3. Linear Measurement

1 What are the various instruments used in Chaining. Describe Briefly.

This are the various instruments used in Chaining.

1 Chain: There are many types of chain use in measurement.
Ex. Metric Chain
Surveyor's Chain
Engineer's Chain.

2 Tapes: In measurement, commanly we use the tapes.

Tapes is made by using different types of matriel. Ex. Cloth tap
Fiber tap
steel tap

3 Arrows: Arrows are made of tempered steel wires.

Arrows are use for counting the number of the chain by measuring chain line.

Arrows are insert every chain end side.

4 Ranging Roads: Ranging roads are use to locate a station for measuring.

Ranging Roads are generally 2 to 3 m or 4 to 5 m in hieght.

Ranging roads are paint with red or white and Red or white colour.

5 Pugs: Pugs are made of timber or steel.

Pugs is also use for locate a station for measuring.

Length of wooden pugs is 15 cm.

Pugs are fixed on a ground using hammer.

6 Plumb Bog: Plumb Bog is use for transfer points on the ground.

Plumb bog is also use to locate station's center.

This are the main instruments use in construstion for measuring area or location.

7 The length of a chain line when measured with a 20 m chain was found to be 1432 m But when a 30 m chain which was 0.65 m too short was used for the purpose, the line was found to be 1445 m long. Find the error in 20 m Chain?

=> For 20 m chain, L = 20 m
error = C?)
M.D. = 1432 m

=> For 30 m Chain, L = 30 m
error = 0.65 m too short
M.D. = 1445 m

$\therefore L' = 30 - 0.65 = 29.35$ m

$T.M.D. = \frac{L'}{L} \times M.D$

$= \frac{29.35}{30} \times 1445$

T.M.D = 1413.9 m

-> For 20 m chain,

$T.M.D = \frac{L'}{L} \times M.D$

$\therefore L' = \frac{1413.9 \times 20}{1432}$

$\therefore L' = 19.74$ m

$\Rightarrow$ Error $= L' - L'$
$= 20 - 19.74$
$= 0.26$ m

In 20 m chain, Error of chain is 0.26 m too short.

2 Explain with sketch different methods of chaining on a slopping Ground.

There are two method of chaining on a slopping Ground.

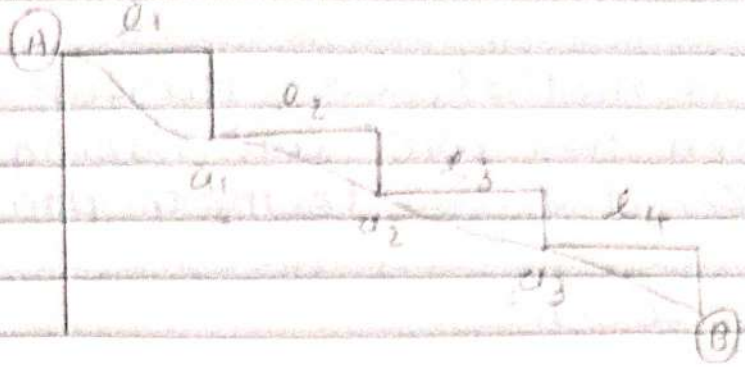
1 Direct Method.

This method is also called method of stepping.

In this method, The distance is measured in small horizontal streches.

A suitable length of chain take l_1 and measure multiple time.

Length of
slopping Ground $= l_1 + l_2 + \cdots + l_n$

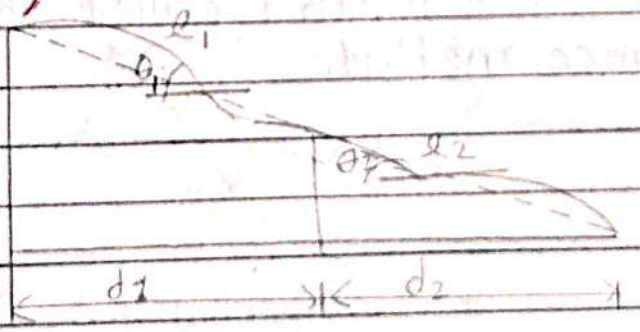


2 Indirect Method:

In this method, we measure three way to distance.

=> Method: 1

In this method measure the distance by knowing sloping length of the segment and angle of inclination with horizontal.



$$\Sigma d = d_1 + d_2 + \cdots d_n$$

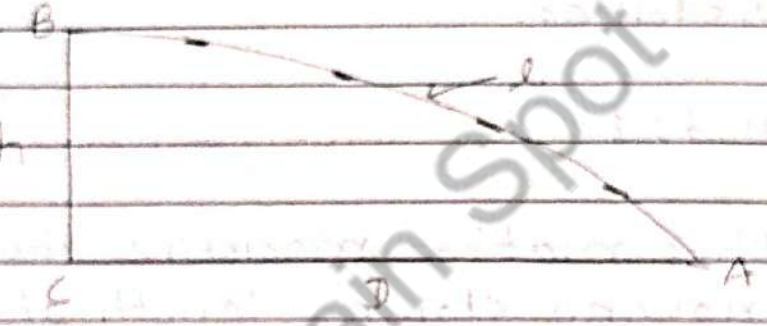
Here $d = \ell \cos\theta$

Method: 3

In this method, we meansur difference between two point and sloping distance between the two terminal point.

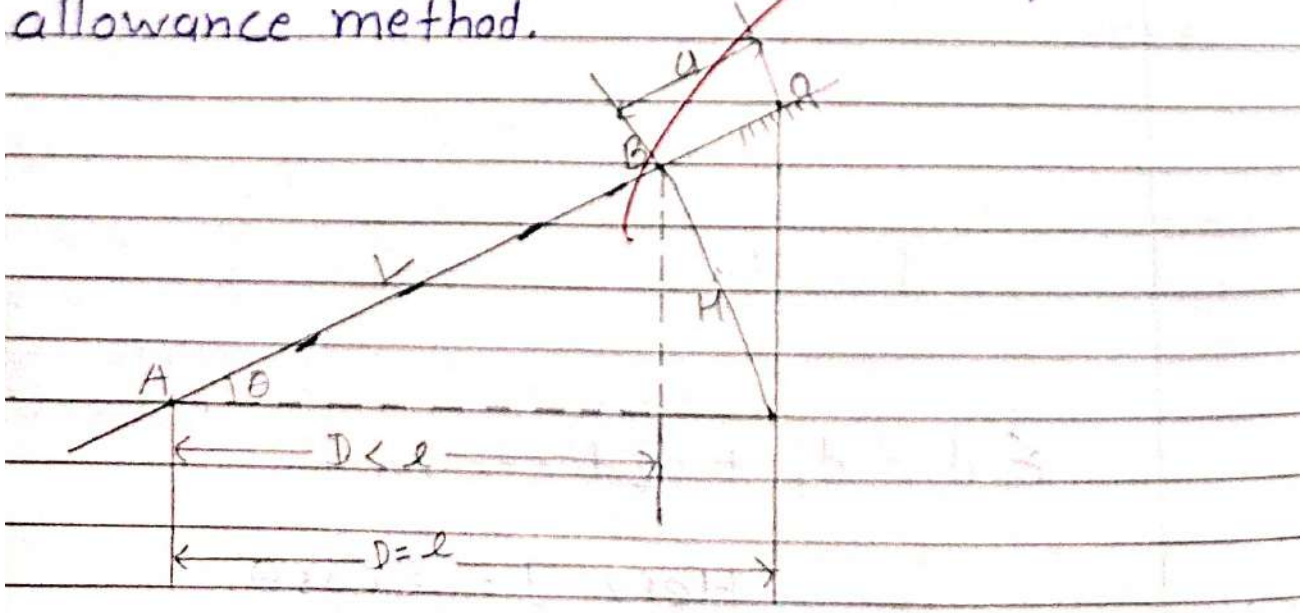
$$D = \sqrt{l^2 - h^2}$$

Here, l = Sloping length
h = height



Method: 4

This method is also called the hypotenusal allowance method.



4 List out the instruments used for laying perpendicular offset. Discuss any in detail.

This are the perpendicular offset used in measuring.

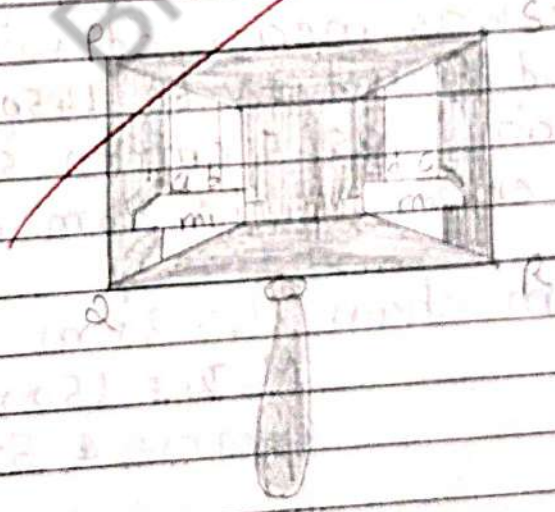
1 Optical Square

2 Indian Optical Square

3 Open cross staff

4 Prism Square.

=> Indian Optical Square:



It is a brass wedge shaped hollow box of 5 cm sides and 3 cm deep with a handle 8 cm long fixed

m_1 and m_2 are two mirror fixed to the inclined of the box at an angle of 45°.

cd are two rectangular openings above mirror.

PQRS is the open face which is to be turned towards the object to which the offset is to be taken.

Indian optical square working and method is same as optical square.

8 The distance between two points on the ground was measured with 30 m chain and found to be 1500 m. The same distance was measured with a 20 m chain and found to be 1450 m. If the 30 m chain was 5 cm to short, what was the error in the 20m chain?

⇒ For 30 m chain, L = 30 m

M.D. = 1500 m

Error = @ 5 cm to sho

$L' = 30 - 0.05$

$= 29.95$ m

=> For 20 m Chain, L = 20 m
M.D. = 1450 m
Error = ?

-> For 30 m Chain,

$$T.M.D = \frac{L'}{L} \times M.D$$

$$= \frac{29.95}{30} \times 1497.5 \; 1500$$

$$= 1497.5 \text{ m}$$

-> For 20 m chain,

$$T.M.D. = \frac{L'}{L} \times M.D$$

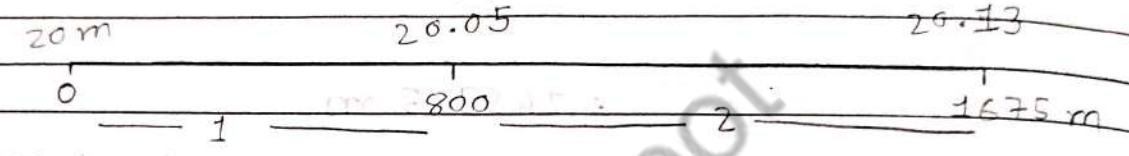
$$\therefore L' = \frac{1497.5 \times 20}{1450}$$

$$= 20.655 \text{ m}$$

-> Error = $L' - L$
= 20.655 - 20
= 0.655 m

20 m chain is 65.5 cm too short

9 A line was measured by a 20 m chain which was accurate before starting the day's work. After chaining 800 m, the chain was found to be 5 cm too long. After chaining a total distance of 1675 m, the chain was found to be 13 cm too long. Find the true distance of the line.



Length = 20 m

=> For Part : 1 => M.D. = 800 m

$$L' = \frac{20\,m + 20.05\,m}{2}$$

$$\therefore L' = 20.025\ m$$

$$T.M.D_1 = \frac{L'}{L} \times M.D$$

$$= \frac{20.025}{20} \times 800$$

$$T.M.D_1 = 801\ m$$

=> For Part : 2 => M.D. = 875 m

$L' = \frac{20.025 + 20.13}{2}$

$L' = 20.077$ m

$T.M.D_2 = \frac{L'}{L} \times M.D$

$= \frac{20.077}{20} \times 875$

$= 878.39$ m

=> Total measure distance = $T.M.D_1 + T.M.D_2$

$= 801 + 878.39$

$= 1679$ m

5 Differentiate between:

(a) Cumulative Error and Compensating Error

	Cumulative Error	Compensating Error
1	Cumulative error is a systematic error.	Compensating error is a non-systematic error.
2	This error follow mathematical rules.	This error does not follow mathematical rules.
3	This is instrumental error.	This is Personal error.
4	This error we can correct using formula.	This error we can not correct using formula.

b) Oblique offset and perpendicular offset.

	Oblique offset	Perpendicular offset
→	The measurements which are not made at right angles to the survey line.	The measurements which are taken at right angles to the survey line.
→	This offset is also called tie line offset.	This offset is also called right angle offset.

6 What are different errors in chaining?

There two different types of errors in Chaining.

1 Cumulative Error
2 Compensating Error.

1 Cumulative Error: Cumulative Error is a systematic error.

This error follow mathematical rules and This is instrumental error.

2 Compensating error: Compensating error is a non-systematic error.

This error does not follow mathematical rules and this is personal error.

=> What are the source of error in chaining.

There are three soure of error in chaining.

1 Instrumental error
2 Personal error.
3 Natural error,

1 Instrumental Error:

This error occurring due to adjustments of instruments as chain or tapes are called instrumental error.

2 Natural error:

This error occurring due to the temperature moisture, nuturn of terrain called natural error,

3 Personal error:

This error occuring due to the working

with faulty methods or mistake done during writing or reading measuremants are called personal error.

10 A line was measured with a steel tape which exactly 30 m at a temperature 18°C and pull of 50 N. and the measure length 459.2 m temperature during measured 28°C and pull applied was 100 N. The tape was uniformly supported during the measurement. Find the true length of the line. if this c/s are of the tape was 0.02 cm^2, the coefficient of thermal expansis per °C = 0.0000117 and $E = 21 \times 10^6$ N/cm^2

→ $T_s = 18°C$
$P_s = 50$ N
$T_m = 28°C$
$P_m = 100$ N
$\alpha = 0.0000117$ °C

(i) Correction for $C_t = \alpha (T_m - T_s) L$

$= 0.0000117 (28.11) \times 30$

$C_t = 0.00351$. (+Ve)

(ii) Correction for $C_p = \frac{(P_m - P_s) L}{AE}$

$$C_p = \frac{(100-50) \times 50}{0.02 \times 21 \times 10^6}$$

$$C_p = 0.00357 \text{ m } (+ve)$$

(iii) $W l_1 = A l_1 \times \gamma$

$= 0.02 \times 3000 \times 0.077$

$W = 4.62 \text{ N}$

$$C_{rg} = \frac{l_1 (W)^2}{24 (P_m)^2}$$

$$= \frac{30 \times (4.62)^2}{24 \times (100)^2}$$

$$C_{rg} = 0.00267 \text{ (-ve)}$$

$\Rightarrow$ Total correction to be applied for tape length,

$$C_T = C_t + C_p - C_{sg}$$

$$= 0.00351 + 0.00317 - 0.00267$$

$$C_T = 0.00401 \text{ m}$$

11 A line was measured with a steel tape which was exactly 30 m long at 18°c and found to be 452.34 m. The temperature during measurement was 32°c. Find the true length of line. Take cofficient of thermal expansion per °C = 0.0000117

$L = 30\ m$

$T_s = 18°c$

$ML = 452.34\ m$

$T_m = 32°c$

$\alpha = 0.0000117$

$C = \alpha (T_m - T_s) \ell$

$= 0.0000117 (32-18) 30$

$C = 4.914 \times 10^{-3}$ (+ve)

$L' = L + C_+ = 30 + 0.0049$

$= 30.0049$

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

$= \frac{30.0049}{30} \times 452.34$

$TL = 452.416\ m$

12 To measure a base line, a steel tape 30 m long, standardised at 15°C with a pull of 80 N was used. Find the correction per tape length, if the temperature at the time of measurement in 25°C and the pull exerted is 150 N. Take Young's modulus $E = 2 \times 10^5$ N/mm² and coefficient of thermal expansion $\alpha = 11.2 \times 10^{-6}$ /°C. Cross-sectional area of tape is 8 mm².

$T_s = 15°C$

$P_s = 80$ N

$T_m = 25°C$

$P_m = 150$ N

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

$= 11.2 \times 10^{-6} (25 - 15) 30$

$= 0.336$ (+Ve)

$C_s = \frac{(P_m - P_s) L}{AE} = \frac{(150 - 80) 30}{8 \times 2 \times 10^5}$

$C_s = 0.00131$ (+Ve)

$L' = 30 + 0.336 + 0.00131 = 30.3373$

$TL = \frac{\Delta'}{L} \times ML$

The horizontal Distance

$$D = (l + a)\cos\theta$$

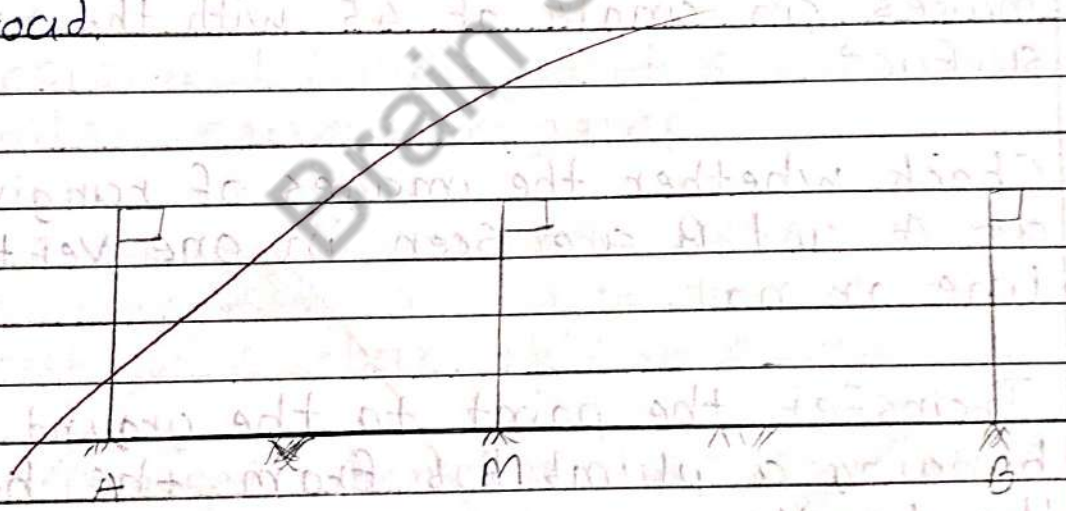
34 What is Ranging? Discuss with sketch reciprocal / indirect Ranging.

Ranging is arrage the station in a rows with a specified manner.

There are two types of Ranging.

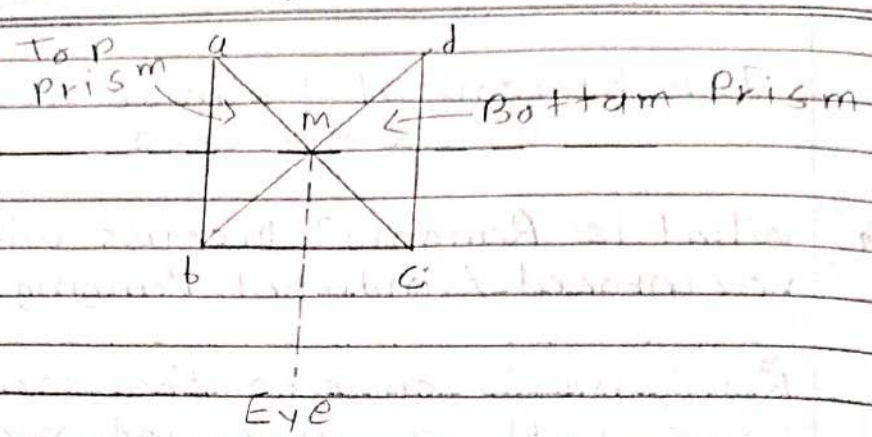
1 Direct Ranging:

When intermediate ranging roads are fixed on a straight line by Ranging road.



2 Direct Ranging with a Line Ranger.

In this method, A line ranger consists of two right angled isosceles triangular prisms placed one above the other.



(i) Hold the line ranger in hand at the level of the eye.

(ii) Observe the ranging road at A through the upper prism abc. The ray of light from A enters the upper prism and incident ray makes an angle of 45° with the reflecting surface.

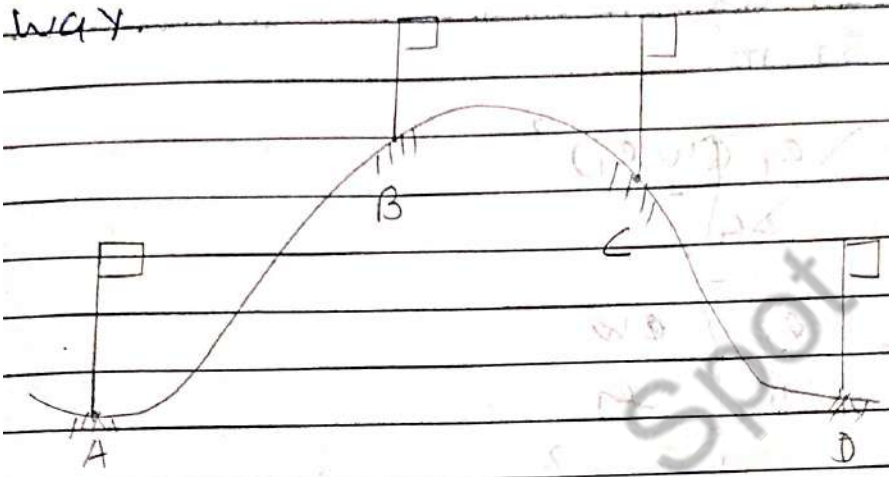
(iii) Check whether the images of ranging roads at A and B are seen in one vertical line or not.

(iv) Transfer the point to the ground by hanging a plumb bob from the hook the handle.

The point M so transfered is exactly below the intersection of the two diagonals.

Reciprocal Ranging:

When the end stations are not intervisible due to there being high ground between them, intermediate ranging rods are fixed on the line in an indirect way.



Reciprocal Ranging ~~indirect~~ is also called indirect ranging.

Due to ~~inv~~ intervening ground, the ranging rod B is not visible from station A than this ranging use.

It is used when the two station of the survey line are not visible due to long distance.

13 A 50 m tape is suspended between the ends under a pull of 10 kg. The weight of the tape 1.8 kg. Find the corrected length of the tape between its ends

$W = 1.8$ kg
$P_m = 10$ kg
$l_1 = 50$ m

$$C_{sg} = \frac{l_1 (W l_1)^2}{24}$$

$$C_{sg} = \frac{l_1}{24}\left(\frac{W}{P_m}\right)^2$$

$$= \frac{50}{24}\left(\frac{1.8}{10}\right)^2$$

$$C_{sg} = 0.0675 \text{ m}$$

$$\Rightarrow L' = l_1 - C_{sg}$$

$$= 50 - 0.0675$$

$$L' = 49.932 \text{ m}$$

M.A. Rod
10/5/22