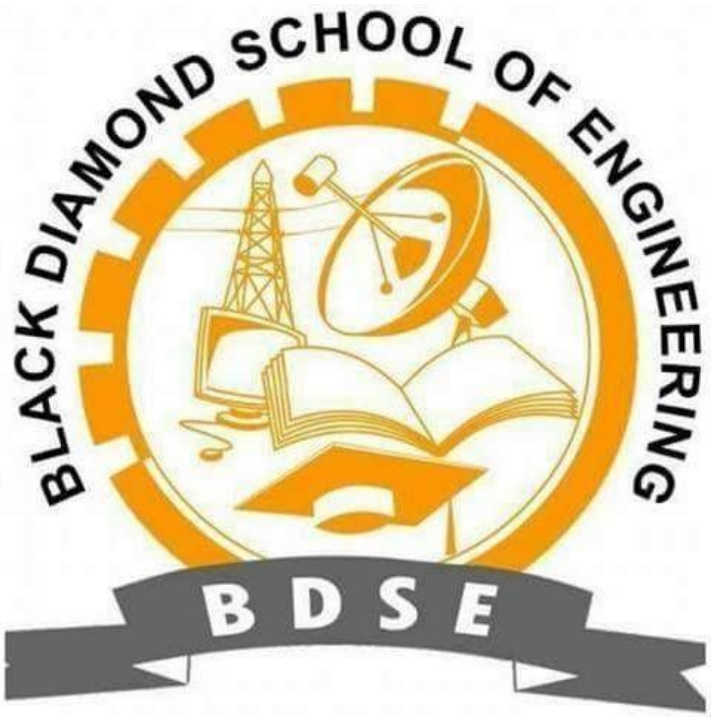
BLACK DIAMOND SCHOOL OF ENGINEERING, JHARSUGUDA

STUDY MATERIAL



ON

LAND SURVEY-I (TH-3)
FOURTH SEMESTER CIVIL ENGINEERING

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BASIC CONCEPTS

→ Objective of Surveying

(i) To take measurements for determining the locations of existing ground features.

(ii) To mark the positions of objects wrt. assumed datum

(iii) To calculate the related quantities like areas & volumes

→ Primary Divisions of Surveying:

(i) Plane Surveying
- neglect the curvature of earth.
- distances less than 18.5 km and areas less than 250 km^2.
- less accurate.

(ii) Geodetic Surveying.
- consider the curvature of Earth.
- large areas and more accurate.
- fixing the control points and boundary points of a field.

→ Classification of Surveys

* Based on Function:-

1. Control Survey
2. Land Survey
3. City Survey
4. Engineering Survey
5. Topographic Survey
6. Geological Survey
7. Archaeological Survey
8. Astronomical Survey
9. Hydrographic Survey
10. Gravity Survey.
11. Mining Survey
12. Military Survey
13. Satellite Survey

Topographic Survey:- It is carried out to dilineate features such as hills, rivers, forests and man made features like villages, buildings, transmission lines and roads.

Hydrographic Survey:- Related with water bodies like low water level, high flood level etc.

Gravity Survey:- Fluctuation of gravity value from place to place.

* Based on Instrument:

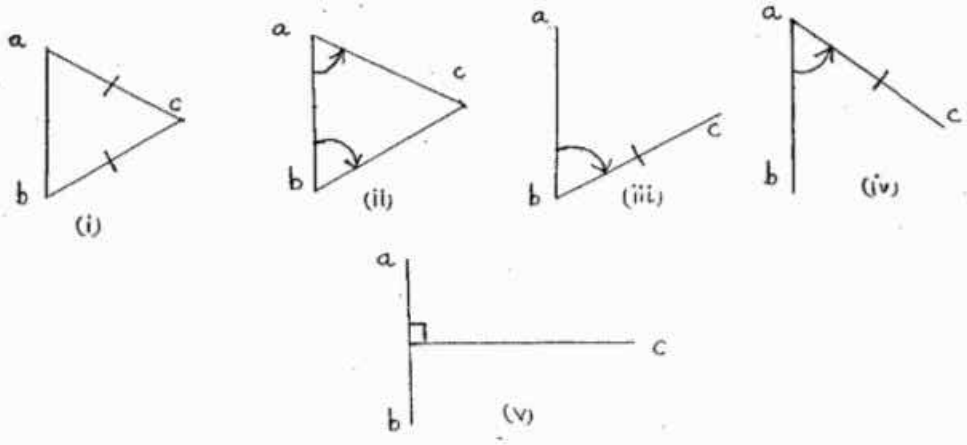
1. Chain Surveying
2. Compass Surveying
3. Plane table Surveying.
4. Levelling Surveying.
5. Theodolite Surveying
6. Photogrammetry.
7. EDM's. – Electronic Distance Measuring equipment.

– Trailetaration :-

It is the procors of measuring the sides of a triangle with the help of EDMs; esp.

→ Principles of Surveying

1. To locate the point wrt two known points.



2. Working from whole to the part but not from part to a whole.

Accumulation of errors can be reduced.

→ Basic Measurements in Survey

(i) Horizontal Distance.

Done by chain, tape, tacheometer, total station.

(ii) Vertical Distance.

Level, total station, tacheometer & sextant, Abney level (minor instrument)

(iii) Horizontal Angle

Compass, theodolite, clinometer (minor instrument), total station.

(iv) Vertical Angles.

Theodolite, sextant and total station.

→ Scale of a Map

It is the ratio blw distance on the map to the distance on the ground.

$$\text{Scale} = \frac{\text{distance on the map}}{\text{distance on the ground.}}$$

1 : 1000 ⇒ 1 unit on map = 1000 units on ground.

(i) Large Scale — 1 cm = 10 m

(ii) Medium Scale. — 1 cm = 100 m

(iii) Small Scale. — 1 cm > = 100 m

(iv) Engineer's Scale — 1 cm = 50 m

Degree of accuracy = 1 in n.

ie 1 unit of error in n units of measured value.

→ Precision.

It is closeness to the some other measured quantity.

→ Sources of Errors

(i) Instrumental errors :- when instrument is not caliberated at regular intervals. by permanent adjustments.

(ii) Personal errors :-

(iii) Natural errors

→ Types of Errors

(i) Mistakes.

(ii) Systematic errors

(iii) Accidental or Random error.

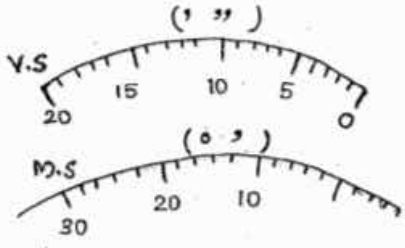
Random errors are directly proportional to square root of 'n'; where n is ~~total no: of observations~~

$$\boxed{\text{Random error} \propto \sqrt{n}}$$

→ Vernier Scales

$$\text{Least Count, } LC = \frac{S}{n}$$

$$= \frac{1 \text{ MSD}}{\text{No. of VSD's}}$$



* Types of Verniers

(i) Direct Vernier.

'n' divisions of vernier = (n-1) divisions of MS

(ii) ~~Extended~~ Retrogade. Vernier

'n' divisions of vernier = (n+1). divisions of MS

(iii) ~~Retrograde~~ extended Vernier

'n' division of vernier = (2n−1) . div. of MS

Q.9. Scale = 1 : 1000

1 mm ⇒ 1000 mm.

0.25 mm ⇒ ?

$= \frac{0.25}{1} \times 1000$

= 250 mm = 0.25 m

Q.10. Representative fraction, RF = $\frac{0.5 \text{ cm}}{10 \text{ m}} = \frac{0.5}{10 \times 100} = \frac{1}{2000}$

Q.11 $CD = MD\left(\frac{\text{R.F of WS}}{\text{RF of CS}}\right) = 468\left(\frac{\frac{1}{2000}}{\frac{1}{4000}}\right)$

= 936 m

Q.12. 1 MSD = S = 30'

No: of VSD, n = 60

$LS = \frac{30'}{60} = \frac{(30 \times 60)''}{60} = 30''$

Q.13. 1 MSD = $S = \frac{1}{6} \times 60' = 10'$

n = 20

$LC = \frac{(10 \times 60)''}{20} = 30''$

14 $S = 1^\circ = 60'$

For extended vernier,

$$2n - 1 = 11$$

$$n = 6$$

$$\therefore \text{LC} = \frac{60'}{6} = 10'$$

15. n div. of 'V' = (n+1) div. of 'S'

$$10\ V = 11\ S$$

16 RF = $1/2500$

1 cm = 2500 cm

$\Rightarrow$ 1 cm = 25 m

18. $\text{SF} = \frac{90}{100} = 0.9$.

SRF = Original RF * SF

$$= \frac{1}{1000} * 0.9 = 9 \times 10^{-4}$$

$$= \frac{1}{1111}$$

$\Rightarrow$ 1 : 1111

24. $\text{SRF} = \frac{1}{2500} * \frac{24}{25} = \frac{1}{2604.16}$

$\Rightarrow$ 1 : 2600

25 $\text{SF} = \frac{9}{10} = 0.9$

$\text{CA} = \frac{\text{MA}}{\text{SF}^2} = \frac{81}{(0.9)^2} = 100\ \text{cm}^2$ (on the plan).

CA on the field = $100 \times 10 \times 10 = 10000\ \text{m}^2$ (SCALE $1 : 10^m$).

2. LINEAR MEASUREMENTS

1. Direct Method : Chain or tape.
2. Optical Method : EDM

EDMs are classified as:

(i) Light Waves – Geodimeter, Mekameter & Range Finder

(ii) Microwaves – Distomat, Decca navigator, Lambda Omega, Tellurometer etc.

3. Approximate Methods:
   a) Pacing : 75 cm to 95 cm
   b) Parsometer : gives the no. of foot steps covered.
   c) Pedometer
   d) Perambulator / Odometer
   e) Speedometer

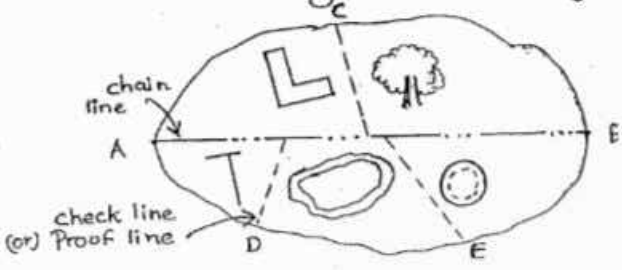
→ Chain Survey

→ Principle

(i) Triangulation.

Baseline : Longest line laid approximately through middle of field. It is a chain connecting main survey stations.

Offsets : lateral distances measured from chain line (base line) to objects.



Offsets are of two types:

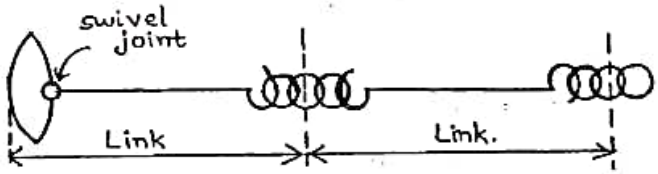
(i) 1^{st} offset.

(ii) Oblique offset.

→ Instruments for Chain Surveying

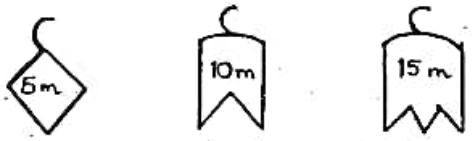
(i) Chains
(ii) Tape
(iii) Ranging rods.
(iv) Arrows.
(v) Offset Rod.
(vi) Cross Staff
(vii) Plumb bob
(viii) Wooden Peg
(ix) Plasterers, laths & whites

→ Chain (metric)

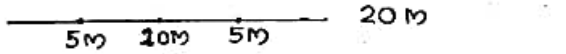


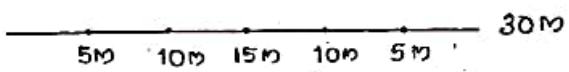
In metric chain, link = 0.2 m
= 20 cm

- Brass rings are provided every 1 m
- Tallies are provided for every 5 m.



Tallies	5 M	10 M	15 M
20 M	2	1	0
30 M	2	2	1





- Standard temp : 20°c
  Allowable pull : 8 kg
- 20 m ⟹ ±5mm
  30 m ⟹ ±8mm

→ Types of Chains

(i) Metric Chain : 20 M, 30 M

(ii) Gunter's chain : 66 ft, 100 links (Surveyor's chain)

(iii) Revenue Chain : 33 ft, 16 links

(iv) Engineer's chain : 100 ft, 100 links.

→ Sources of Errors

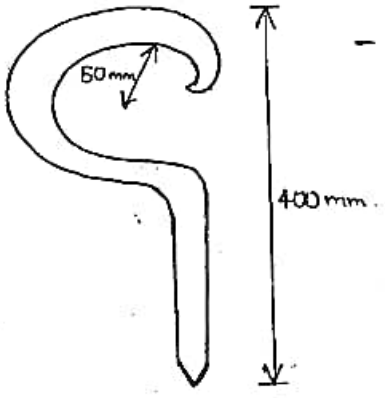
→ Tapes :

- Least count : 1 mm.
- Types of tapes :-
  - (i) Cloth or linen tape :- 10 m, 15 m, 20 m, 30 m
  - (ii) Metallic tape : Survey works, construction works
  - (iii) Steel tape : 2 m, 5 m, 10 m, 15 m, 20 m, 30 m, 50 m)
  - (iv) Invar tape : steel (64%) & nickel (36%)

Invar tape is used for baseline measurements.

$$\alpha = 1.2 \times 10^{-6}/^{\circ}C \quad \Rightarrow \quad \alpha = \frac{1}{10}\alpha_s$$

→ Arrows :



- At the end of every chain length, an arrow is fixed.

→ Ranging Rods:

- purpose of ranging rods is to range a line.
- they are available at 2m & 3m length

→ Offset Rod:

- maximum length is 5m.

→ Cross Staff:

(i) Open Type – 90°

(ii) French type – 45° & 90°

(iii) Adjustable ± @ 15° interval

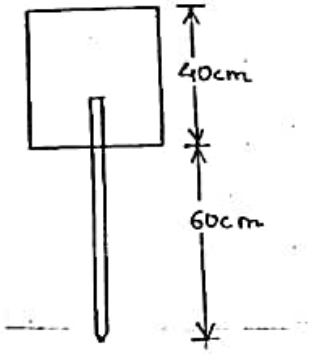
→ Plumb bob:

To check the verticality of ranging rods, cross staff e

→ Wooden Pegs:

To mark the terminal stations

→ Plasterers Lath's & whites



– used to mark the intermediate station in an open level ground online with a base line.

→ Ranging out Survey Lines:

– Ranging is required when the length of a line to be measured is greater than the chain length

– methods of ranging:

(i) Direct Ranging: It is possible when two stations are intervisible.

a) By eye judgement

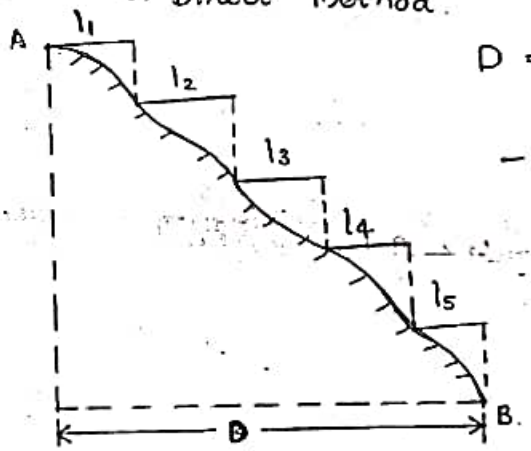
b) By using Line Ranger

(ii) Indirect Ranging / Reciprocal Ranging:

– when stations are not intervisible.

→ Chaining on Uneven / Sloping Ground:

(i) Direct Method.



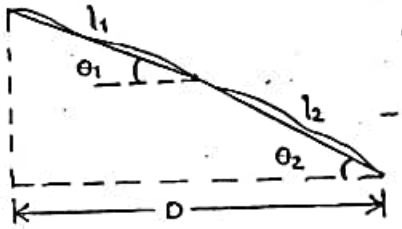
$$D = \sum_{i=1}^{n} l_i$$

- measuring down the hill is easier than up the hill.

E → Young's modulus

(ii) Indirect Method.

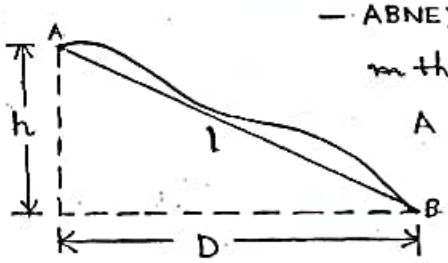
a)



- Clinometer is used to measure the angles.

- $D = \sum_{i=1}^{n} l \cos\theta$

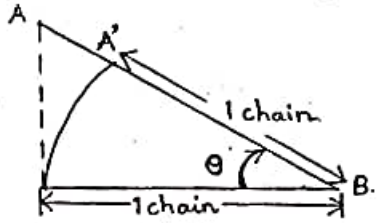
b)



- ABNEY level is used to measure the level difference b/w A & B.

$$D = \sqrt{l^2 - h^2}$$

c) Hypotenusal Allowance



It is the correction to be applied in the field at every chain length and every point, where the slope changes.

This facilitates in locating & surveying the intermediate points.

Hypotenusal Allowance, $AA' = AB - BA'$

$$\cos\theta = \frac{BC}{AB} = \frac{100 \text{ links}}{AB}$$

$$\therefore AB = 100 \sec\theta \text{ link}$$

$$\therefore AA' = (100 \sec\theta - 100) \text{ links} = 100 (\sec\theta - 1) \text{ links}$$

AA' is the correction for 1 chain ($= 20m = 100$ links). This can be extended to any length.

$$\Rightarrow AA' = 50\theta \; 100 \left(1 + \frac{\theta^2}{2} + \cdots - 1\right)$$

$$\therefore AA' = 50\theta^2 \text{ links.} \quad (\theta \text{ radians})$$

$$= 0.015\theta^2 \text{ links} \quad (\theta \text{ degrees})$$

⊙ When slope is given as 1 in n ($\theta \approx \tan\theta \approx \frac{1}{n}$)

$$AA' = \frac{50}{n^2} \text{ links.} = \frac{50}{n^2} \times 0.02 \text{ m.}$$

NOTE:

For 30 m chain, $AA' = 150 (\sec\theta - 1)$ links.

$$= 75\theta^2 \text{ links; } (\theta \text{ radians})$$

→ Errors in Chaining:

(i) Cumulative Errors

Cumulative error is the one which occurs in the same direction and get accumulate.

(ii) Compensating Errors

Compensating error may occur in either direction and tends to compensate.

1. Erraneous Length of a Chain/tape: cumulative '±'
2. Bad Ranging cumulative '+'
3. Careless holding & marking compensating '±'

4. Bad straightening. Non horizantality & Sag in Chains. } Cumulative '+'

5. Variation in temp : Cumulative '±'

6. Variation in pull : Cumulative '±'

TAPE CORRECTIONS

1. Correction for Standardisation

$$C_a = \frac{L \cdot C}{l}$$

$L \rightarrow$ measured length of a line.

$C \rightarrow$ correction for tape length.

$l \rightarrow$ designated length of a tape.

$C_a \rightarrow$ +ve if tape or chain is too long

$C_a \rightarrow$ −ve if tape or chain is too short.

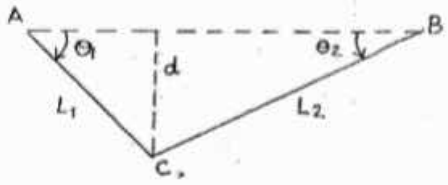
2. Correction for Slope

$$C_{SL} = L - \sqrt{L^2 - h^2} = \frac{h^2}{2L}$$

$$C_{SL} = L - L\cos\theta = L(1-\cos\theta) = 2L\sin^2\left(\frac{\theta}{2}\right)$$

C_{SL} is always −ve.

3. Correction for misalignment.



$$C_{MA} = \frac{d^2}{2L_1} + \frac{d^2}{2L_2}$$

$$C_{MA} = L_1(1-\cos\theta_1) + L_2(1-\cos\theta_2) \quad \{C_{MA} \text{ is always } -ve\}$$

4. Correction for temperature

$$C_t = L\alpha(T_m - T_0)$$

where T_m → temperature during measurement.
T_o → standard temperature.

C_t is +ve ($T_m > T_o$) & C_t is −ve ($T_m < T_o$)

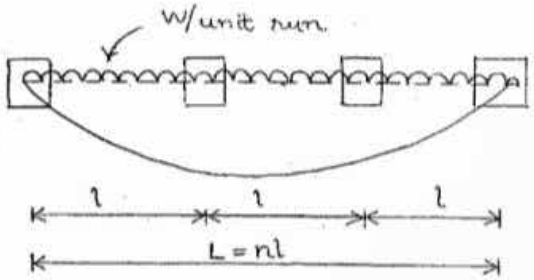
5. Correction for Pull.

$$C_p = \frac{(P - P_o) * L}{AE}$$

C_p is +ve ($P > P_o$)
C_p is −ve ($P < P_o$)

P_o → standard pull.
E → Young's modulus of tape ($= 2 \times 10^5$ MPa if not given)
A → c/s area of tape
P → pull applied during measurement.

6. Correction for Sag.



n = no. of bays.

(i) If both the supports are at same level.

$$C_{sag} = \frac{(wl)^2 l}{24 P^2} \quad ; \text{ for length 'l'}$$

$$= \left(\frac{(wl)^2 l}{24 P^2}\right) * n \quad ; \text{ for 'n' no. of bays.}$$

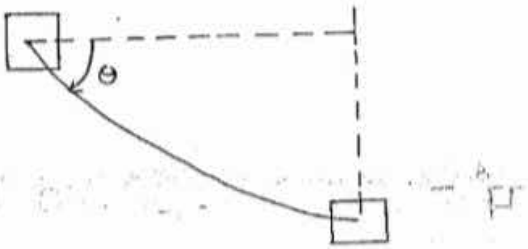
$$= \frac{w^2 \left(\frac{L}{n}\right)^2 L}{24 P^2} = \frac{(wL)^2 L}{24 n^2 P^2} \quad ; \text{ for length 'L'}$$

$$= \frac{W^2 L}{24 n^2 P^2}$$

$W = wL$
= weight of tape

Correction for sag is always −ve

(ii) If ends are at different level.



$$C'_{sag} = C_{sag} \times \cos^2\theta.$$

7. Correction for normal tension.

$$P_n = \frac{0.204\, w \sqrt{AE}}{\sqrt{P_n - P_o}}$$

where $P_n \rightarrow$ normal tension.

$P_o \rightarrow$ standard pull.

$w \rightarrow$ total weight of tape

$A \rightarrow$ c/s area of tape

$E \rightarrow$ young's modulus of material of tape

8. Correction for Mean Sea Level.

$$C_{MSL} = \frac{Lh}{R}$$

where $L \rightarrow$ length of a tape.

$h \rightarrow$ height of object above or below MSL

$R \rightarrow$ radius of curvature of earth. ($= 6370$ km).

$C_{MSL} \rightarrow$ +ve ; if object lies above MSL

$C_{MSL} \rightarrow$ -ve ; if object lies below MSL

→ Limiting Length of Offset

The min. length of an offset in plotting is 0.25 mm

The length of offset on ground depends on scale value that we are using

1 mm → 100 mm

0.25 mm → 25 mm.

Eg: 1) Scale 1 : 100.

Length of offset on ground = 25 mm

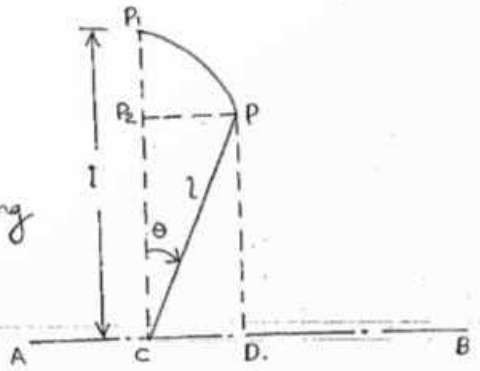
2) Scale 1 : 500

Length of offset on ground = 125 mm.

Let the scale of a map be

1 cm = 'S' m.

Degree of accuracy in limiting the length of an offset = 1 in r



- Displacement of point P parallel to the chain line = PP_2

$$PP_2 = l \sin\theta$$

$$= \frac{l \sin\theta}{S} \text{ cm}$$

$$\frac{l \sin\theta}{S} = 0.025$$

ie limiting length of an offset, $l = 0.025\, S\, \text{cosec}\,\theta$.

$$\boxed{l = 0.025 * S * \text{cosec}\,\theta}$$

- Displacement of point P perpendicular to chain line

$$= P_1P_2$$

$$P_1P_2 = l - l\cos\theta$$

$$= \frac{l(1-\cos\theta)}{s}$$

$$\therefore \boxed{P_1P_2 = \frac{l(1-\cos\theta)}{s}}$$

Degree of accuracy can be calculated from,

$$\boxed{r = \text{cosec}\,\theta.}$$

Limiting length of an offset by considering both linear and angular displacements,

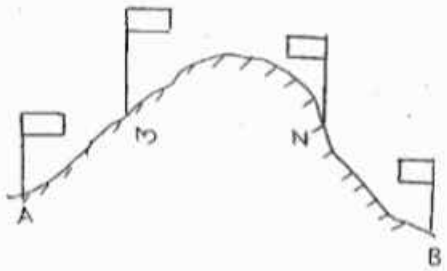
$$\boxed{l = \frac{s.r}{40\sqrt{2}}}$$

→ Instruments for setting Perpendicular Offsets.

1. Cross-staff : 90° only.
2. Optical square : 90° only.
3. Prism square : 45° & 90° only
4. Side square : 90° only.

→ Obstacles in Chain Surveying

1. Obstacle to Ranging but not chaining

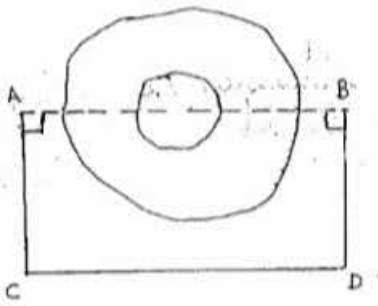


Eg: Hill.

2. Obstacle to Chaining but not Ranging

Eg: Pond, river.

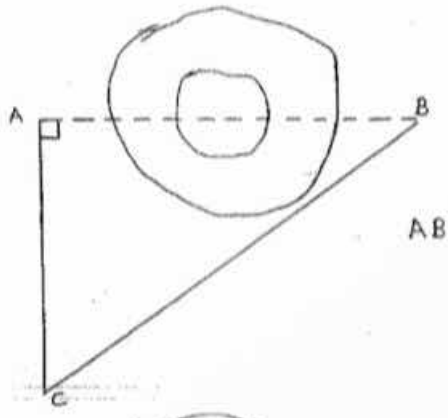
(i)



$BD = AC$

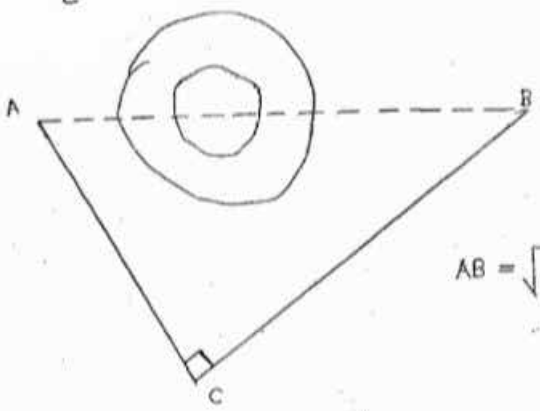
$\therefore AB = CD.$

(ii)



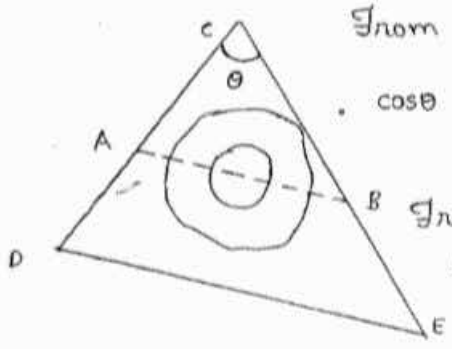
$$AB = \sqrt{BC^2 - AC^2}$$

(iii)



$$AB = \sqrt{AC^2 + BC^2}$$

(iv)



From triangle DCE,

$$\cos\theta = \frac{CD^2 + CE^2 - DE^2}{2 * CD * CE} \rightarrow (1)$$

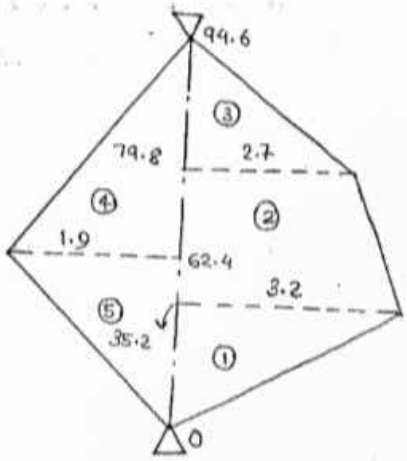
From triangle ACB,

$$\cos\theta = \frac{CA^2 + CB^2 - AB^2}{2 * CA * CB} \rightarrow (2)$$

Equating ① & ②, find AB.

→ Cross - staff Survey

It is done to locate the boundaries of field and also to to calculate the area.



$A_1 = \frac{1}{2} \times 35.2 \times 3.2 = 56.32\ m^2$

$A_2 = \frac{1}{2}(79.8 - 35.2)(3.2 + 2.7) = 131.57\ m^2$

$A_3 = \frac{1}{2}(94.6 - 79.8)(2.7) = 19.98\ m^2$

$A_4 = \frac{1}{2}(94.6 - 62.4)(1.9) = 30.59\ m^2$

$A_5 = \frac{1}{2}(62.4)(1.9) = 59.28\ m^2$

Total area, $A = A_1 + A_2 + A_3 + A_4 + A_5$

$= 297.74\ m^2$

07. Correction for temperature, $C_t = L\alpha(T_m - T_0)$

$= 20 \times (6 \times 10^{-6}) \times (30 - 55)$.

$= -0.003\ m$

11. $L' = \frac{20.10 + 20.30}{2} = 20.2\ m$

$A = A'\left(\frac{L'}{L}\right)^2 = 32.56\left(\frac{20.2}{20}\right)^2 = 33.21\ cm^2$

$10\ cm = 8\ m \Rightarrow 1\ cm = 0.8\ m.$

$33.21\ cm^2 = 33.21 \times 0.8 \times 0.8$

$= 21.256\ m^2$

12 With 20m chain :

$$\text{Corrected distance} = 1200 \times \frac{20.1}{20} = 1206 \text{ m}$$

With 25 m chain :

$$1206 = 1212 \times \frac{L'}{25}$$

$$\Rightarrow L' = \underline{24.88 \text{ m}}$$

13. $W = \gamma V = (7.86 \times 0.08 \times 3000) \times 10^{-3}$.

$= 1.8864$ kg.

Correction for sag, $C_{sag} = \frac{W^2 L}{24 n^2 p^2} = \frac{1.886^2 \times 30}{24 \times 3^2 \times 10^2}$

$= 0.0049$ m.

C_{sag} is always negative.

$\therefore C_{sag} = -0.0049$ m

15. Degree of accuracy, $r = \text{cosec } \theta$

$= \text{cosec } 1°30'$

$= 38.25$.

DA = 1 in r

= 1 in 38.25 ($\simeq$ 1 in 39).

16. $l = \frac{S \cdot r}{40\sqrt{2}} = \frac{20 \times 40}{40\sqrt{2}} = \underline{14.14 \text{ m}}$

S : 1 cm = 20 m

r : 1 in 40.

20 $1\,mm = 1000\,mm$

$0.1\,mm = 100\,mm$

$\therefore 0.1\,mm = 0.1\,m$

P-8

19 $\tan\theta = \frac{1}{20}$

$\therefore \theta = 2.86^{\circ}$

$\cos\theta = 0.998$

Correction for slope, $C_{SL} = L(1-\cos\theta)$

$= 60(1-0.998) = 0.075\,m$

$= 7.5\,cm$

COMPASS SURVEY

* Principle

Direction of a line can be measured

→ Types of Meridian

(i) True meridian

It is at a point a grade circle passing throug the geographical north and south pole of earth surface.

(ii) Magnetic meridian.

It is a direction shown by a magnetic north when it is freely suspended.

(iii) Grid meridian

It is a reference line established by state governments in the middle of the state for their cross projec in various departments.

(iv) Arbitary meridian

It is a local reference point taken for measurem

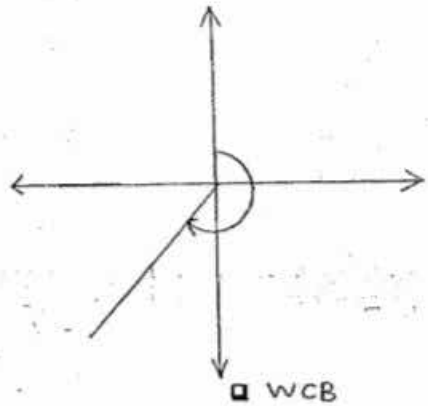
→ Bearing of a Line

It is the horizontal angle made by a line with any type of reference meridian.

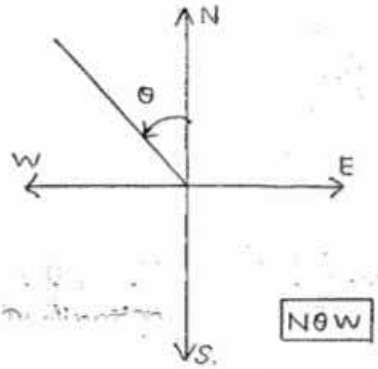
→ Systems of Bearing

1. Whole Circle Bearing (WCB) System (Azimuthal System)
2. Quadrantal (or) Reduced Bearing System.

Bearing of line will be measured wrt N or S whichever is nearer.



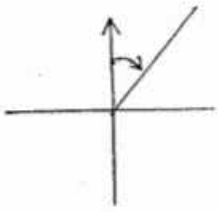
■ WCB



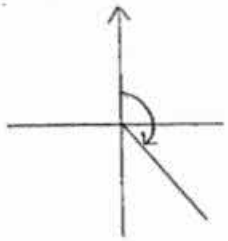
NθW

■ QB or RB.

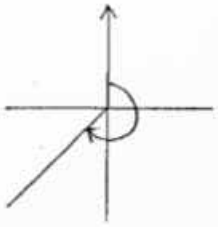
* Conversion of WCB into QB.



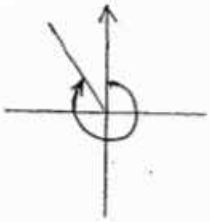
NθE



S(180-θ)E

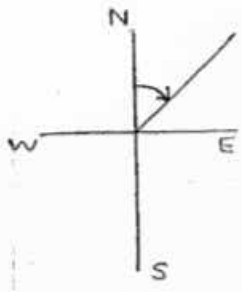


S(θ-180)W

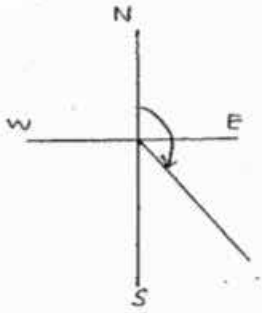


N(360-θ)W

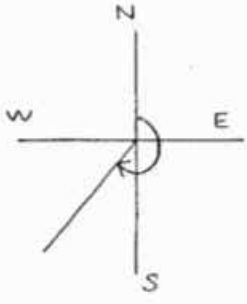
* Conversion of QB into WCB.



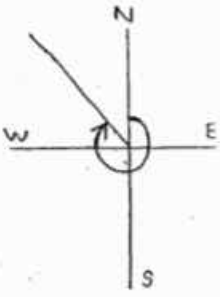
θ



180-θ



180+θ



360-θ

→ Forebearing & Backbearing of a Line.

Forebearing of a line is the bearing of a line measured in the direction of progression of a survey.

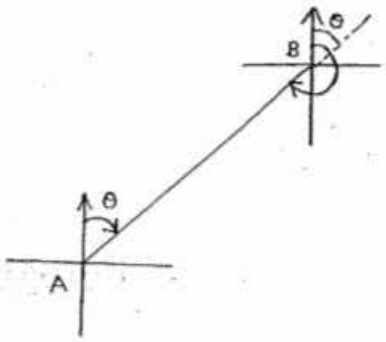
Backbearing of a line is the bearing of a line measured opposite to the direction of progression of survey.

- Backbearing of line AB

= Bearing of line BA.

$= \theta + 180$

$= FB + 180$



$$\boxed{BB = FB \pm 180^\circ}$$

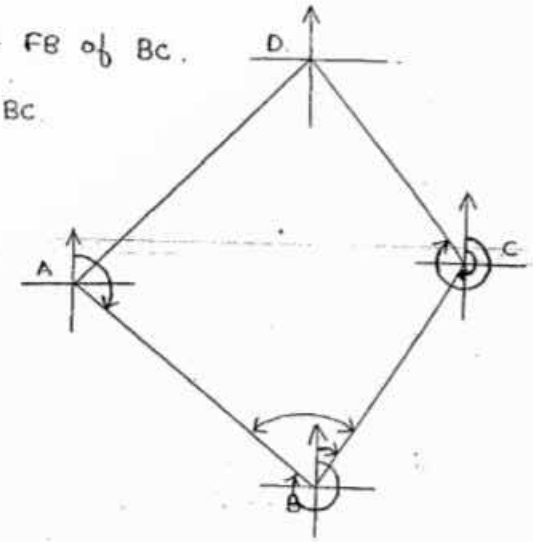
Use '+', if $FB < 180^\circ$

'−', if $FB > 180^\circ$

* Calculation of Interior Angles from given bearings.

$\angle B = (360 - BB \text{ of } AB) + FB \text{ of } BC.$

$\angle C = FB \text{ of } CD - BB \text{ of } BC$

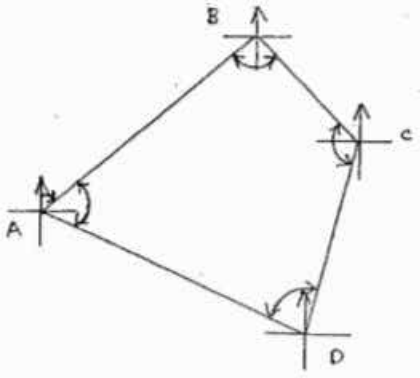


* Calculation of Bearings from given interior angles.

$(FB)_{BC} = (BB)_{AB} - \angle B.$

$360 - (FB)_{DA} + (BB)_{CD} = \angle D.$

$(FB)_{DA} = 360 - \angle D + (BB)_{CD.}$

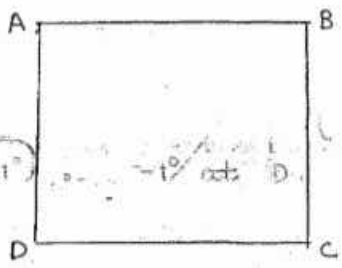


NOTE :

⊙ In a rectangle or square ABCD shown in fig,

-bearing of AB = bearing of DC.

-bearing of AD = bearing of BC



→ Differences b/w Prismatic Compass & Surveyor's Compass.

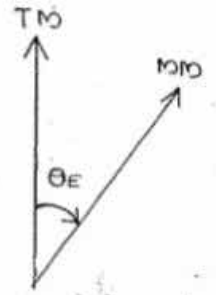
Prismatic Compass	Surveyor's Compass.
1. Broad type of magnetic needle. 	1. Edge bar type
2. Graduated card ring is attached to the needle	2. Graduated chord ring is attached to compass box.
3. Graduations marked are inverted.	3. Direct graduations are marked.
4. WCB system is followed. 0° at S, 180° at N, 90° at W, 270° at E	4. QB system is followed. 0° at N & S, 90° at E & W.

→ Temporary Adjustments.

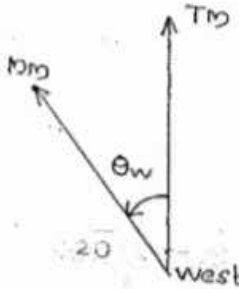
Centering, levelling & focusing the prism.

→ Magnetic Declination.

It is at the place, horizontal angle b/w true meridian and magnetic meridian shown by needle at the time of observation.



Eastern Declination



Western Declination

$$TB = MB \pm \text{Declination}.$$

Use +, if declination is towards east.
−, if declination is towards west

$$MB = TB \mp \text{Declination}$$

Use −, if eastern declination.
+, if western declination

→ Diurnal Variation.

- calculated for 24 hours.
- Ranges blw 3' to 12'

→ Annual Variation

- calculated for 365 day
- Ranges blw 1' to 2'

→ Secular Variation

- calculated for 250 years.
- blw 5' to 10' per year.

→ Irregular Variation.

- calculated during natural calamities, magnetic storm.
- observed as 2'

→ Isogonic Lines

It is a line joining the points of same declination.

→ Agonic Lines

It is a line joining points of zero declination (when MD & TD coincides).

→ Dip.

Inclination of magnetic needle with horizontal.

Dip is zero at equator and 90° at S & N magnetic pole

NOTE :

- TB is also called as 'Azimuth'.
- TB of sun at noon (12.00 hrs) is 180°
- If longitude is greater than the standard meridian, the difference blw them will be added to the standard time to get the local mean time.

→ Local Attraction:

It is the deviation of magnetic needle with the influence of magnetic attracted materials like fencing, steel materials etc

- Detection of local attraction :-

. If the difference blw FB & BB is not 180°, stations represented by that line are affected by local attraction.

- Correction for Local Attraction :-

a) For bearings

Line	FB	BB	Line	FB	BB
AB	120°30'	299°	CD	80°	261°
BC	140°30'	320°30'	DA	100°30'	281°

Find the correction for bearings:

) Ans.

Line	FB	BB	Correction
AB	120°30' (119°)	299°	0° at B.
BC	140°30'	320°30'	0° at C.
CD	80°	261° (260°) →	-1' at D.
DA.	100°30'	281°	-1°30' at A.
	-1°	-	=
	99°30'	+180 = 279°30' ↗	

$\{(BB)_{BC} - (FB)_{BC} = 180°$ ∴ B & C are free from corrections.$\}$

b) For Interior Angles.

Step 1:

Q. Calculate the interior angles at all stations from the given bearings

Step 2:

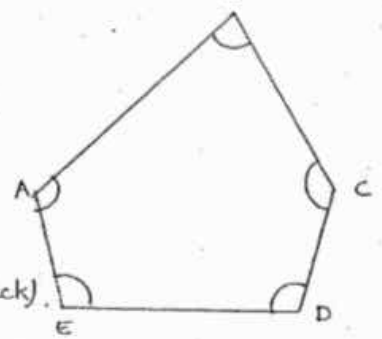
Check for a closed traverse, ie, sum of interior angles $= (2n-4)90$ where n is no. of sides in a closed traverse.

For exterior angles, check will be applied

Sum of exterior angles $= (2n+4)90$; for a closed traver

Step 3:

If check is not verified, total correction obtained from the check verification, is distributed equally to all interior angles. and calculate corrected interior angles.



Sum of interior angles
$= 538° 30'$ (given).

Sum of interior angles
$= (2n-4)90$
$= (2\times5-4)90 = 540°$ (check).

Correction $= \frac{540 - 538°30'}{5} = 0°18'0''$

Step 4:

Calculate correct bearings of lines in a closed traverse by taking FB of first line (AB). as correct. and the corrected interior angles.

NOTE:

If there is no line that is unaffected by local attractic the line whose FB and BB differs least from 180°, find mean bearing of that line by distributing half the error to each of FB & BB.

P-29

01. MB = S 28°30' E

= 151° 30'

TB = MB ± Declination

= 151°30' + 5° 38' = 157° 08'

= S 22° 52' E

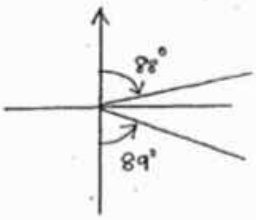
02 TB = 48° 24' + 5° 38' = 54° 02'

03. Declination = 184° − 180°

= 4° W

04. TB = 180 − 89 = 91°

Declination = 3° E



05 True bearing = Azimuth = 268

06. S10° W = 180 + 10 = 190° (in WCB).

08. MB < 180 (Sun in Eastern Hemisphere).

MB > 180 (Sun in Western Hemisphere.

09. If FB is given as N θ E,
then BB is obtained as S Q W and vice versa.

$FB = 225^\circ$

$BB = 225 - 180 = 45^\circ$

$= N\,45\,E$

12. $\angle BAC = 120^\circ - 30^\circ = \underline{90^\circ}$

13 $\angle ABC = (BB)_{AB} - (FB)_{BC}$

$= (180+150) - 310 = \underline{80^\circ}$

14. $(FB)_{AB} = N\,70\,W$ $\quad (FB)_{BC} = N\,70^\circ W = 290$

$(BB)_{AB} = S\,70\,E = 110$

$\angle ABC = 290 - 110 = \underline{180^\circ}$

15. $(FB)_{AB} = N\,38\,E = 88^\circ$ $\quad (FB)_{BC} = S\,70\,E = 110.$

$(BB)_{AB} = 180+38 = 218^\circ$

$\angle ABC = 218 - 110 = \underline{108^\circ}$

17. 16. $(FB)_{AB} = N\,30\,E = 30^\circ.$

$\angle ABC = 90^\circ.$ (Square).

$(FB)_{BC} = (BB)_{AB} - 90^\circ = 210 - 90 = 120^\circ = \underline{S\,60^\circ E}$

18. $(FB)_{AB} = 30^\circ$ $\quad (FB)_{BC} = 150$ $\quad (FB)_{CA} = 270$

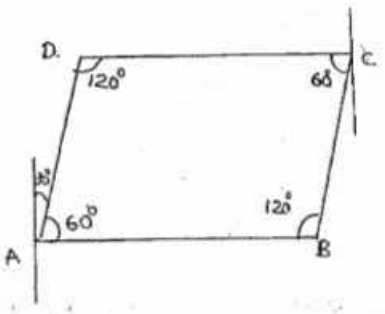
$(BB)_{AB} = 210$ $\quad (BB)_{BC} = 330$ $\quad (BB)_{CA} = 90$

$\angle ABC = 210 - 150 = 60^\circ$ $\quad \angle BCA = 330 - 270 = 60^\circ$

$\angle CAB = 90 - 30 = \underline{60^\circ}$

$\Rightarrow$ equilateral triangle

20.



$(FB)_{AB} = 30^\circ$

$(BB)_{AB} = 210^\circ$

$(FB)_{BC} = 210 - 120 = 90^\circ$

$(BB)_{BC} = \underset{15}{210^\circ} = (FB)_{CD}$

22. MB of AB $= 89^\circ + 1^\circ = 90^\circ$

MB of BA $= 360 - 90 = \underline{270^\circ}$

23.

	FB	BB
PQ	59° ✓	235° 239°
QR	$125^\circ 30'$ $129^\circ 30'$	$309^\circ 30'$

For an open traverse, first reading is assumed as correct

$\angle PQR = (BB)_{PQ} - (FB)_{QR}$

$= 239 - 129^\circ 30^\circ = \underline{109^\circ 30^\circ}$

24. MB $= S\ 45\ E = 135^\circ$

Declination $= 5^\circ W.$

TB $= 135 \mp 5 = 140^\circ - 5 - 5 = 130^\circ.$

$\Rightarrow \underline{S\ 50^\circ E}$

25 TB = MB + declination − correction

$= 185 + 3.5 - 1.5 = \underline{187}$

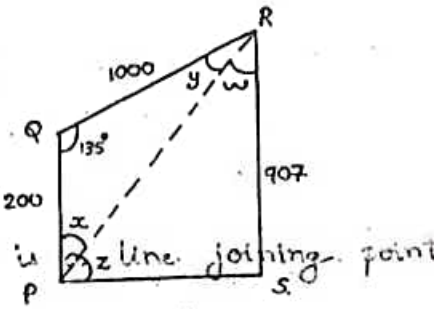
28.

Line	AB	BC	CD.	DA
FB	$120^\circ 30'$ ✓	$78^\circ 15'$ ✓	$300^\circ 30'$ $+2^\circ 15'$	$210^\circ 15' = 207^\circ 45'$
BB	$300^\circ 30'$ ✓	256° $258^\circ 15'$	$125^\circ 15'$ $(122^\circ 45')$	$12^\circ 45' = 27^\circ 40'$

P-28

Q.51.

Line	Length (m)	Bearing (WCB)
PQ	200	0°
QR	1000	45°
RS	907	180°
SP	?	?



It is a line joining point

$\angle PQR = (BB)_{PQ} - (FB)_{QR}$

$= (180+0) - 45 = 135°$

$PR^2 = PQ^2 + QR^2 - 2PQ.QR \cos 135°$

$= 200^2 + 1000^2 - 2 \times 200 \times 1000 \cos 135°$

$\Rightarrow PR = \underline{1150 \text{ m}}$

Applying sine rule in ΔPQR,

$$\frac{\sin x}{1000} = \frac{\sin y}{200} = \frac{\sin 135}{1150}$$

$$\Rightarrow \sin x = \frac{1000 \sin 135}{1150}$$

$$\therefore x = \underline{37.94°}$$

Similarly $y = 7.06°$

$\angle QRS = (BB)_{QR} - (FB)_{RS}$

$= (180+45) - 180 = \underline{45°}$

$\therefore y + w = 45°$

or $w = 45 - 7.06 = \underline{37.94°}$

$SP^2 = PR^2 + RS^2 - 2 PR.RS \cos 37.94°$

$= 1150^2 + 907^2 - 2 \times 1150 \times 907 \cos 37.94°$

$\Rightarrow SP = \underline{707.06 \text{ m}}$

Applying sine rule in ΔPRS

$$\frac{\sin z}{907} = \frac{\sin 37.94}{707.06}$$

$$\Rightarrow z = \underline{52.06^\circ}$$

$$\angle QPS = (BB)_{QP} \mp (FB)_{PS}$$

(iv) Orientation — It is the process of

$$= 0 - (FB)_{PS}$$

But $\angle QPS = x + z = 52.06 + 37.94 = \underline{90^\circ}$

$$\therefore \angle QPS = (FB)_{PS} = (BB)_{SP} = \underline{90^\circ}$$

$$(FB)_{SP} - (BB)_{SP} = 180^\circ$$

$$(FB)_{SP} = 180^\circ + 90^\circ = \underline{270^\circ}$$

52. Find lengths PQ & QR.

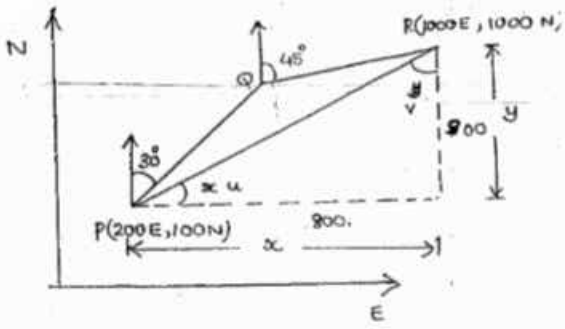
$x = 1000 - 200 = 800$

$y = 1000 - 100 = 900$

$$\tan u = \frac{900}{800}$$

$$\therefore u = \tan^{-1}\left(\frac{9}{8}\right) = 48.36$$

$$\therefore V = 90 - u = 41.64$$



$$PR = \sqrt{x^2 + y^2} = \sqrt{800^2 + 900^2} = 1204.16 \text{ m.}$$

$$30^\circ + u + \angle QPR = 90^\circ$$

$$\therefore \angle QPR = \underline{11.64^\circ}$$

$$\angle PQR = (BB)_{PQ} - (FB)_{QR} = 210 - 45 = 165^\circ$$

$$\therefore \angle QRP = 180 - (11.64 + 165) = \underline{3.36^\circ}$$

Applying sine rule,

$$\frac{\sin 165}{PR} = \frac{\sin(3.36)}{PQ} = \frac{\sin(11.64)}{QR} \Rightarrow$$

$$PQ = \frac{\sin 3.36}{\sin 165} \times PR = \underline{272.68 \text{ m}}$$

$$QR = \frac{\sin 11.64}{\sin 165} \times PR = \underline{938.7 \text{ m}}$$

31 24 hours ⟶ 360°

1 hour ⟶ 15°

Degree System	Hour System.
15°	1 hour
15'	1 min.
15"	1 sec.

Difference = 90° 40' − 82° 30'

= 8° 10'

$\frac{8^\circ}{15}$ ⇒ 0 hour

$\frac{490'}{15}$ ⇒ 32 min.

$\frac{10 \times 60}{15}$ ⇒ 40 sec.

Local mean time = 6hr 30m 0s
0hr 32m 40s
7hr 02m 40s

Q

Line	FB	BB	
AB	131° 30' / 126° 45'	311° 30' / 308°	3° 30' @ B.
BC	45° 15' / 48° 45'	227° 30'	
CD	340° 30'	161° 45'	
DE	258° 30'	78° 30'	
EA.	216° 30'	31° 45' / 36° 30'	+4° 45' @ A.

After applying correction for local attraction, correct bearing of line BC = ?

⇒ $(FB)_{BC} = 48^\circ\ 45'$