applied will be negative.

Q.4. A field was measured with a 30m chain and was found to be 21.50 hectares. It was afterwards found that the chain was 0.08m too short. Find out the true area of land.

Soln: Given:

Length of the chain, $L = 30m$

Measured Area $= 21.50$ Hectares

$e = 0.08m$

Incorrect Length of chain, $L_1 = L - e$ [∵ chain is short]

$\Rightarrow L_1 = 30 - 0.08 = 29.92m$

True area of land $= \left(\frac{L_1}{L}\right)^2 \times$ Measured area

$= \left(\frac{29.92}{30}\right)^2 \times 21.50$

$= 21.38$ hectares Ans.

Q.5. A distance of 4666 m was measured by a 30m chain, later it was detected that chain was 1.5 cm too long. Another distance of 2334 m was measured and the chain was found 2.5 cm too long. If the chain was initially correct, determine the exact length that was measured.

Solⁿ.

For 4666 m distance,

Length of chain, $L = 30m$

$e_1 = 0$ m

$e_2 = 1.5cm = 0.015m$

$\therefore$ Mean elongation $e = \frac{e_1 + e_2}{2} = \frac{0 + 0.015}{2} = 0.0075m$

$\therefore$ Incorrect length of chain $L_1 = L + e$

$= 30 + 0.0075$

$= 30.0075$ m

True length of Line $= \frac{L_1}{L} \times$ Measured Length

$= \frac{30.0075}{30} \times 4666$

$= 4667.16m$

For 2334m distance:-

$L = 30\,m$

$e_1 = 0.015\,m$

$e_2 = 2.5\,cm = 0.025\,m$

Mean elongation $e = \frac{e_1 + e_2}{2} = \frac{0.015 + 0.025}{2}$

$e = 0.02\,m$

$L_1 = 30 + 0.02 = 30.02\,m$

True length $= \frac{L_1}{L} \times$ Measured Length

$= \frac{30.02}{L} \times 2334$

$= 2335.55\,m$

Total distance $= 4667.16 + 2335.55$

$= 7002.71\,m$ Ans.

Q.6. The measurements of computing the volume of excavation were taken with a 20m chain which was found to be 0.03 m long. If the computed volume is 5000 m^3, find out the correct volume of excavation.

Soln. Given:

$$L = 20\ m$$

$$e = 0.03\ m \text{ long}$$

$$L_1 = 20 + 0.3 = 20.03\ m$$

Measured Volume $= 5000\ m^3$

$$\text{True Volume} = \left(\frac{L_1}{L}\right)^3 \times \text{Measured Vol}^u$$

$$= \left(\frac{20.03}{20}\right)^3 \times 5000$$

$$= 5022.5335\ m^3$$

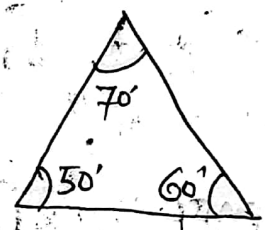
Chain Surveying

In this type of surveying only linear measurements are made, no angular measurements are taken.

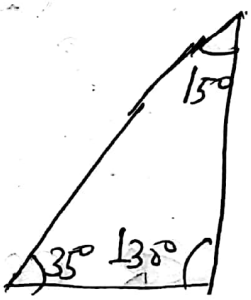
Principle of Chain Surveying:-

The principle of chain surveying is triangulation i.e. to divide the whole area in to no. of triangles of suitable sides.

(a) Ideal Triangle



(b) Well conditioned Δ (∵ 30° to 120°)



(c) Ill conditioned Δ

Survey Stations and Survey Lines:-

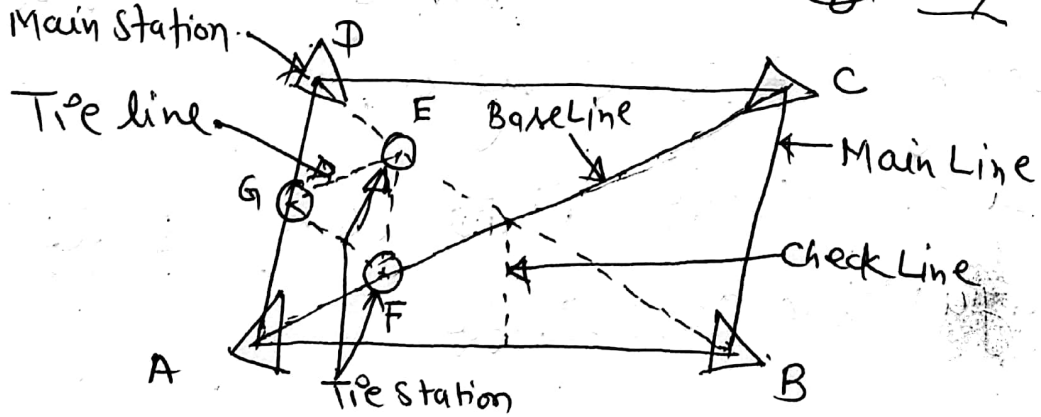
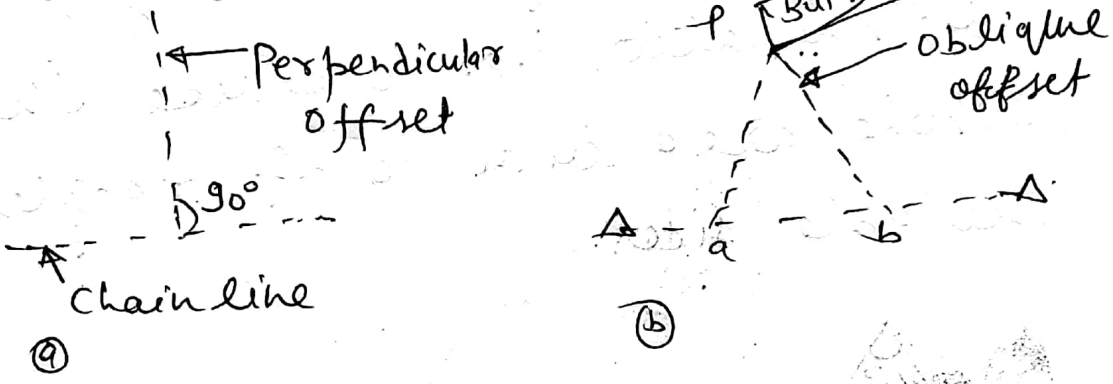


Fig. Survey station & Survey Lines

OFFSETS:-

Offsets are the lateral distances measured from the survey lines, to locate the position of a point w.r.t. the survey lines.

(i) Perpendicular offsets (ii) Oblique offset



CROSS STAFF:-

The cross staff is a simple instrument, which is used for setting out offsets to the chain line. This is also useful for setting out right angles.

(i) open cross-staff (ii) French cross staff

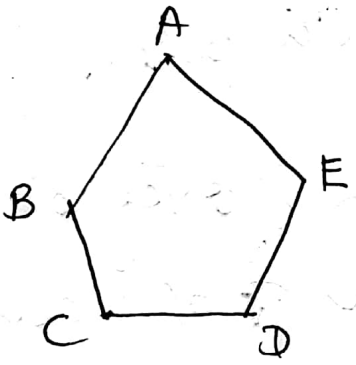
(iii) Adjustable cross staff

Compass Surveying :-

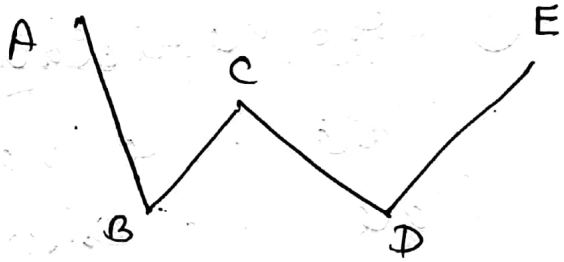
The branch of surveying in which directions of survey lines are determined by a compass and their lengths by chaining or taping is called compass surveying.

Traverse :-

A series of connected straight lines whose lengths and directions are known is called as traverse.



① Closed Traverse



② Open Traverse

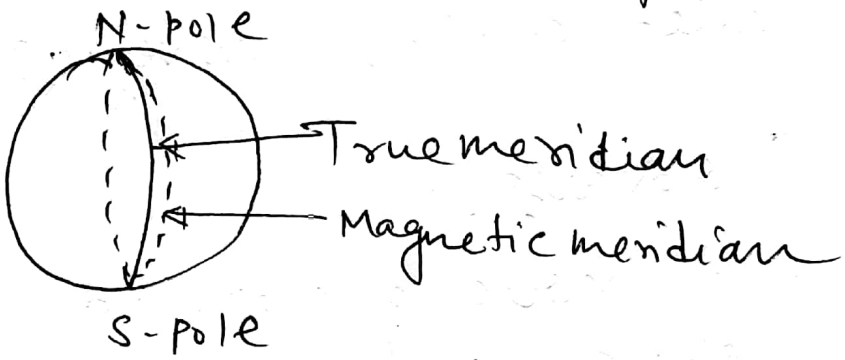
Types of Compass :-

① Prismatic Compass ← WCB (0-360°)

② Surveyor's Compass → QB (0-90°)
N K S

Meridian:- The direction/meridian is defined by the horizontal angle which the line makes with a reference line.

(1) True meridian:- Line joining the geographical north and south poles.



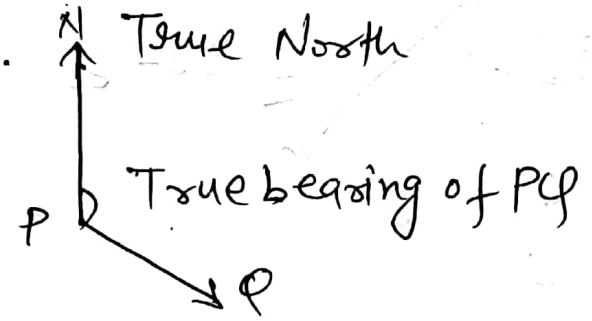
(2) Magnetic Meridian:- Lines joining the magnetic north and south poles.

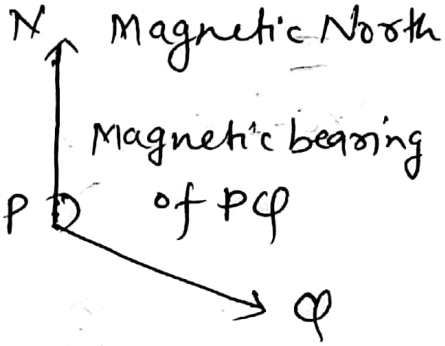
(3) Grid Meridian:- For survey of a state, true meridian of a central place is considered as grid meridian.

(4) Arbitrary meridian:- It is any convenient direction towards a permanent and prominent mark such as temple, chimney etc.

Bearing:- Bearing of a line is the the horizontal angle which it makes with a reference/meridian.

(1) **True bearing**:- It is the horizontal angle b/w the true meridian and a line.





(2) Magnetic Bearing

(3) Grid ~~Ber~~ Bearing

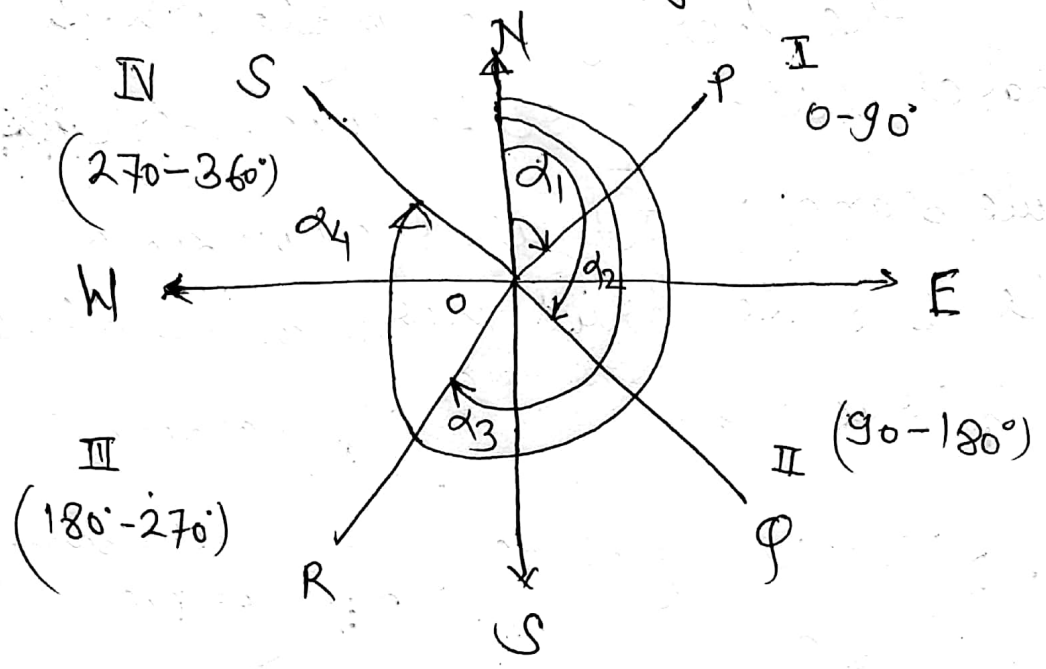
(4) Arbitrary Bearing

Designation of Bearings:-

(1) Whole Circle Bearing (WCB)

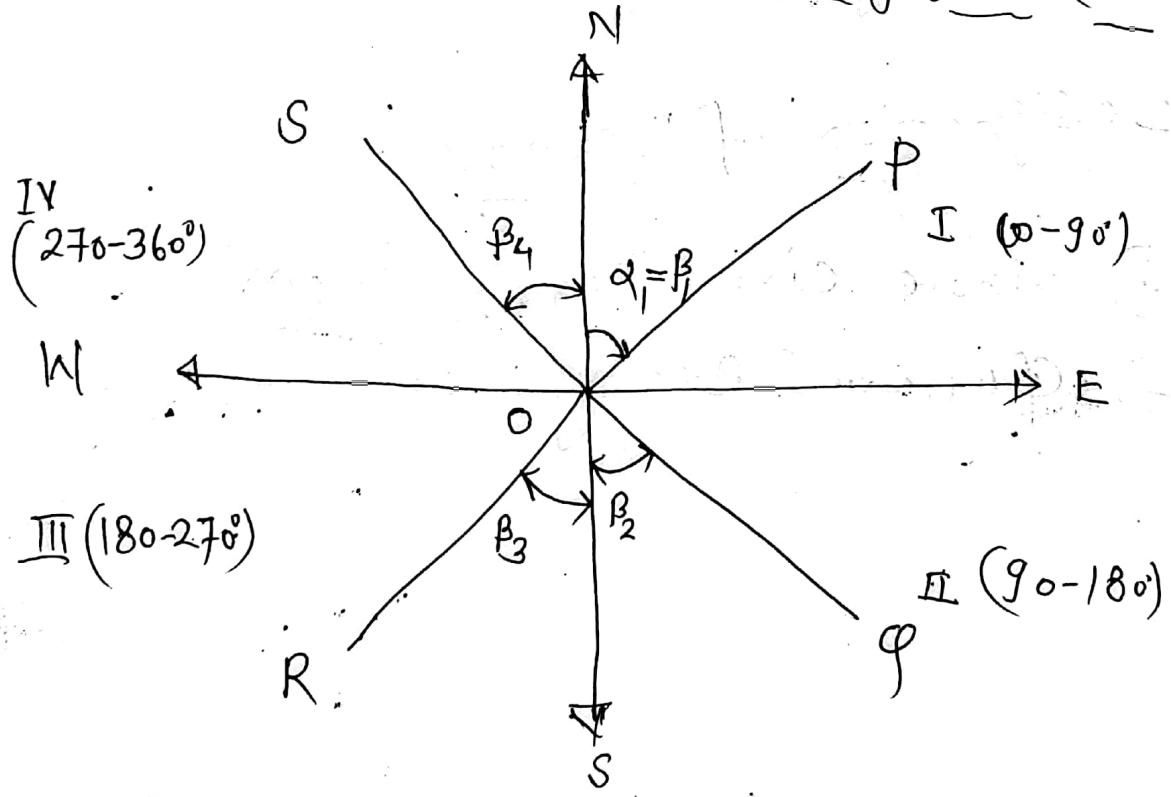
(2) Quadrantal Bearing or Reduced Bearing

① Whole Circle Bearing (WCB):-



④ WCB System

② Quadrantal or Reduced Bearing System (RB or QB):-



① QB or RB System

Conversion of WCB in to RB/QB

Line	Quadrant	WCB	Rule for RB	R.B.
OP	I	$\alpha_1 = 0° - 90°$	RB = WCB	$N \alpha_{\beta_1} E$
OQ	II	$\alpha_2 = 90 - 180°$	RB = 180° - WCB	$S \beta_2 E$
OR	III	$\alpha_3 = 180 - 270°$	RB = WCB - 180°	$S \beta_3 W$
OS	IV	$\alpha_4 = 270 - 360$	RB = 360° - WCB	$N \beta_4 W$

Conversion of RB in to WCB.

Line	Quadrant	R.B.	Rule for WCB.	W.C.B.
OP	I	$N \beta_1 E$	WCB = R.B.	$\beta_1 = \alpha_1$
OQ	II	$S \beta_2 E$	WCB = 180° - R.B.	$180° - \beta_2$
OR	III	$S \beta_3 W$	WCB = 180° + R.B.	$180° + \beta_3$
OS	IV	$N \beta_4 W$	WCB = 360° - R.B.	$360° - \beta_4$

Q. 1. Convert the following WCB to QB/R.B :-

(i) 22°50′ (ii) 130°20′ (iii) 190°40′ (iv) 290°30′

Soln. (i) R.B. = WCB = 22°50′ = N 22°50′ E

(ii) WCB = 130°20′

R.B = S (180° − 130°20′) E

R.B. = S 49°40′ E

(iii) WCB = 190°40′

R.B. = WCB − 180°

R.B = S (190°40′ − 180°) W

R.B = S 10°40′ W

(iv) WCB = 290°30′

R.B. = 360° − WCB

= 360° − 290°30′

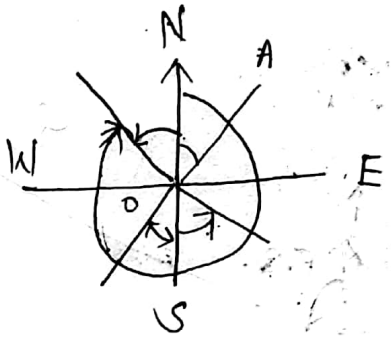
= N 69°30′ W

Convert the following Q.B. to W.C.B. −

(i) N 15°20E (ii) S 20°30′E (iii) S 56°20′W

(iv) N45°30′W

Sol^{n} (i) R.B. = N15°20'E



$\therefore$ WCB = RB.

WCB = 15°20'

(ii) R.B. = S20°30'E

W.C.B. = 180° − R.B

W.C.B. = 180° − 20°30' = 159°30'

(iii) R.B. = S 56°20'W

W.C.B = 180° + R.B.

W.C.B = 180° + 56°20' = 236°20'

(iv) R.B. = N45°30'W

W.C.B = 360° − R.B.

W.C.B. = 360° − 45°30' = 314°30'

Fore Bearing and Back Bearing:-

The bearing of a line in the direction of the progress of survey is called the fore bearing. The bearing of the line in the direction opposite to the direction of progress of survey is called back bearing.

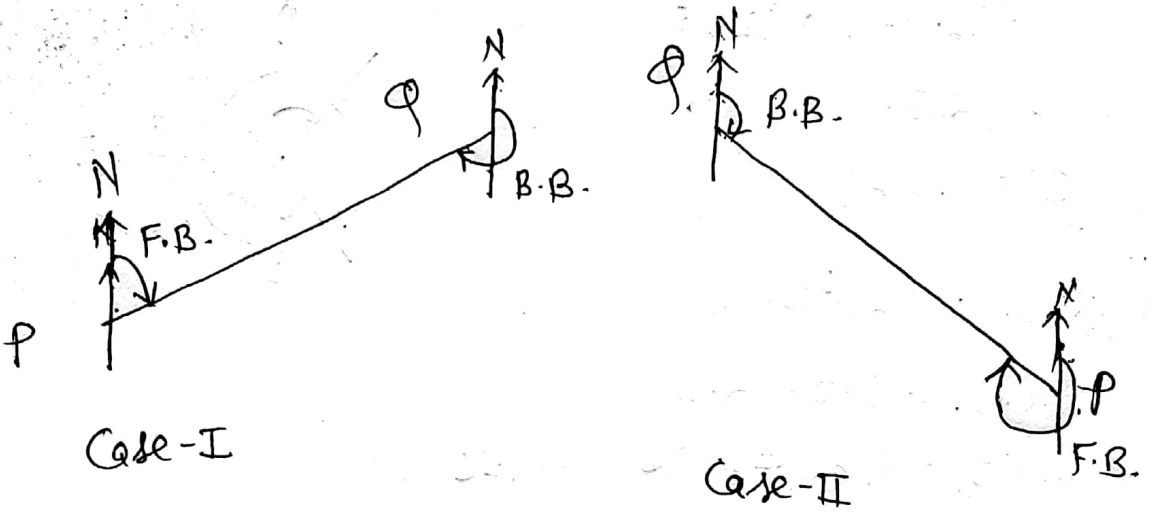


Fig. Fore and Back Bearing

$$B.B. = F.B. \pm 180^\circ$$

$$B.B. = F.B. + 180^\circ \quad \text{If } F.B. < 180^\circ$$

$$B.B. = F.B. - 180^\circ \quad \text{If } F.B > 180^\circ$$

Q.1. The fore bearings of the lines AB, CD, EF, and GH are as under –

(i) $15^\circ 30'$ (ii) $112^\circ 30'$ (iii) $260^\circ 20'$ (iv) $335^\circ 30'$

Determine the back bearings.

Soln (i) B.B. of line AB = F.B. $+180^\circ = 15^\circ 30' + 180^\circ = 195^\circ 30'$

(ii) B.B. of line CD = $112^\circ 30' + 180^\circ = 292^\circ 30'$

(iii) B.B. of line EF = $260^\circ 20' - 180^\circ = 80^\circ 20'$

(iv) B.B. of line GH = $335^\circ 30' - 180^\circ = 155^\circ 30'$

Q.2. Find the F.B. of the following lines from their B.B. —

(i) Line AB = 75°30′ (ii) Line CD = 110°30′

(iii) Line EF = 220°30′ (iv) Line GH = 280°30′

Soln. (i) F.B. of line AB = 75°30′ + 180° = 255°30′

(ii) F.B. of line CD = 110°30′ + 180° = 290°30′

(iii) F.B of line EF = 220°30′ − 180° = 40°30′

(iv) F.B. of line GH = 280°30′ − 180° = 100°30′

Q.3. Find the F.B. of the following lines from their B.B. —

(i) Line AB = N 50°30′ E (ii) Line CD = S 40°30′ E

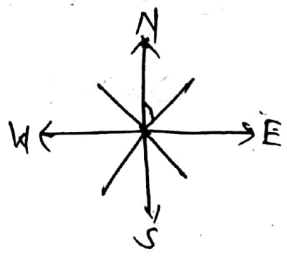
(iii) Line EF = S 30°30′ W (iv) Line GH = N 20°25′ W

Soln. (i) F.B. of line AB = S 50°30′ W

(ii) F.B. of line CD = N 40°30′ W

(iii) F.B. of line EF = N 30°30′ E

(iv) F.B. of line GH = S 20°25′ E



Q.4. Find the B.B. of following —

Soln (i) F.B. of Line AB = N 50°25′ W, B.B of Line AB = S 50°25′ W

(ii) FB of line CD = S 36°40′ W, B.B. of line CD = N 36°40′ E

(iii) FB of line EF = S 42°30′ E, B.B. of line EF = N 42°30′ W

(iv) F.B. of line GH = N 75°35′ E, BB of line GH = S 75°35′ W Ans.

Calculation of Included Angles from Bearings :-

> Included Angle = Bearing of Next line − Bearing of Preceding line

Note :- (1) If direction of traverse is clockwise then the direction of included angle will be anticlockwise (with −Ve sign). If I/A comes (+Ve), then minus this exterior Angle from 360° to get I/A.

(2) If direction of traverse is anticlockwise then the direction of included angle will be clockwise (with +Ve) sign). If I/A comes anticlockwise (-Ve), i.e. it is the exterior angle, then for finding out the interior angle, reduce the it from 360°.

(3) Sum of Interior Angles $= (2n-4) \times 90°$

(4) Sum of Exterior Angles $= (2n+4) \times 90°$

where, n = No. of sides of traverse

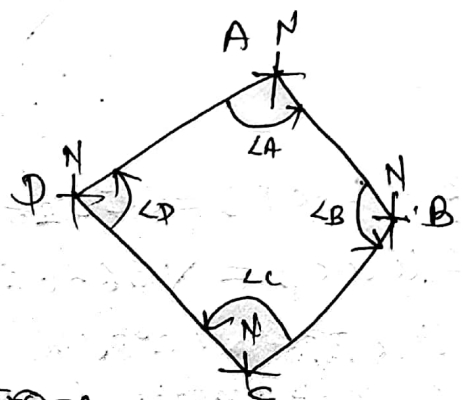
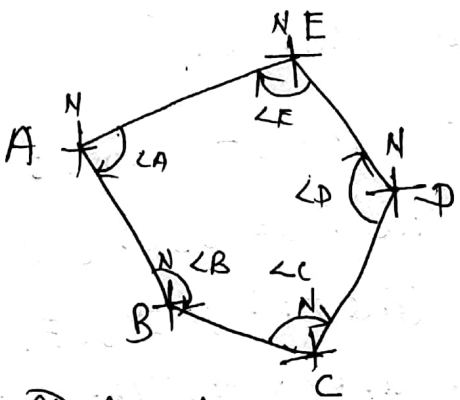


Fig (a) Clockwise Traverse

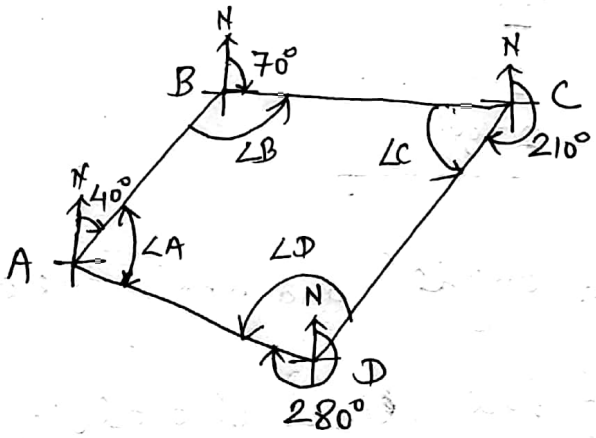


(b) Anticlockwise Traverse

Q.1. Find the included angles from the bearings of lines measured during a compass survey of a closed traverse ABCD, conducted in clockwise direction. Apply check.

Line	Fore Bearing	B.B = F.B ± 180°
AB	40°	220°
BC	70°	250°
CD	210°	30°
DA	280°	100°

Soln. I/A = Bearing of next line − Bearing of preceeding line



$\angle A$ = Bearing of line AB − Bearing of line AD

$\angle A = 40° - 100° = -60° = 60°$ (Anticlockwise)

$\angle B$ = Bearing of line BC − Bearing of line BA

$\angle B = 70° - 220° = -150° = 150°$ (Anticlockwise)

$\angle C$ = Bearing of line CD − Bearing of line CB

$\angle C = 210° - 250° = -40° = 40°$ (Anticlockwise)

$\angle D$ = Bearing of line DA − Bearing of line DC

$\angle D = 280° - 30° = 250°$ (clockwise) (Exterior Angle)

∴ Interior Angle $\angle D = 360° - 250° = 110°$ (Anti-clockwise)

Check - $\angle A + \angle B + \angle C + \angle D = (2n-4) \times 90° = (2\times4-4)\times90°$

$\Rightarrow 60° + 150° + 40° + 110° = 360° = 360°$ Hence ok

Q.2. Following bearings were observed during a Compass Survey of a closed traverse ABCD in a clockwise direction -

Line	F.B.
AB	38°
BC	72°
CD	197°
DA	279°

Find the included angles and apply the check.

Q.3- The bearings of the sides of a closed traverse ABCDEA are as follows -

Line	F.B.	B.B.
AB	107°15′	287°15′
BC	22° 00′	202° 00′
CD	281°30′	101°30′
DE	189°15′	9°15′
EA	124°45′	304°45′

Compute the interior angles of the traverse and apply checks.

Sol^{n}:

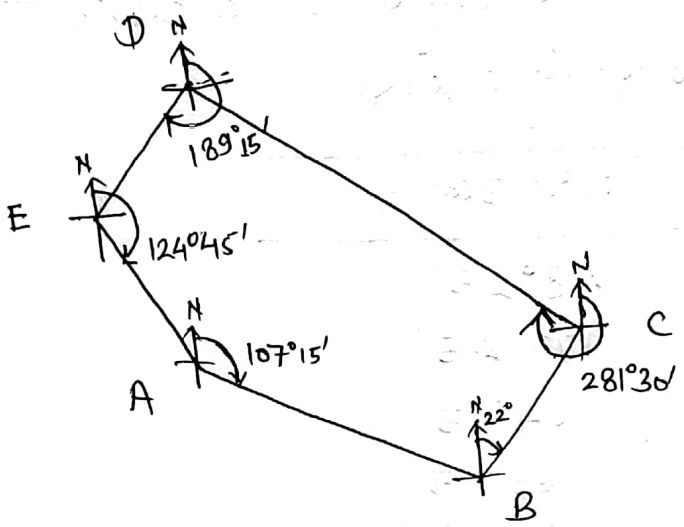


Fig. Traverse ABCDEA

Included Angle = Bearing of Next line - Bearing of preceeding Line

$\angle A$ = Bearing of line AB − Bearing of line AE

$\angle A = 107°15' - 304°45' = -197°30' = 197°30'$ (−Ve) Exterior Angle

∵ Traverse is anticlockwise, ∴ I/A should be clockwise (+Ve)

∴ I/A $\angle A = 360° - 197°30' = 162°30'$ (clockwise)

$\angle B$ = Bearing of line BC − Bearing of line BA

$= 22° - 287°15' = -265°15'$ (Anticlockwise) (Exterior)

∴ $\angle B = 360° - 265°15' = 94°45'$ (clockwise)

$\angle C$ = Bearing of line CD − Bearing of line CB

$\angle C = 281°30' - 202° = 79°30'$ (clockwise)

$\angle D$ = Bearing of line DE − Bearing of line DC

$\angle D = 189°15' - 101°30' = 87°45'$ (clockwise)

$\angle E = 124°45' - 9°45' = 115°30'$

Check: $\angle A + \angle B + \angle C + \angle D + \angle E = 540°$ $[(2n-4)\times 90 = (2\times 5-4)\times 90 = 540°]$ Ans

Q.4 Calculate included angle of a closed traverse, Given - Also apply checks.

Line	Fore Bearing
AB	48°25′
BC	177°45′
CD	104°15′
DE	165°15′
EA	295°30′

LOCAL ATTRACTION

It is the attraction to the magnetic needle due to sorrounding earth magnetic field such as iron ores, magnetic rocks, iron electric poles, cables carrying currents etc.

Detection of Local Attraction's -

If the difference between the fore and back bearings of any line not exactly 180°, that means line is affected by local attraction.

Q. 1. The following bearing were taken in running a compass traverse -

Line	F.B.	B.B.
AB	124°30′	304°30′
BC	68°15′	246°00′
CD	310°30′	135°15′
DA	200°15′	17°15′

At what stations do you suspect local attraction? Find the correct bearings of the lines and also compute the included angles.

Sol^n

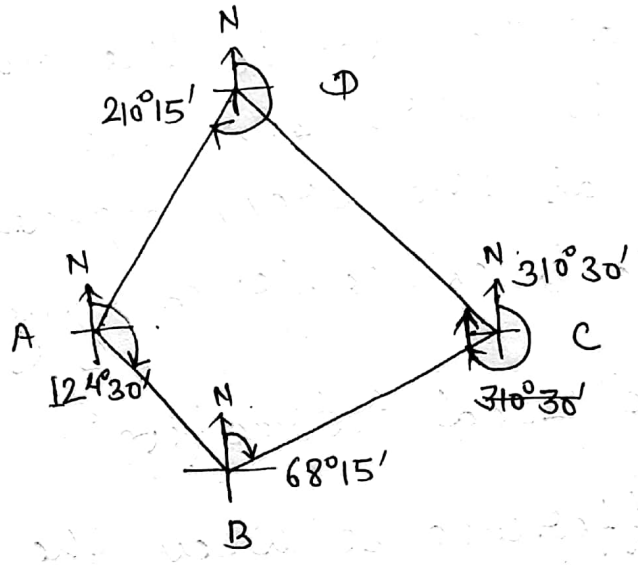


Fig. Traverse ABCDA (Anticlockwise)

Step 1 Calculation of Included Angles :-

$\angle A$ = Bearing of line AB − Bearing of line AD

$\angle A = 124°30' - 17°15' = 107°15'$ (clockwise) (+ve)

$\angle B$ = Bearing of line BC − Bearing of line BA

$= 68°15' - 304°30' = -236°15'$ (Anticlockwise) (Exterior) (−ve)

∴ I/A $\angle B = 360° - 236°15' = 123°45'$ (clockwise) +ve

$\angle C$ = Bearing of line CD − Bearing of line CB

$\angle C = 310°30' - 246° = 64°30'$ (clockwise) (+ve)

$\angle D$ = Bearing of line DA − Bearing of line DC

$\angle D = 200°15' - 135°15'$

$\angle D = 65°0'$ (clockwise) (+ve)

Step-2: Check for Included Angles:-

Sum of Included Angles $= (2n-4) \times 90^\circ$

$\angle A + \angle B + \angle C + \angle D = (2\times4-4)\times90^\circ = 360^\circ$

$107^\circ15' + 123^\circ45' + 64^\circ30' + 65^\circ = 360^\circ30'$

$\therefore$ Error $= 360^\circ30' - 360^\circ = 30'$

$\therefore$ Correction for each angle $= \frac{30'}{4} = 7'30''$

Therefore corrected angles of the traverse are -

$\angle A = 107^\circ15' - 7'30'' = 107^\circ7'30''$

$\angle B = 123^\circ45' - 7'30'' = 123^\circ37'30''$

$\angle C = 64^\circ30' - 7'30'' = 64^\circ22'30''$

$\angle D = 65^\circ - 7'30'' = 64^\circ52'30''$

Step-3: Finding out the line which is free from local attraction:-

F.B. and B.B. of line AB are differ exactly by 180°. Hence station A and B are free from local attraction.

Step-4: Calculation of Corrected Bearings:-

Corrected F.B of line AB $= 124^\circ30'$

Corrected B.B. of line AB $= 304^\circ30'$

$\therefore \angle B$ = Corrected F.B. of line BC − corrected bearing of BA

$\Rightarrow$ corrected F.B. of line BC $= 123^\circ37'30'' + 304^\circ30'$

$= 428^\circ7'30''$

∴ Corrected F.B. of line BC = 428°7'30" − 360° = 68°7'30"

∴ corrected BB of line BC = 68°7'30" + 180° = 248°7'30"

∠C = FB of line CD − Bearing of line CB

⇒ Corrected FB of line CD = Corrected ∠C + Bearing of line CB

= 64°22'30" + 248°7'30" = 312°30'

Corrected B.B. of line CD = 312°30' − 180° = 132°30'

∠D = Bearing of line DA − Bearing of line DC

⇒ Corrected F.B. of line DA = ∠D + Bearing of line DC

= 64°52'30" + 132°30' = 197°22'30"

Corrected B.B. of line DA = 197°22'30" − 180°

= 17°22'30"

Q.2

Line	Corrected F.B	Corrected B.B
AB	124°30'	304°30'
BC	68°7'30"	248°7'30"
CD	312°30'	132°30'
DA	197°22'30"	17°22'30"

Q.2. A closed compass traverse ABCD was conducted round a lake and the following bearings were obtained. Determine which of the stations are suffering from local attraction and give the values of the corrected bearing by included angle method.

Line	F.B.	B.B.
AB	74°20′	256°0′
BC	107°20′	286°20′
CD	224°50′	44°50′
DA	306°40′	126°0′

Q.3 The following bearings were observed during a compass survey. Name the stations which are affected by local attraction and find out the corrected bearings.

Line	F.B.	B.B.
AB	S 55°30′E	N 55°30′W
BC	N 68°15′E	S 66°0′W
CD	N 49°30′W	S 44°45′E
DA	S 20°15′W	N 17°45′E