

# SURVEYING

## (#) Introduction :-

Earth - earth is an oblate spheroid.

Diameter = 12740 km (Average)

Average Radius = 6370 km

At equator = 12756.75 km

At Poles = 12713.86 km

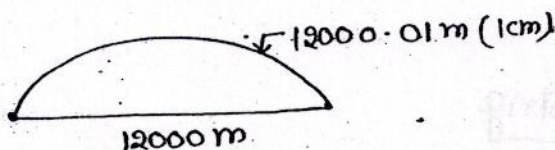
difference = 42.95 km

0.34 %

## (#) Types of Surveying :-

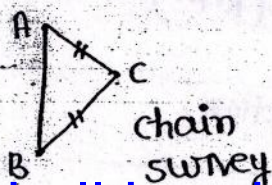
(1) Geodetic Survey :- If earth curvature is considered for survey work.

(2) Plane survey :- If earth curvature is not considered suitable for small distance.

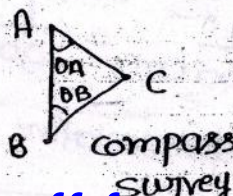


## (#) Principle of surveying :-

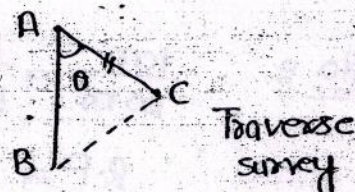
(1) Location of point is measured w.r.t. two reference points.



chain survey

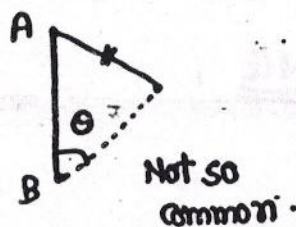
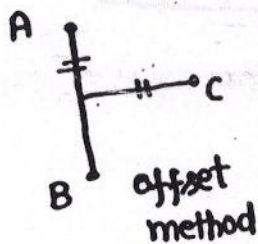


compass survey

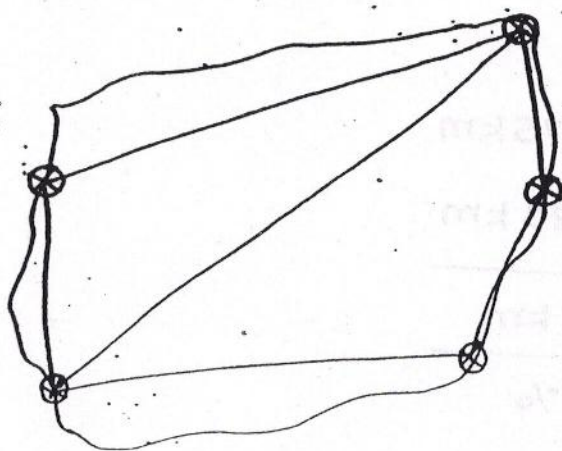


Traverse survey





(2) Working Whole to part :-



→ Major Control points are decided & measured accurately with high degree of precision. Minor details can be collected later to avoid the error to be accumulated.

### LINEAR MEASUREMENTS

(#)(1) Scale :- Scale is a ratio of map distance to ground distance.

If on the drawing

Scale  $\Rightarrow 1\text{ cm} = 100\text{ m}$

1 cm on paper = 100 m on ground

$$\text{Ratio} \Rightarrow \frac{1\text{ cm}}{100\text{ m}} = \frac{1\text{ cm}}{10,000\text{ cm}} = \frac{1}{10000} \text{ (R.F.)}$$

R.F = Representative fraction.

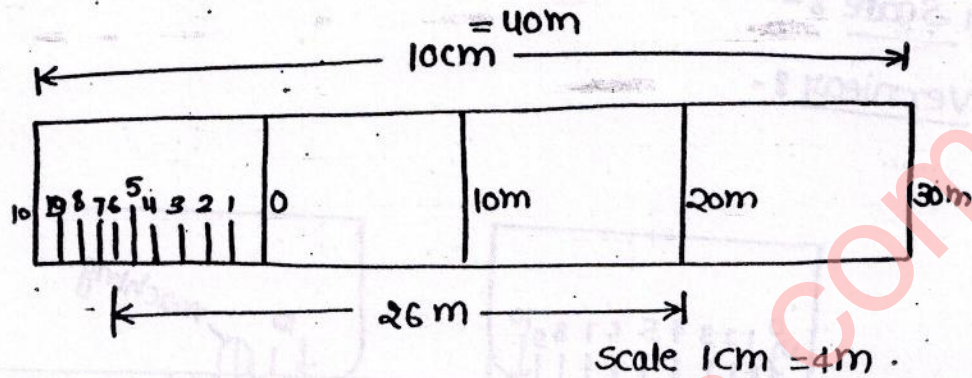


## Types of Scale :-

(1) Plane scale :- Plane scale measure only two dimension.

$$1\text{cm} = 4\text{m}$$

(#): How to make a scale  $1\text{cm} = 4\text{m}$  —



(1) Take a 10cm long line. divide it in 4 equal parts. Each part is of 10m length.

(2) Now divide 1st part in another 10 parts. This smaller divisions will show 1m.

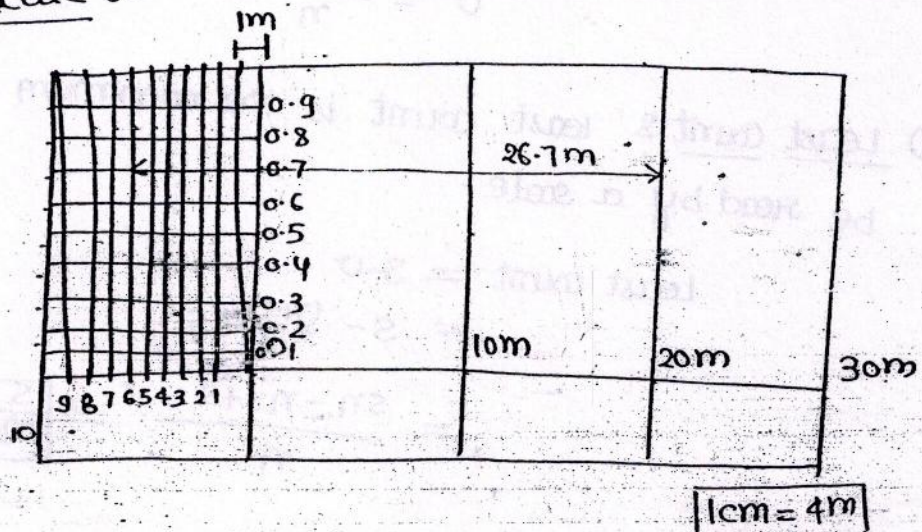
Two dimension that can be read

(1) 10m (Decameter)

(2) 1m (meter)

(2) Diagonal Scale :-

this scale can read up to three dimension





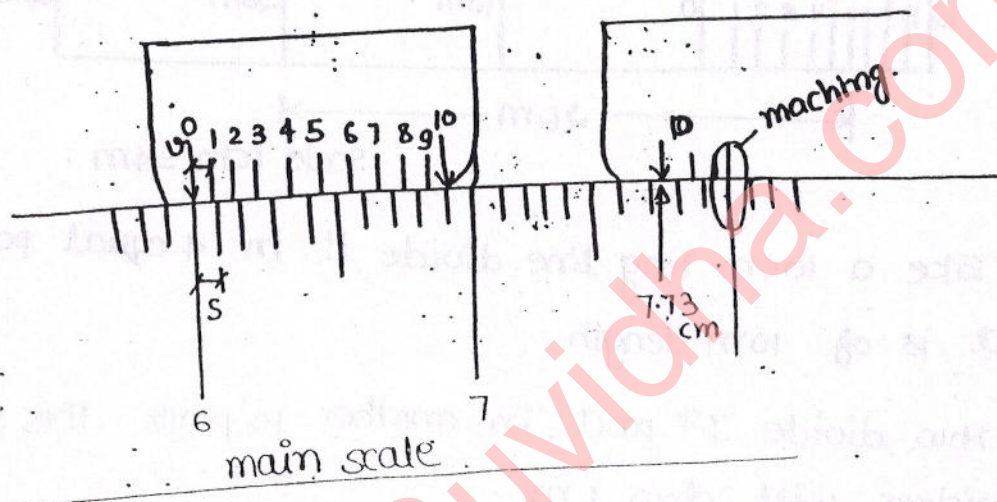
→ It works on the principle of similar triangle.

→ Three dimension

(1) 10m	→ Decameter
(2) 1m	→ meter
(3) 0.1m (10cm)	→ Decimeter.

(3) Vernier Scale :-

(b) Direct Vernier :-



→ In case of direct vernier  $(n-1)$  division of main scale is divided into  $n$  divisions of vernier scale.

$$(n-1)S = n \times v$$

$$v = \frac{(n-1)}{n} \times S$$

⊕ Least count :- least count is the minimum dimension that can be read by a scale.

$$\text{Least count} = S - v$$

$$= S - \frac{(n-1)}{n} \times S$$

$$= \frac{Sn - nS + S}{n} = \boxed{\frac{S}{n}}$$



For Example -

$$S = 1\text{m}$$

$$n = 10$$

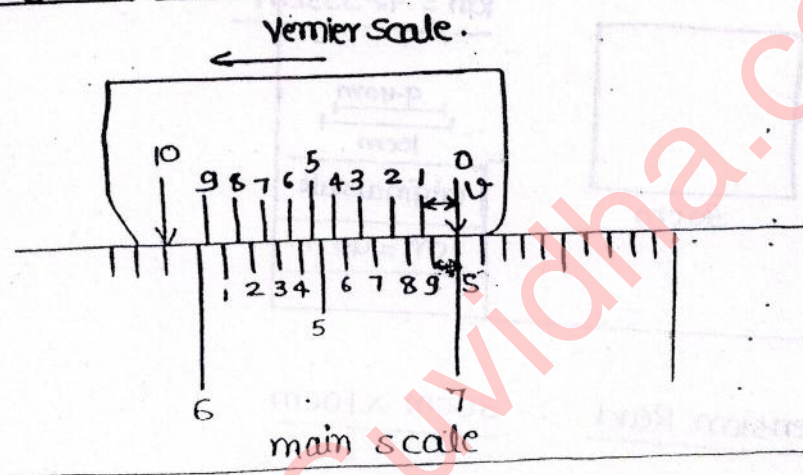
Least Count

$$= \frac{S}{n} = \frac{1\text{mm}}{10} = 0.1\text{mm}$$

⊕ Reading of Vernier is taken by the line of Vernier scale that will be exactly above of any one line of main scale.

In direct Vernier → Vernier scale moves in the same dir<sup>n</sup> of main scale.

(ii) Retrograde Vernier -



→ In this case

(n+1) division of main scale is divided into n division of Vernier scale.

$$(n+1)S = n \cdot v$$

$$v = \left( \frac{n+1}{n} \right) \cdot S \quad \text{--- (1)}$$

Least Count →

$$\begin{aligned} &= v - S = \left( \frac{n+1}{n} \right) S - S = \frac{ns + S - ns}{S} \\ &= \frac{S}{n} \end{aligned}$$

Example

$$S = 1\text{mm}$$

$$n = 10\text{mm}$$

$$LC = \frac{1}{10} = 0.1\text{mm}$$

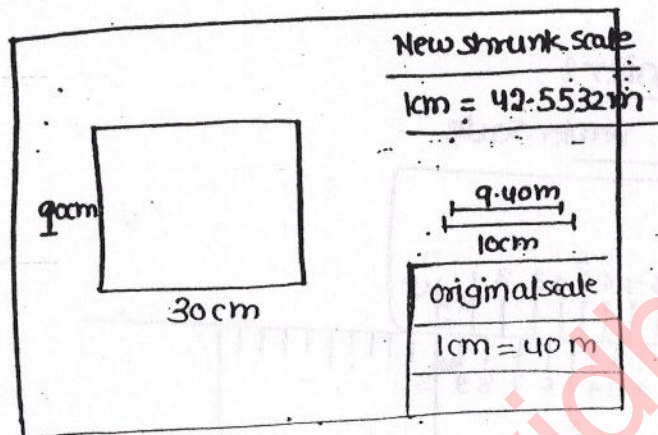


→ In this scale, Vernier scale moves in opposite dir<sup>n</sup> to the main scale.

(iii) Double Vernier 8-

The direct vernier (or Retrograde Vernier), placed back to back with common zero value is called double vernier.

(4) Shrunk Scale 8-



Present dimension Read : 30cm x 10cm

9.40 line was 10cm long -

$$30\text{cm} \longrightarrow \frac{10}{9.40} \times 30\text{cm} = 31.915\text{cm}$$

# Ground length =  $31.915 \times 40$   
= 1276.60 m

$$10\text{cm} \longrightarrow \frac{10}{9.4} \times 10 = 10.638\text{cm}$$

$$10.638 \times 40 = 425.53\text{m}$$

Actual area of plot

$$L \times B = 1276.6 \times 425.53 = 543234\text{m}^2$$



## # Shrink scale —

$$\text{shrinkage Factor} = \frac{\text{shrink length}}{\text{original length}}$$

shrink scale = shrinkage Factor  $\times$  original scale.

## # shrinkage Factor

$$S.F. = \frac{940}{1000} = 0.94$$

$$\begin{aligned} \frac{\text{original scale}}{1 \text{ cm} &= 40 \text{ m}} \\ &= \frac{1}{4000} \end{aligned}$$

$$\begin{aligned} \text{shrink scale} &= 0.94 \times \frac{1}{4000} \\ &= \frac{1}{4255.319} \end{aligned}$$

$$1 \text{ cm} = 42.5532 \text{ m}$$

$$\text{Area of the plot} = (30 \times 42.5532) \times (10 \times 42.5532)$$

$$A = 543232.23 \text{ m}^2$$

## ⊕ Correction due to Incorrect length of chain/tape :-

⊕ Qb

$L$  = Designated (True) length of a tape (should be) (say 30.0 m.)

$L'$  = wrong length of Tape (say 30.25 m.)

$l'$  = wrong length of line measured.

$l$  = True length of line.

$$\text{True} \times \text{True} = \text{wrong} \times \text{wrong}$$

$$L \times l = L' \times l'$$

$$l = \left( \frac{L'}{L} \right) \times l' \quad \text{--- (A)}$$



example ①  $L = 30 \text{ m}$   
 $L' = 30.25 \text{ m}$   
 $l' = 6500 \text{ m}$

$$\therefore l = \left(\frac{L'}{L}\right) \times l'$$

$$= \frac{30.25}{30} \times 6500$$

$$l = 6554.167 \text{ m}$$

Ex: 2  $L = 30 \text{ m}$   
 $L' = 29.70 \text{ m}$   
 $l' = 6500 \text{ m}$

$$\therefore l = \left(\frac{L'}{L}\right) \times l'$$

$$= \left(\frac{29.70}{30}\right) \times 6500$$

$$l = 6435 \text{ m}$$

Measured Value on ground	Noted down value	Error	Correction
30.25 m (more)	30 m (less)	(-ve) (- 0.25)	(+) ve (+) 0.25 m
29.70 m (less)	30 m (more)	(+ve) (+ 0.3)	(-) ve (-) 0.30 m



### ⊕ Tape Correction :-

#### (i) Correction due to standardization :-

If length of Tape | chain is not correct.

#### ⊕ Correction per chain length :-

$$C = (L' - L) \quad \left[ \begin{array}{l} +ve \rightarrow (+) \text{ Correction} \\ -ve \rightarrow (-) \text{ Value} \end{array} \right]$$

#### (ii) Total Correction required :-

$$C_{\text{Total}} = (\text{No. of chains}) \times C$$

$$C_{\text{Total}} = \left( \frac{L'}{L} \right) (L' - L)$$

Case : (1)

$$L = 30 \text{ m}$$

$$L' = 30.10 \text{ m}$$

$$l' = 7200 \text{ m}$$

$$l = \left( \frac{L'}{L} \right) \times l'$$
$$= \frac{30.10}{30} \times 7200$$

$$l = 7224 \text{ m}$$

Correction per chain length

$$C = (L' - L) = (30.10 - 30.0)$$

$$C = 0.10 \text{ m}$$

$$\text{No. of chains} = \frac{7200}{30} = 240 \text{ chains}$$

$$\text{Total correction} = 240 \times 0.10 = +24 \text{ m}$$

$$\text{corrected length} = 7200 + 24 = 7224 \text{ m}$$



# This correction may be either '+ve' or '-ve'

⊕ In case of Area :-

$$A = \left(\frac{L'}{L}\right)^2 \times A' \quad \text{--- (3)}$$

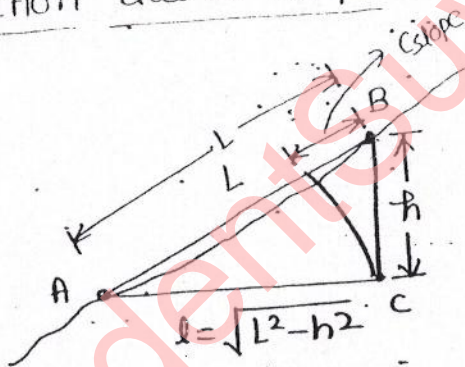
⊕ In case of Volume :-

$$V = \left(\frac{L'}{L}\right)^3 \times V' \quad \text{--- (3)}$$

⊕ For length :-

$$l = \left(\frac{L'}{L}\right) \times l' \quad \text{--- (1)}$$

⊕ (2) Correction due to slope :-



Correction : For slope

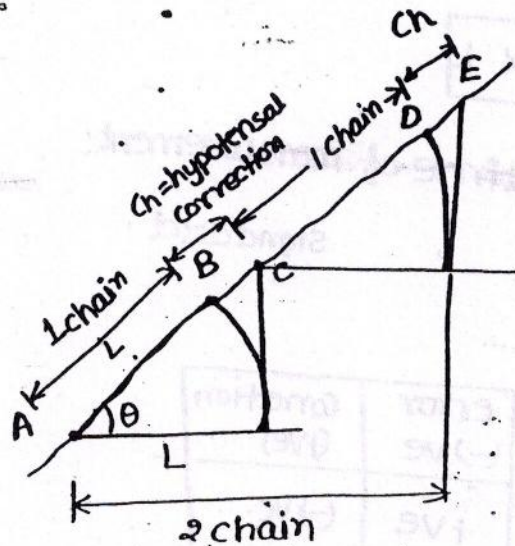
$$C_{\text{slope}} = L - l = L - \sqrt{L^2 - h^2} \quad \rightarrow \text{exact difference}$$

$$C_{\text{slope}} = \frac{h^2}{2L} \quad \rightarrow \text{approximate formula}$$

This correction is always (-)ve.



## Hypotenusal Correction



$$Ch = L(\sec \theta - 1)$$

$$= 100 \text{ links} \times \frac{\theta^2}{2}$$

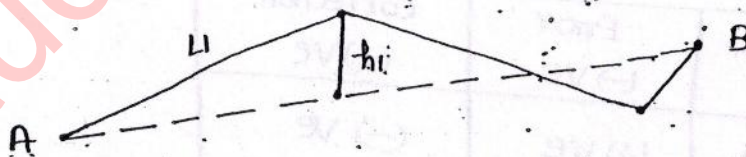
$$= 50 \theta^2 \text{ links}$$

$$AC = L \sec \theta$$

$$BC = AC - AB = L \sec \theta - L$$

$Ch = L(\sec \theta - 1) \Rightarrow$  Hypotenusal correction  
applied (added) after every chain length

### (3) Correction due to Alignment :-



Correction due to alignment -

$$Cal = L - \sqrt{L^2 - h^2}$$

$$\boxed{Cal = \frac{h^2}{2L}}$$

$\rightarrow$  This correction is also (-)ve. (always)



## Correction due to temperature :-

Correction :

$$C_T = (T_m - T_0) \cdot \alpha \cdot L$$

$T_m$  = Temp. at the time of measurement.

$T_0$  = " " " " Standard.

$T_m > T_0$	Length of Tape more.	error (-)ve	Correction (+)ve
$T_m < T_0$	Tape length less	+ve	(-)ve.

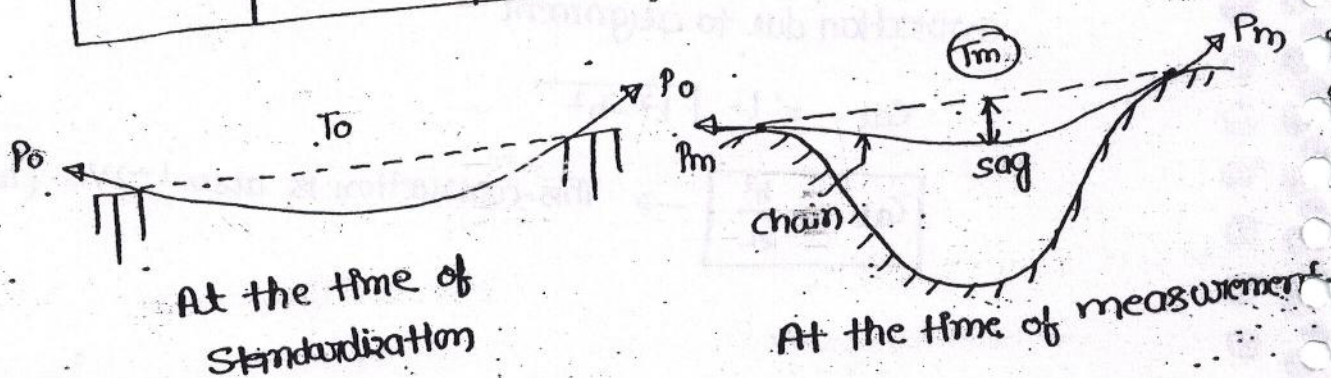
## (5) Correction due to pull applied :-

$$C_{pull} = \frac{(P_m - P_0) \cdot l}{AE}$$

$P_m$  = Pull applied at the time of measurement.

$P_0$  = " " " " Standardization.

$P_m > P_0$	Error (-)ve	Correction (+)ve
$P_m < P_0$	(+)ve	(-)ve





(6) Due to Sag :-

$$C_{\text{sag}} = \frac{(w \cdot L)^2 \cdot L}{24 P_m^2}$$

The correction is  
always (-ve)

$w = \text{wt. of tape / unit length}$

# Normal tension :-

It is the value of pull ( $P_m$ ) applied so that (+ve) pull correction is same as (-ve) sag correction, and they neutralize each other.

$$C_{\text{pull}} = C_{\text{sag}}$$

$$\frac{(P_m - P_0) L}{A E} = \frac{(w L)^2 \cdot L}{24 P_m^2}$$

Solve by  
trial & error