GOVT. POLYTECHNIC, JAGATSINGHPUR

CIVIL ENGINEERING DEPARTMENT

LEARNING MATERIAL OF **LAND SURVERYING - 1**

4^{TH} SEMESTER

FACULTY NAME – SOUMYAKANTA SAHOO

Basic concept of surveying :-

D.06.09.2020

*What is surveying?

→ It is an art and science of determining the relative position of objects lying on the surface of Earth or lying above or below the earth surface by means of distance, measurement, direction and elivation.

The Relative positions are expressed with respect to:-

1. horizontal distance
2. horizental angle.
3. vertical distance
4. vertical angle.

Objective of surveying :-

1. To prepare maps and plans.
2. To calculate areas and volume.
3. To set out a structure on the field.

D.07.09.2020

* The shape of the Earth is oblate spheroid.

Sphere

d = 12740km

oblate spheroid

d1 = 12,713.5km.

d2 = 12713.5+43
= 12756.5km

→ Surveying is devided into two types :-

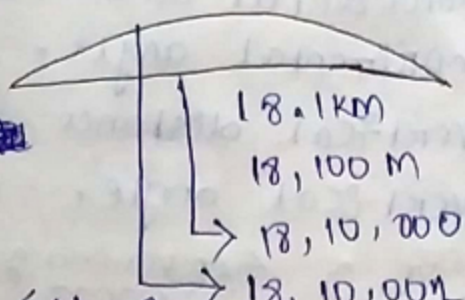
1. plane surveying
2. Geodetic surveying.

1. Plane Surveying :-

→ In plane surveying we donot consider the curvature of earth. We assume that the surface of the earth is flat or horizontal.

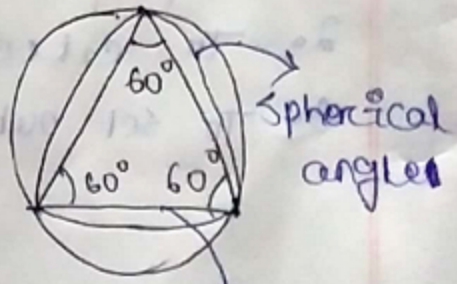
→ Plane surveying can be used when the area to surveyed is small. Or the area should be within 250km² (less than 250km²).

→ The distance should be less the 18.1km (< 18.1 km) when plane surveying is done.

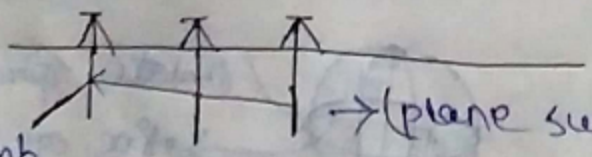


→ Plane surveying is less accurate than Geodetic surveying.

→ In plane surveying the spherical angles are considered as plane angles.



→ The direction of plumb line for different point are assume to be parallel to each other.



Plumb line → (plane surveying)

Soumyakanta Sahoo

2. Geodetic Surveying :-

→ In Geodetic Surveying we consider the curvature of earth. Here the true surface of the earth is curve.

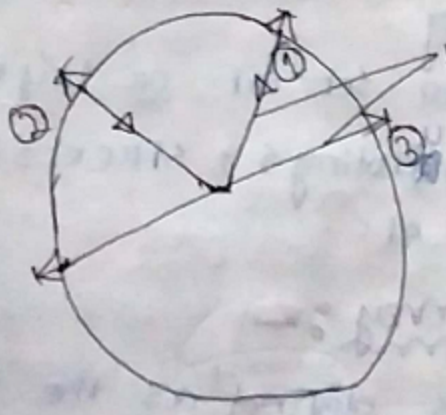
→ Geodetic surveying can be used when the area to surveyed is large. or the area should be greater the 250 km^2.

→ The distance should be greater than 18.2 KM (>18.1km) when Geodetic surveying done.

→ The Geodetic surveying is more accurate than plane surveying.

→ The Geodetic surveying we consider the spherical angles.

→ In Geodetic surveying the plumb line (the direction of gravity) are not parallel, they converge/meet at a point known as center of Earth.



Geodetic surveying.

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Classification of surveying :- 8.08.01.2020

1. Control survey :-

→ These are geodetic survey done to establish control points.

→ Control points are well defind point with respect to which relative position of other points are determine.

2. Land survey :-

→ It is also called as cadastral survey. It is used to determine the boundries and areas of different plots of land.

→ It is also done to make map/plan of plots.

3. City survey :-

→ These surveys are conducted for the propes of urban planning.

→ It is required to set out or layout important structures like buildings, streets (road), sewerage system etc.

4. Topographic survey :-

→ Topographic survey is defind as the shape of different areas.

→ It is used to vally, summit, mountain, rivers etc.....

→ It is used to determine the natural ground feturs.

5. Hydrographic survey :-

→ It is done on or near by the water bodies such as river, lages, marin. marin survey is covered a large area because it consist of sea.

6. Engineering survey :-

→ It is conducted to collect data for designing and planning of engeneering work such as buildings, roads, bridges, dams, reserchories, sewers and water supply line.

7. Astronomic survey :-

→ It is carried out for determination of latitudes, longitudes azimuths, local time, etc.
→ for various places on the earth by observing heavenly bodies. (the sun or stars).

8. satellite survey :-

→ It is conducted to obtain intercontinental, intercolatum and interisland geodetic ties all the world over by artificial earth satellites.

9. Geological survey :-

→ It is carried to obtain information about different strata of earth's surface for geological studies.

10. Construction survey :-

→ After the plans have been prepared and the structures designed, the construction survey is conducted.

09.02.2020

Classification of Survey Based on Instruments use:-

1. Chain/tape
2. Compass
3. plane table survey
4. Level.
5. Theodolite
6. Tacheometor
7. EDM (Electronic digital Measurment)
8. Total station.

1. Horizental distance:-
   Chain/tape, Tacheometor, EDM.
2. Horizental Angle:-
   Compass, Theodolite, EDM.
3. Vertical distance:-
   Level, Tacheometor, EDM.
4. Vertical Angle:-
   Theodolite, EDM, clinometere.

1. MAP

Principale of surveying:-

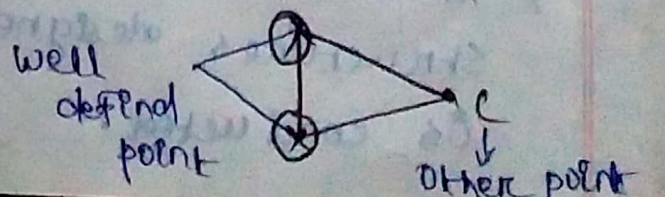
1. To Work From Whole two part:-

→ It is essential to establish control point and with respect to control point we measure minor details.

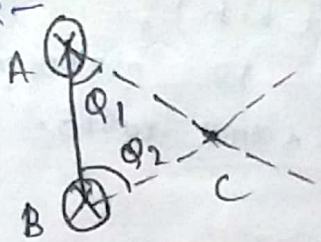
→ It localies the arrere.

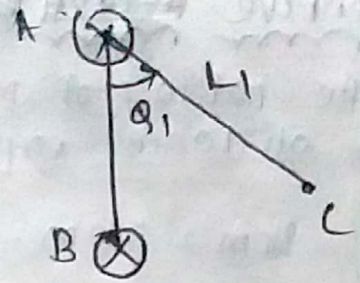
2. Location of a point with respect to at least two well defind points:-

→



E.g.:-





Maps and plans :-

→ These are the representation of ground points, on horizontal sheet.

→ Maps cover a very large extend of areas.
Eg :- country map, state map .etc.

→ plan covers a small portion of area. It is used to survey specific structures.
Eg :- Building plan, , dam plan .etc.

Scale :-

→ It is the relationship bet^n paper distance to corresponding ground distance.

Types of scale :-

1. large scale (<10m - 1m)
2. Middlium scale (>10-<100) ↓ 1m
3. small scale, (>100m - 1cm)

Note :-

→ The larger the distance cover on the ground smaller is the scale.

→ Maps are prepared by smaller scale.

→ plan are prepared by larger scale.

D 10.01.2020

Representative [redacted] Fraction (R.F) :-

→ It the ratio of map distance to corresponding ground distance expressed in same units.

Eg :- 1cm = 500m.

1cm = 500 × 100 = 50000 cm.

= 1 : 5×10^4

= $\frac{1}{5 \times 10^4}$

Note :-

As the denominator of the R.F increases the size of the scale decreases (small scale).

Engg. scale :-

Engg. scale = **1cm = 50m**

Types of Measuring scale :-

1. plane scale :-

→ It is used to measure 2 successive dimension.

eg :- (8cm, 2mm)

2. digonal scale :-

→ It is used to measure 3 successive dimension

eg :- 8.26 m → 8m, 2dm, 6cm.

3. Chourd scale :-

→ It is used to measure angles without using protracter.

4. Vernier scale :-

→ This scale increase the accuracy of main scale.

Types of vernier scale :-

(i) direct vernier :-

→ n divisions of main scale will be equal to (n+1) divisions on vernier scale.

eg :- $n(s) = (n+1)v$ unit of

s = each length of main scale

n = no. of reading on main scale.

v = 2 lengths of each unit of vernier scale.

n+1 = no. of reading on vernier scale.

(ii). Retrograde vernier :-

→ n divisions of vernier scale will be equal to (n+1) main scale.

$$n(v) = (n+1)s$$

(iii) Extended vernier :-

→ n divisions of vernier scale will be equal to (2n-1) divisions on main scale.

$$n(v) = (2n-1)s$$

Errors :-

→ Error due to shrinkage of a map :-

→ The ratio shrunk length to actual length is known as shrinkage ratio.

→ Value of shrinkage ratio will always be less than 1.

$$\text{Shrinake ratio} = \frac{\text{Shrunk length}}{\text{actual length}}$$

$$\text{actual length} = \frac{\text{Shrunk length}}{\text{Shrinake ration}}$$

$$\text{actual area} = \frac{\text{Shrunk area}}{(\text{Shrinake ratio})^2}$$

→ Shrinkage ratio is also known as shrinkage factor

$$\text{actual volume} = \frac{\text{Shrunk volume}}{(\text{Shrinake ratio})^3}$$

Q. if a line of 5cm has shrunk to 4.5cm than determine (a) shrinkage Factor
(b) Correct length if measured length = 90m.
(c) Correct area if measured area = 81m²

Ans :-
Given data,

(a) $\text{Shrinake ratio} = \frac{4.5}{5} = 0.9$

Shrunk = 4.5

(b) Shrinake ratio = 0.9

$\text{Correct length} = \frac{90}{0.9} = 100\text{m}$.

(c) $\text{Current Area} = \frac{81}{(0.9)^2} = 100\text{m}^2$

Error due to Wrong measuring scale :-

Formula : Current Length

$$= \frac{\text{R.F of wrong scale}}{\text{R.F of actual scale}} \times \text{measured length}$$

$$\text{Current Area} = \left(\frac{\text{R.F of wrong scale}}{\text{R.F of current scale}}\right)^2 \times \text{measured Area}.$$

Question :-

A man measure the distance both 2 point marked on the plan to a scale 1 cm : 1m and found it to be $50m^2$ length and $100.m^2$ Area. Later, he found A wrong scale of 1cm : 0.5m scale was used. determend the current length and current Area.

$$\text{Current length} = \frac{\frac{1}{50}}{\frac{1}{100}} \times 50$$

$$= 100m.$$

$$\text{Current Area} = \left(\frac{\frac{1}{50}}{\frac{1}{100}}\right)^2 \times 100$$

$$= 400m^2.$$

Accuracy & precision :—

Accuracy :-

→ It is the closeness of observation to the true value of a quentity.

Precision :-

→ It is the closeness of values among themselves.

Types of Errors :-

(i) Mistakes :- Mistakes occur in measurements due to carelessness, inattention, inexperience or poor judgement of the surveyor. Mistakes are quite common in a careless work done by an experienced person.

(ii) Systematic Error :-

→ Systematic errors follow some well-defined mathematical or physical law or system.

(iii) Accidental Errors :-

→ Accidental errors are random in nature. These are, therefore, also known as random errors. These errors do not follow any fixed pattern of law. These errors can be positive or negative.

D- 16.01.2020

LINEAR MEASUREMENT AND CHAIN SURVEY :-

Methods of Linear measurement :-

1. Direct distance measurement → chain, tape
2. optical measurement - Tacheometer } → Indirect method or measurement
3. Electronic distance measurement - EDM, TS

Chain survey :-

→ It is the Branch of survey in which only linear measurements are taken and no angular measurements are taken.

→ Principle of chain surveying :-

→ In chain surveying the area to be surveyed is devided into a network of well-conditioned triangle.

→ or chain surveying works by the principle of triangulation.

Well-condition triangle :- A triangle is said to be well-condition if all the interior angles of the triangle have angles betn $30^\circ < \theta < 120^\circ$.

→ well condition triangles have higher accuracy compair ill-condition triangle.

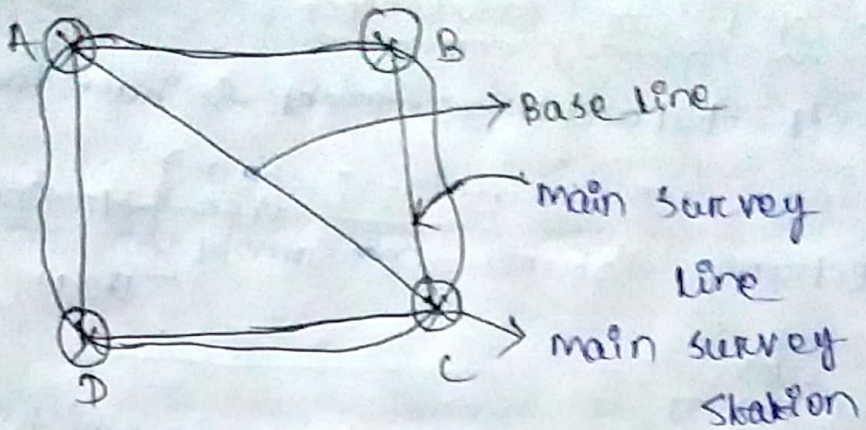
Terminology :-

1. Main survey station :-

→ These are important points taken around the boundries of area to be surveyed.

2. Main survey lines :-

→ The lines connecting the main survey station are called main survey lines.



3. Base line or chain line :-

→ It represents the chain length passing through the center of area to be surveyed.

→ It is also called as back bone line.

→ It is represented by (—.—.—.—.—).

4. Check lines :-

→ These lines are used to check the accuracy of triangles formed.

5. OFFSET :-

→ These are lateral measurement taken from a chain line to measure the details.

→ There are two types of offset :-

1. perpendicular offset (90°)
2. Oblique offset (≠90°)

6. Subsidary station :-

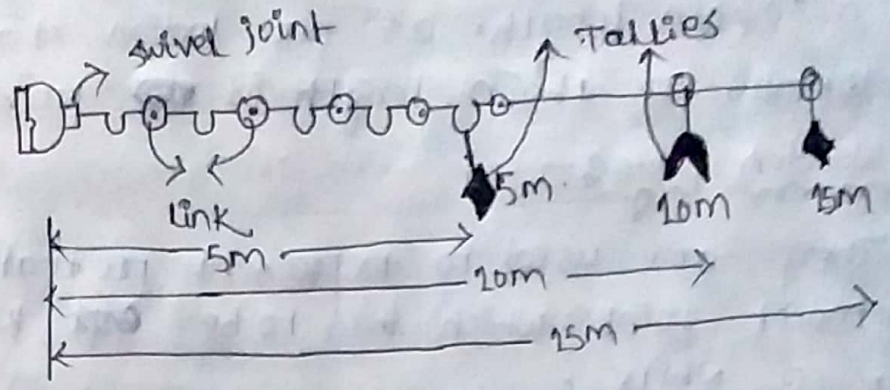
→ These are the station located on the survey lines both which the tie line runes.

7. Tie Line :-

→ These lines run very close to the details plotted so as to reduced the length of offset.

→ tie lines runs beth subsidary station.

Instrument used in chain survey :- D-17-01-2020



:- Chain :-

1. Metric chain (20m, 30m)
2. Revenue chain (33Ft) 16 links 2.06Ft → 1 link
3. Surveyors Chain or Gunters chain (66Ft) 100 link's 1 Link = 0.66Ft
4. Engg. chain (100Ft) 100 link 1 link = 1Ft
5. Band chain

Standardisation of chain :-

→ A chain at 20°C should be given a pull of 80N.

Types of Taps :-

1. Liner Tap or cloth tap
2. Glass fiber tap
3. metallick tap
4. steel tap
5. Invar tap (Ni-36%) [Iron - 64% (steel)]

3. Arrow :-

→ They are used to represent the end points of a chain length. as per Indian standard 10 arrow per chain length is provided.

4. Wooden pegs :-

→ They are used to represent relatively permanent point which has to be kept for a while.

5. Ranging Rod :-

→ They are used for establishing intermediate points in the line which comes betn two stations of a survey line.

6. Cross - Staff :-

→ They are used for setting out off set.

Ranging :-

→ It is the process of establishing or setting an intermediate point in betn the main station point of a survey line.

→ It is mandatory when the length of survey line is greater than chain length.

→ It is of 2 types.

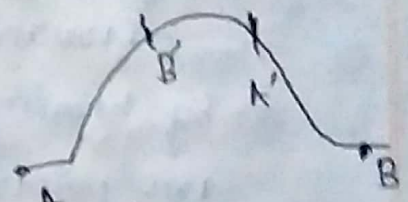
1. Direct Ranging
2. Indirect Ranging

1. Direct Ranging :-

→ It is adopted when the station are intervisible.

→ It is done by
(a) eye adjustment
(b) Line ranger.

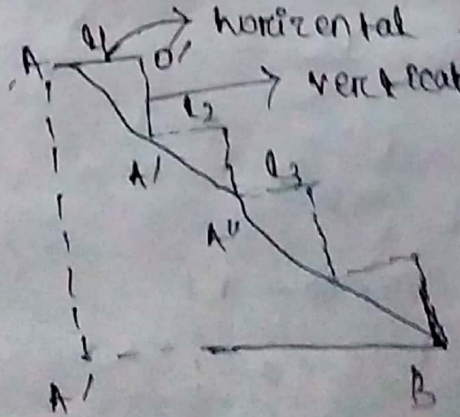
2. In-direct Ranging :-
→ It is adopted when the end station are not intervisibel
→ It can be done by putting intermediate point which is visibel to both the station.



Methods of chaining on slooping ground :-
→ ~~Horizental~~ In surveying horizental distances are measured. show chaining along a sloping ground is measured carefully by 2 method.

1. Direct method
2. In-direct method

1. Direct method :-
→ In that method we apply when the ground is very ~~steep~~ steep. In this method the ground is divided into a no. of horizental and vertical strips. Like steps.
→ This method is also called as. steping method.



horizental distance A'B = $L_1 + L_2 + L_3 + L_4$ ---

2. In-direct Method :-

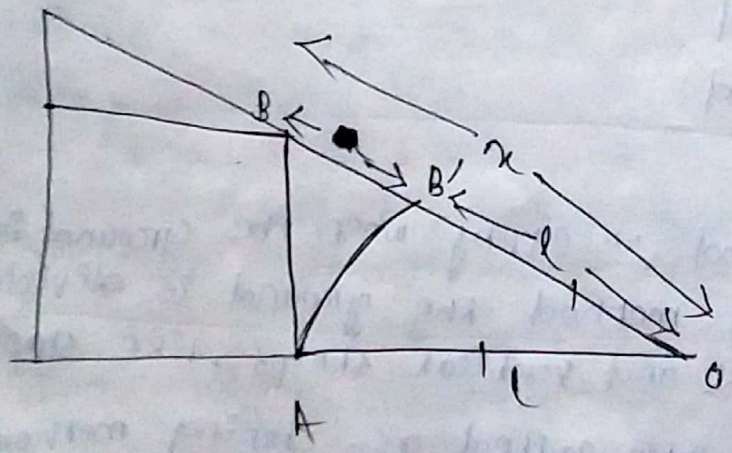
→ It is adopted when the ground is long and gentle.

→ It can be done by 3 methods.

1. by measuring with clinometer (It measured vertical slope)
2. by measuring or appling hypotenusal allowance
3. by knowing the difference of level beth two points.

2. By appling hypotenusal allowance :-

→ In this method the slope of the ground is first measured by clinometer. Than hypotenusal allowance is made for each chain length.



$$\cos\theta = \frac{l}{x}$$

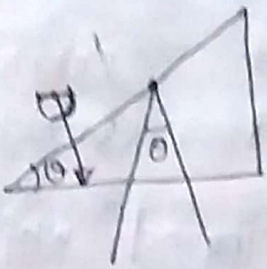
$$x = \frac{l}{\cos\theta} = l\sec\theta$$

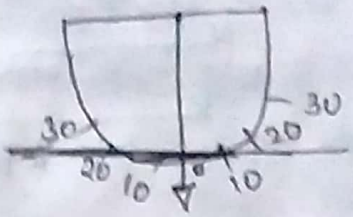
$$BB' = x - l$$

$$= l\sec\theta - l$$

$$= l(\sec\theta - 1)$$

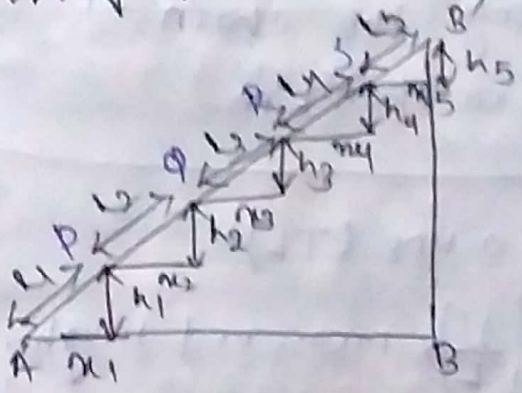
1. By measuring with clinometer :-





clinometer.

3. By knowing the difference of level betn two points :-



$$x_1^2 + h_1^2 = l_1^2$$

$$\Rightarrow x_1 = \sqrt{l_1^2 - h_1^2}$$

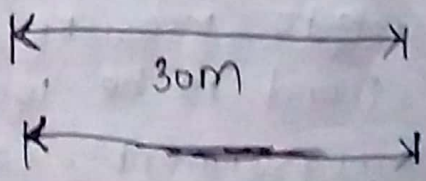
horizontal distance AB = $x_1 + x_2 + x_3 \cdots$

→ Here we have to know the hight of different intermediate points, example :-

We have the hights of point A, P, Q, R, S, B'.

Error due to incorrect chain :-

1. When the too long.

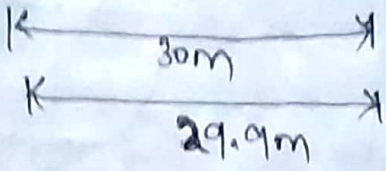


error = -ve

correction = +ve

If you measure the ground which is originally L' m. by measuring the same length of ground by using the chain the length L becomes less than L'.

2. When chain is too short



error = +ve
correction = -ve

→ If you measure the ground which is originaly 'L'm by measuring the same length of ground by using the chain + length L becomes greater than 'L'm.

> True length of a line (TL) =
> $\left(\frac{L'}{L}\right)$ x measured length.

L = original length of a chain
L' = original length ± error of a chain.

> True area of a line (TA) =
> $\left(\frac{L'}{L}\right)^2$ x measured Area

Q. A 20m chain was used to measure a survey line & the chain was found to be 10cm too short through out the measurement. Calculate the measured or correct length of a line if the measured length is 200m.

Given data,

L' = 20m - 0.1m = 19.9m

L = 20m.

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

$$= \frac{19.9}{20} \times 200$$

$$= 199\,m.$$

Q The distance betn two station is 1200 m when measured with a 20m chain. The same distance when measured with a 30m chain. The length was found to be 1195 m. If the 20m chain was 5cm too long than what is the error in 30m chain.

Given data,

For 20 m chain

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

$$L' = 20 + 0.05 = 20.05\,m.$$

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

$$= \frac{20.05}{20} \times 1200$$

$$= 1203\,m$$

$$T.L = 1203\,m.$$

For 30m chain

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

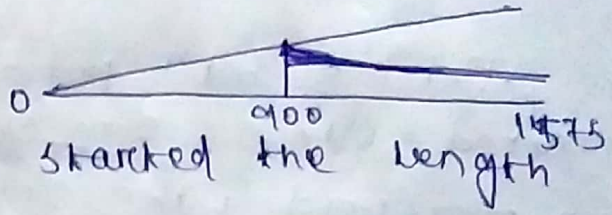
$$1203 = \frac{L'}{30} \times 1195 \Rightarrow L' = 30.20\,m.$$

error = 30.20 − 30 = 20cm

The error is 2cm too long.

9- A chain line was measured by 20m chain which was accurate before the starting of the day. After chaining 900m the chain was found to be 6 cm too long. After chaining a total distance of 1575m the chain was found to be 14cm too long. Find the true distance of line.

Ans:-



When the chain is started the length of the chain 20m.

(i) $TL = \frac{L'}{L} \times M.L$

$L' = \frac{0+6}{2} = 3cm = 0.03m = 20+0.03$

$= 20.03m$

$TL = \frac{20.03}{20} \times 900$

$= 901.7m.$

(ii) $TL = \frac{L'}{L} \times M.L$

$L' = \frac{6+14}{2} = \frac{20}{2} = 10cm = 0.1m.$

$M.L = 1575 - 900 = 675m.$ $= 20+0.1 = 20.1m.$

$TL = \frac{20.1}{20} \times 675.$

$= 678.325m.$

1. Compensating Errors :-

Errors which may occur in both direction (i.e. both positive and negative) and which finally tend to compensate are known as compensating errors. These errors do not affect survey work seriously. They are proportional to $\sqrt{L}$ where L is the length of the line. Such errors may be caused by

(a) Incorrect holding of the chain,

(b) Horizontality and verticality of steps not being properly maintained during the stepping operation.

(c) Fractional parts of the chain or tape not being uniform throughout its length, and

(d) Inaccurate measurement of right angles with chain and tape.

2. Cumulative Errors :-

Errors which may occur in the same direction and which finally tend to accumulate are said to be cumulative. They seriously affect the accuracy of the work, and are proportional to the length of the line (L). The errors may be positive or negative.

Positive Errors :-

When the measured length is more than the actual length (i.e. when the chain is too short), the error is said to be positive. Such errors occur due to

(a) The length of chain or tape being shorter than the standard length.

(b) Slope correction not being applied.

(c) Correction for sag not being made,

(d) Measurment being taken with faulty alignment and

(e) Measurment being taken in high winds with the tape in suspension.

Negative Errors :-

When the measured of the line is less than the actual length (i.e. when the chain is too long), the error is said to be negative. These errors occure when the length of the chain or tape is greater than the standard length due to the following reasons.

(a) The opening of ring joints,
(b) The applied pull being much greater than the standard pull,
(c) The temperature during measurement being much higher than the standard temperature,
(d) wearing of connecting rings, and
(e) Elongation of the links due to heavy pull.

CHAIN AND TAPE CORRECTIONS :-

A. Tap correction :-

1. Temperature correction (Ct)

This correction is necessary because the length of the tape or chain may increase or decrease due to rise or fall of temperature during measurment. The correction is given by the expression.

$$Ct = \alpha (Tm - To) L$$

where, Ct = correction for temperature, in metres.

α = coefficient of thermal expansion

Tm = tem. during measuring in degrees centigrade or celsius.

To = tem. at which the tape was standardised, in degrees centigrade or celsius.

L = length of tape in metres.

The sign of correction may be positive or negative according as Tm is greater or less than To.

When a for the steel tape is not given, it may be assumed to be 11×10^{-6} per degree centigrade or celsius.

2. Pull correction (Cp) :-

During measurement the applied pull may be either more or less than the pull at which the chain or tape was standardised. Due to the elastic property of materials the strain will very according to the variation of applied pull and hence necessary correction should be applied. This correction is given by the expression.

$$Cp = \frac{(Pm - Po)L}{AXE}$$

where,

Cp = Pull correction in metres.

Pm = pull applied during measurement, in kilograms

Po = pull at which the tape was standardised, in kilograms.

L = length of tape in metre.

A = Cross-sectional area of tape, in square centimetres

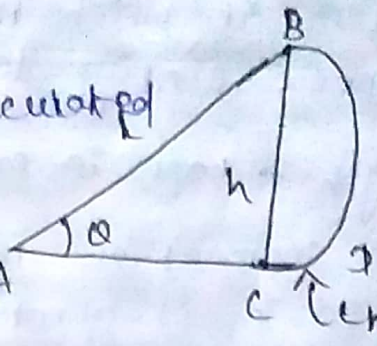
E = modulus of elasticity (Young's modulus)

The sign of correction will be positive or negative according as Pm is greater or less than Po.

When E is not given, it may be assumed 2.1×10^6 kg/cm^2.

3. Slope correction (C_h) :-

Slope correction is calculated as follows.



$C_h = L - \sqrt{L^2 - h^2}$ (exact)

$= L(1 - \cos\theta)$ (exact)

$= \boxed{\frac{h^2}{2L}}$ (approx)

Slope correction

This correct is always negative.

4. Sag correction (C_s) :-

This correction is necessary when the measurement is taken with the tape in suspension (i.e. in the form of a catenary). It is given by the expression.

$$C_s = \frac{L(WL)^2}{24n^2P_m^2}$$

when unit weight is given,

and $C_s = \frac{LW^2}{24n^2P_m^2}$

when total weight is given

where, C_s = Sag correction, in metres

L = Length of tape or chain, in metres

W = weight of tape per unit length, in kilograms per metre

W = Total weight of tape, in kilograms

n = number of spans.

P_m = pull applied during measurement, in kilograms.

The sign of correction is always negative.

5. Normal Tension (P_n) :-

The tension at which the effect of pull is neutralised by the effect of sag is known as normal tension. At this tension, the elongation due to pull is balanced by the shortening due to sag. So, equating the expressions for correction for pull and sag, we have.

$$\boxed{\frac{(P_n - P_0)L}{AE} = \frac{L(WL)^2}{24 P_n^2}} \quad \text{(considering } n = 1\text{)}$$

where, P_n = normal pull or tension.

Here, the value of P_n may be determined by trial, by forming an equation by putting the known values.

$$\frac{(P_n - P_0)L}{AE} = \frac{L(WL)^2}{24 P_n^2} \quad \text{(considering } n = 1\text{)}$$

or $$\frac{(P_n - P_0)}{AE} = \frac{W^2}{24 P_n^2}$$

or $$\boxed{(P_n - P_0) P_n^2 = \frac{W^2 AE}{24}}$$

By substituting the values of P_0, W, A and E an equation will be obtained in the following form.

$$x P_n^3 \pm x P_n^3 \pm c = 0$$

Then, the value of P_n is to be determined by satisfying the equation by trial and error.

A steel tape was exactly 30 m long at 20°C when supported throughout its length under a pull of 10 kg. A line was measured with his tape under a pull of 15 kg and at a mean temp. of 32°C and found to be 780 m long. The cross-sectional area of the tape = 0.03 cm² and its total weight = 0.693 kg. α for steel = 11 × 10⁻⁶ per °C and E for steel = 2.1 × 10⁶ kg/cm². Compute the true length of the line if the tape was supported during measurement,

(a) at every 30 m and

(b) at every 15 m.

Given data,

Steel tape, L = 30 m

$T_0 = 20°C$

$P_0 = 10$ kg

$P_m = 15$ kg

$T_m = 32°C$

M.L = 780 m.

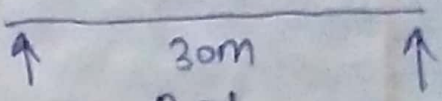
$A = 0.03 cm^2$

$W = 0.693$ kg

$\alpha = 11 \times 10^{-6}$ per °C

$E = 2.1 \times 10^6$ kg/cm²

(i) Case 1 For 30 m support of tape



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

$$= 11 \times 10^{-6} (32 - 20) 30$$

$$= +3.96 \times 10^{-3} m$$

$$C_p = \frac{(P_m - P_0) L}{AE}$$

$$= \frac{(15 - 10) 30}{0.03 \times 2.1 \times 10^{-6}} = +2.38 \times 10^{-3} m$$

$$C_s = \frac{L (WL)^2}{24 n^2 p^2 m}$$

$$= \frac{30 \times (0.693)^2}{24 \times 1 \times (15)^2}$$

$$= -2.66 \times 10^{-3} m$$

Total error $= +3.96 \times 10^{-3} + 2.38 \times 10^{-3} - 2.66 \times 10^{-3}$

$$= 3.68 \times 10^{-3}$$

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

$$L' = L + e = 30 + 3.68 \times 10^{-3}$$

$$= 30.003 m$$

$$T.L = \frac{30.003}{30} \times 780$$

$$= 780.09 m.$$

(ii) Case 2 for 15m support of tape.

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

$= 11 \times 10^{-6} (32 - 20) 30$

$= +3.96 \times 10^{-3} m.$

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

$= \frac{(15-10)30}{0.03 \times 2.1 \times 10^{-6}} = +2.38 \times 10^{-3} m.$

$C_s = \frac{L(WL)^2}{24n^2 p^2 m}$

$= \frac{30 \times (0.693)^2}{24 \times 4 \times 15^2}$

$= 6.670 \times 10^{-4} m.$

Total error $= +3.96 \times 10^{-3} + 2.38 \times 10^{-3} - 6.670 \times 10^{-4}$

$= 5.673 \times 10^{-3} m.$

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

$L' = L + e = 30 + 5.673 \times 10^{-3}$

$= 30.005 m.$

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

$= \frac{30.005}{30} \times 780$

$= 780.13 m.$

Q- A 20m steel tape was standardised on flat ground, at a temperature of 20°c and under a pull of 15kg. The tape was used in catenary at a temperature of 30°c and under a pull of P kg. The cross-sectional area of the tape is 0.22cm², and its total weight is 400g. The Young's modulus and coefficient of linear expansion of steel are 2.1×10^6 kg/cm² and 11×10^{-6} per°c respectively. Find the correct horizontal distance if p is equal to 10kg.

Given data,

$L = 20m$ $\quad W = 400g = \frac{400}{1000} = 0.4kg$

$T_0 = 20°C$ $\quad E = 2.1 \times 10^6$ kg/cm²

$P_0 = 15kg$ $\quad \alpha = 11 \times 10^{-6}$ per°c

$T_m = 30°C$ $\quad P = 10kg$ $\quad n = 2$

$A = 0.22cm^2$

$n = 2$
$n^2 = 2$

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

$= 11 \times 10^{-6}(30° - 20°) \times 20$

$= 2.2 \times 10^{-3}$ m (+ve)

$C_p = \frac{(P - P_0)L}{A \times E}$

$= \frac{(10 - 15) \times 20}{0.22 \times 2.1 \times 10^6}$

$= -2.1645 \times 10^{-4}$ (-ve)

$C_s = \frac{L(W)^2}{24n^2P^2m}$

$= \frac{20 \times 0.4^2}{24 \times 1 \times (10)^2} = 1.333 \times 10^{-3}$ (-ve)

Total error $= 2.2 \times 10^{-3} - 2.1645 \times 10^{-4} - 1.333 \times 10^{-3}$

$= 6.5055 \times 10^{-4}$

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

$L' = L + e = 20 - 6.5055 \times 10^{-4}$

$= 19.99934\,m.$

Q- A 30 m steel tape was standardised at a temp. of 20°C and under a pull of 5kg. The tape was used in catenary at a temp. of 25°C and under a pull of P kg. The cross-sectional area of the tape is $0.02\,cm^2$, its weight per unit length is 22 g/m, Young's modulus = $2 \times 10^6\,kg/cm^2$, $\alpha = 11 \times 10^{-6}$ per °C. Find the correct horizontal distance, if P is equal to (a) 5kg, and (b) 11kg.

Given data,

$L = 30m$

$T_0 = 20°C$

$P_0 = 5kg$

$T_m = 25°C$

$P = 5kg, 11kg$

$A = 0.02\,cm^2$

$E = 2 \times 10^6\,kg/cm^2$

$W = 22\,g/m$

$\alpha = 11 \times 10^{-6}$ per °C

$n = 1$

$W = L \times D$

$= 22 \times 30 = 660\,g = \frac{660}{1000} = 0.66kg$

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

$= 11 \times 10^{-6} (25 - 20) 30$

$= 1.65 \times 10^{-3}\,m\,(+ve)$

$C_p = \frac{(P - P_0)L}{AE} = \frac{(5 - 5) \times 30}{0.02 \times 2 \times 10^6} = 0.$

$$C_s = \frac{LW^2}{24n^2p_m^2} = \frac{30\times(0.66)^2}{24\times2\times3^2} = 0.02178(-)$$

Total correction $= 1.65\times10^{-3} - 0.02178$

$= -0.02013\ m$

Correct horizontal distance $= 30 - 0.02013$

$= 29.9798m$

(b) $C_t = 1.65\times10^{-3}m$.

$$C_p = \frac{(p-p_0)L}{AF_2}$$

$$= \frac{(10-5)\times30}{0.02\times2\times10^6} = 4.5\times10^{-3}\ (+ve)$$

$$C_s = \frac{LW^2}{24n^2p^2}$$

$$= \frac{30\times(0.66)^2}{24\times11^2}$$

$= 4.5\times10^{-3}\ (-ve)$

Total error $= 4.5\times10^{-3} + 1.65\times10^{-3} - 4.5\times10^{-3}$

$= 1.65\times10^{-3}m$

$L' = L + e$

$= 1.65\times10^{-3} + 30$

$= 30.00165\ m.$

Angular Measurement and Compass Survey :-

D- 27.01.2020

→ Angular measure or compass surveying is done when the Area is large, Crowded, Forest Areas. where chaining is difficult.

Note :-

The principle of compass survey is traversing.

Traversing :-

→ It means the surveying Area is divided into a series of connected lines.

There are 2 types of traverse

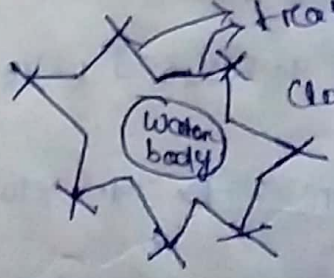
1. closed traverse
2. open traverse

1. closed traverse :-

→ In closed traverse the starting point and the ending point coincide.

(or)

→ When a series of connected lines forms a closed circuit.

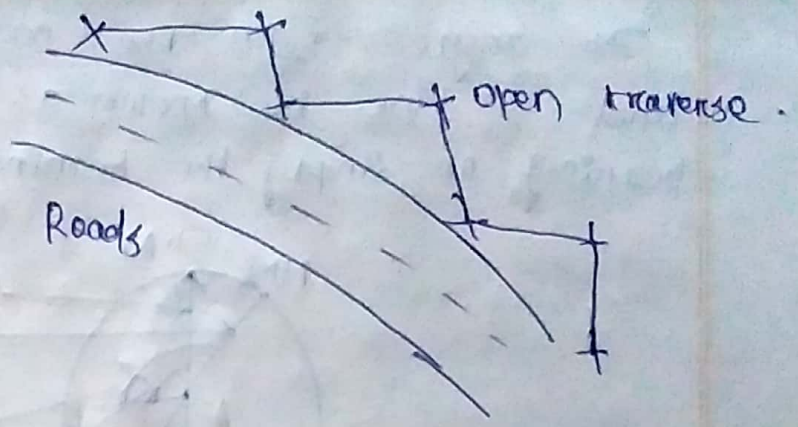


2. open traverse :-

→ In closed traverse the starting point and the ending point do not co-incide.

(or)

→ When a series of connected lines extend along a given direction.



Meridian :-
→ It is an reference through which we measure different angles. (bearinges).

1. True Meridian :-

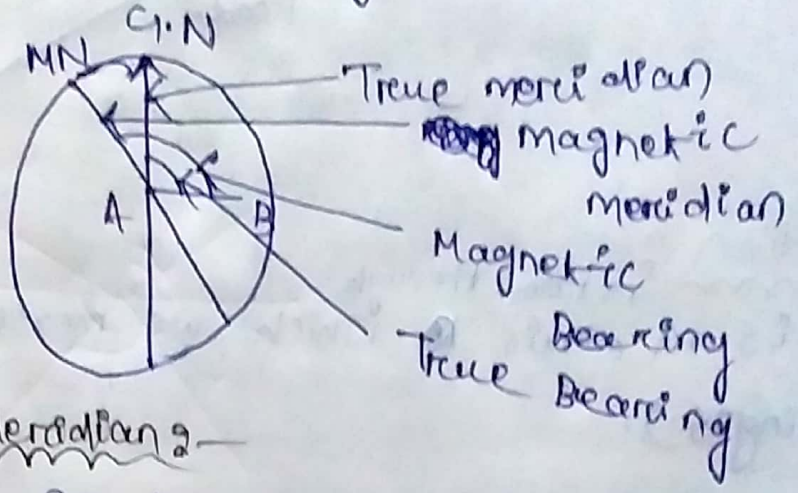
The line or plan through the geographical north pole, geographical south pole and any point on the surface of the earth is known as the true meridian or geographical meridian. The true meridian at a station is constant, The true meridians passing through different points on the earth's surface are not parallel, but converge towards the poles, But for surveys in small areas, the true meridians passing through different points are assumed parallel.

The angle bet^n the true meridian and a line is known as true bearing of the line. It is also known as the azimuth.

2. Magnetic Meridian.

When a magnetic needle is suspended freely and balanced properly unaffected by magnetic substances it indicates a direction. This direction is known as the magnetic meridian.

The angle bet'n the magnetic meridian and a line is known as the magnetic bearing or simply the bearing of the line.



3. Arbitary Meridian :-

Sometimes for the survey of a small area, a convenient direction is assumed as a meridian, known as the arbitrary meridian.

The angle bet'n the arbitary meridian and a line is known as the arbitary bearing of the line.

4. Grid Meridian :-

Sometimes, for preparing a map, some state agencies assume several lines parallel to the true meridian for a particular zone. These lines are termed grid lines and the central line the grid Meridian. The bearing of a line with respect to the grid meridian is known as the grid bearing of the line.

Bearing of A line :-

→ It is measured only in horizental planes.

Designation of Mangetic Bearing :-

It is of 2 types.

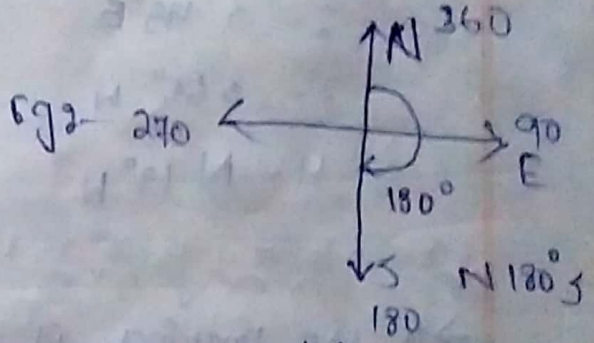
1. whole circle bearing
2. quadrantal bearing

1. Whole circle Bearing :-

→ In this system the Bearings are measured in clock wise sense. or all the Bearing are measured form north.

→ This system is measure by using prismatic compass.

→ It varies form (0° - 360°).



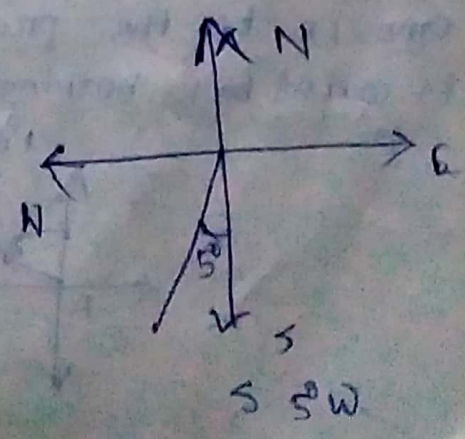
2. Quadrantal Bearing :-

→ In this system the Bearings are measured both in clock wise and anti-clock wise sence.

or all the Bearing can be measured both form north and south.

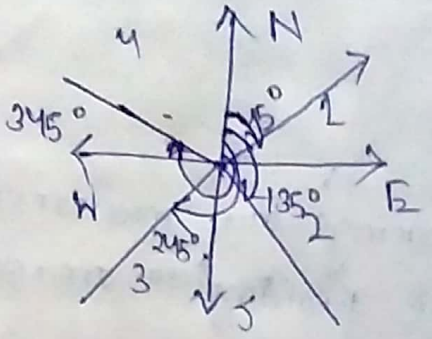
→ This system is measare by using surveyor's compass.

→ It varies form (0° - 90°)



Reduced Bearing :-

→ If whole circle bearing (WCB) is converted to quadrantal bearing (QB) then this Method is known as Reduced Bearing.



1 - N 45° E

2 - S 45° E

3 - S 65° W

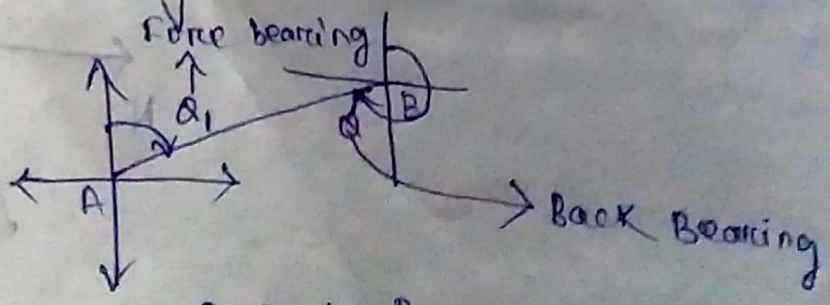
4 - N 15° W

Force Bearing of a line :-

→ If the Bearing of a line is measured in forward direction of a survey line or in progress this is called Fore bearing.

Back Bearing of a line :-

→ If the bearing of a line is measured in backward direction of a survey line or opposite to the progress of survey line this is called back bearing.



$\theta_1 = 180° + \theta$

Case - 1

If F.B > 180°

B.B = F.B - 180°

Case - 2

If F.B < 180°

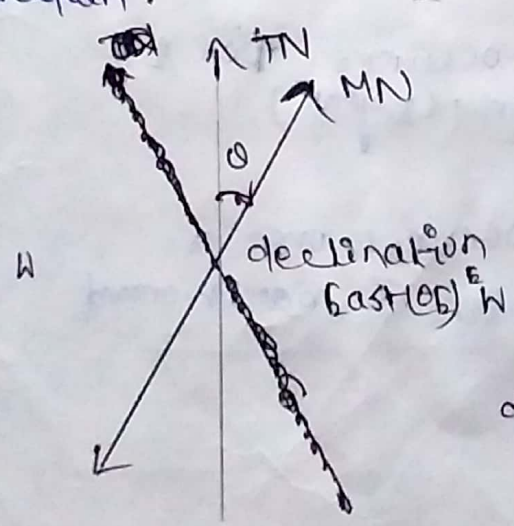
B.B = F.B + 180°

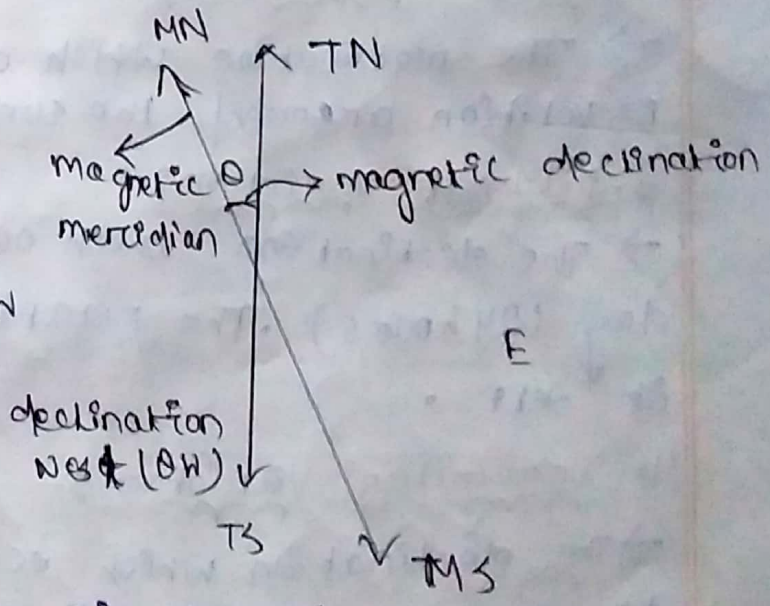
* The difference bet^n fore bearing and back bearing most be 180°. If not than error is present.

Magnetic Declination :-

→ It is horizontal Bearing bet^n Magnetic meridian. True Meridian. OR

It is the difference bet^n true north and magnetic meridian.





→ If the mangetic North is towards the west side of true north than the declination is called declination west. (θW).

→ If the mangetic North is towards the East side of true north than the declination is called declination East. (θE).

Variation of Magnetic declination:-

→ The magnetic declination at a place is not constant. It varies due to following reasons.

1. Seccular variation.
2. Annual variation
3. Durinal variation
4. Irregular variation

1. Seccular variation:-

→ The declination which occures over a long period of time. (100year).

2. Annual variation:-

→ The declination which occures for 1 revolution around the sun. (1 year)

3. Diurnal variation:-

→ The declination which occures over a day (24 hours). The rotation of earth around it self.

4. Irregular variation:-

→ The declination which occures suddenly due to natural hazards like earthquake, floods, volcanic erruption etc.

Isogonic and Agonic:-

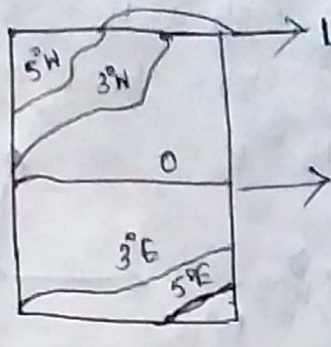
→ Isogonic Line:-

→ The line passing through points of equal declination is called isogonic line.

→ Agonic line:-

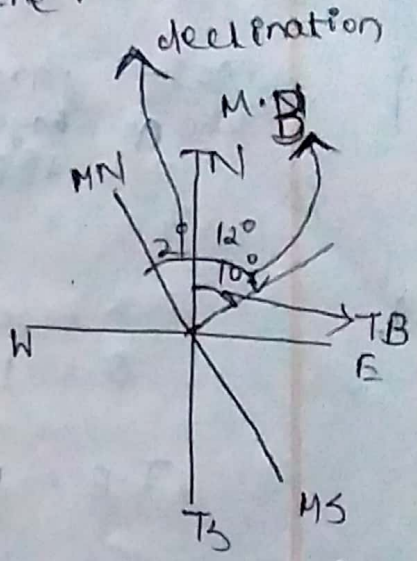
→ The lines passing through point of zero declination is called Agonic line.

Eg 2-



→ Isogonic line

→ Agonic line.



$TB = MB \pm \theta$

$\theta(+) \rightarrow E$

$\theta(-) \rightarrow W$

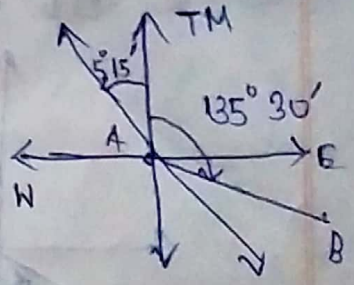
2° W-declination.

Q- The magnetic bearing of a line AB is 135° 30'. What will be the true bearing if the declination is 5°15' W.

$TB = MB \pm \theta$

$TB = 135° 30' - 5° 15'$

$= 130° 15'$ (Ans).



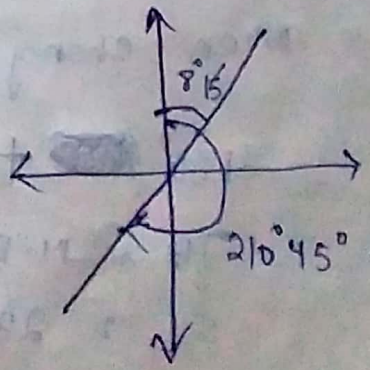
Q- The true bearing of a line CD is 210° 45'. What will be its magnetic bearing if the declination is 8° 15' E

$TB = MB \pm \theta$

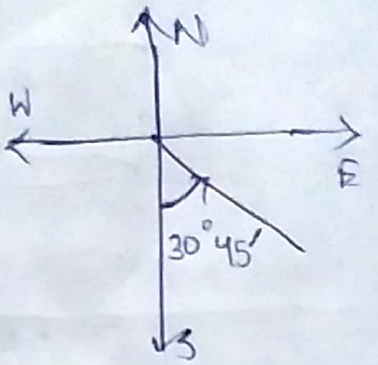
$MB = TB - \theta$

$= 210° 45' - 8° 15'$

$= 202° 30'$



Q The True Bearing of a line CD is S 30° 45' E find the true bearing if the declination is 10° 15' E



Ans :— T.B = M.B ± θ

When Change SB to WCB.

= 180° + 30° 45' − 10° 15'

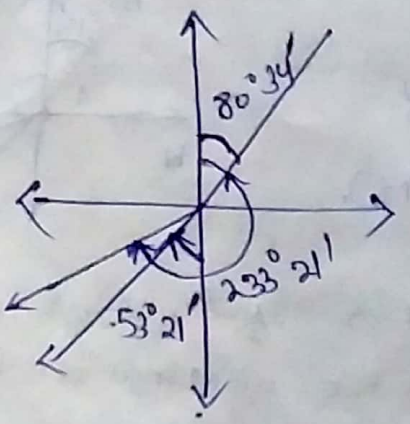
= 149° 15'

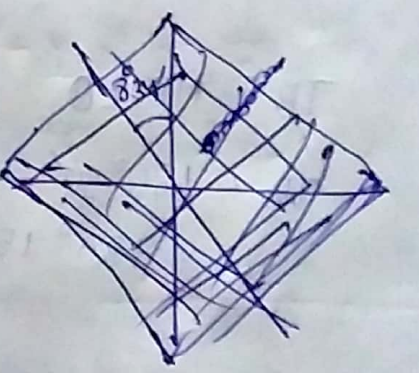
θ = 10° 15' E

T.B = 149° 15' − 10° 15'

= 139° 0' 0" .

Q The Magnetic bearing of a line OA is S 53° 21' W. Find the true bearing if the declination is 8° 34' E.





When Chang SB to WCB

180° + 53° 21' = 233° 21'

TB = M.B + θ

= 233° 21' + 8° 34'

= 241° 55'

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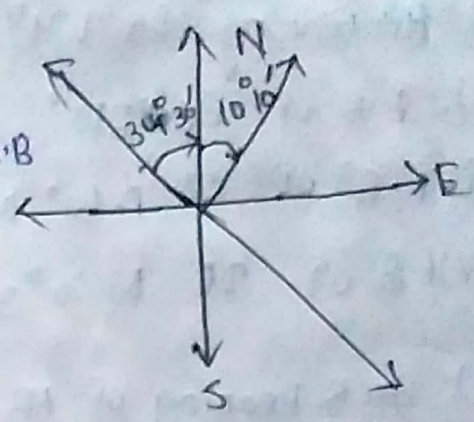
Q- The magnetic bearing of a line OE is N34° 30' W. Find the true bearing if the declination is 10°10' E.



When change to QB to WCB

$= 360° - 34°30' = 325°30'$ = M.B

$\theta = 10°10'$

$TB = M.B + \theta$

$= 325°30' + 10°10'$

$= 335°40'$ (Ans).

Dip of a Magnetic Needle :-

→ If the Needle is perfectly balanced before mangat is sation it does not remain in balanced position after it is mangaties. This is due to magnetic influence of earth.

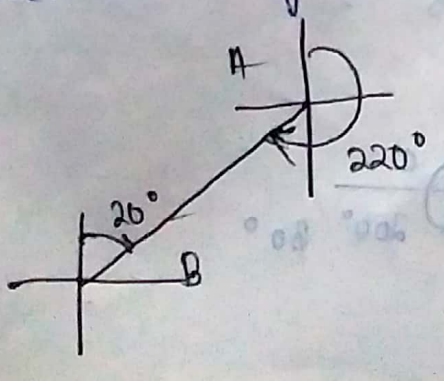
→ The needle is found to be Inclinde towards poles - This Inclination is called dip of magnetic Needle.

Local Attraction :-

→ It is deviation of magnetic Needle due to presentence of of local magnetic field. like, Iron (Fe), Nicale (Ni) Cobalt (Cu) and electric current in wire.

Detection of Local Attraction :-

→ If the fore bearing and back bearing of a line do not ~~defect~~ differ by 180° then we have Local Attraction.



F.B of AB = 200°.

B.B of AB = 20[illegible]°

F.B of BA = 20°

Q- Find the Back Bearing of following lines.

(i) Fore Bearing is 134° AB.

(ii) F.B of BC 210°

(iii) F.B of CD S 60° 14' E

(iv) FB of DE N 30° 30' W

(i) Back Bearing of AB = 180° + 134°

= 314°

(ii) Back Bearing of BC = 210° - 180°

= 30°.

(iii) Back Bearing of CD = 180° - 60°14'

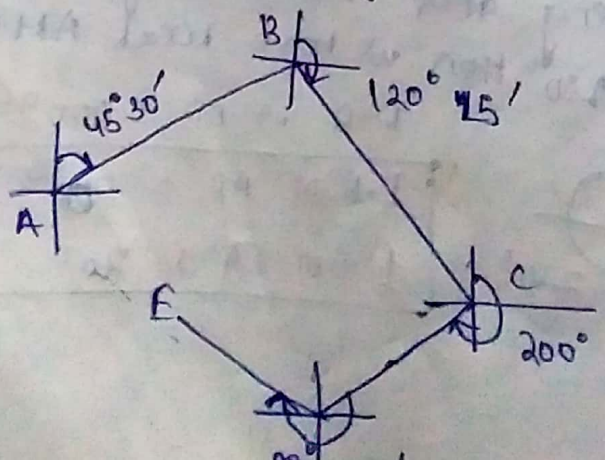
= 119° 46' (WCB)

B.B of CD = 119° 46' + 180° = 299° 46' (B.B)

(iv) Back Bearing of DE = S 30° 30' E

D- 31.01.2020

Q- The Force bearing of lines AB, BC, CD and DE are 45° 30', 120° 15', 200° 30', 280° 45' respectively Find the Interial angles ∠B, ∠C, ∠D



(I) B.B of AB = F.B of BC

= (45°30′ + 180°) − 120°15′

= 105°15′.

∠B = 105°15′

(II) B.B of BC − F.B of CD

= (120°15′ + 180°) − 200°30′

= 99°45′

∠C = 99°45′

(III) F.B of DE − B.B of CD

= 280°45′ − (200°30′ − 180°)

= 280°45′ − 20°30′

= 260°15′

Ext. angle ∠D = 99°45′

9- The following are the bearings of a closed traverse

Side	FB	BB
AB	N 45°30′ E	S 45°30′ W
BC	S 60°0′ E	N 60°0′ W
CD	S 10°30′ W	N 10°30′ E
DA	N 75°45′ W	S 75°45′ E

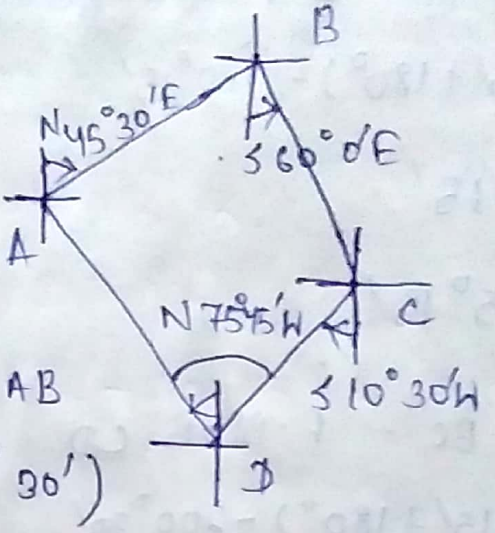
We convert the QB to WCB.

AB - 45° 30'

BC = 120°

CD = 190° 30'

DA = 284° 15'



(i) B.B of DA - F.B of AB

= 284° 15° - (180° - 45° 30')

= 58° 45'

(ii) B.B of A.B - F.B of BC

= (180° + 45° 30') - 120°

= 225° 30' - 120°

= 105° 30'

(iii) B.B of BC - F.B of CD

= (180° + 120°) - 190° 30'

= 300° 0' - 190° 30'

= 109° 30'

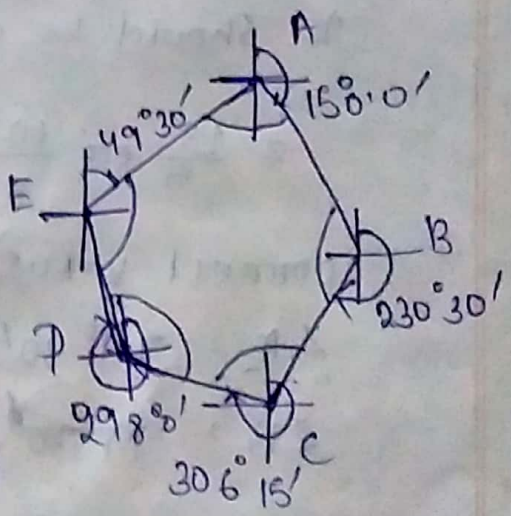
(iv) DA = 360° - 273° 45'

= 86° 15'.

D 30.02.2020

Q- The following at the bearing of a traverse taken by a compass in this area local attraction was encected. Calculate the internal angles of the traves and correct them if necessary.

Line	F.B	BB
AB	150°0′	330°0′ ~
BC	230°30′	48°0′ (x)
CD	306°15′	127°45′ (x)
DE	298°0′	120°0′
EA	49°30′	229°30′



(I) ∠A = B.B of EA − F.B of AB
= 229°30′ − 150°0′
= 79°30′ (Interior)

(II) ∠B = B.B of AB − F.B of BC
= 330°0′ − 230°30′
= 99°30′ (Interior)

(III) ∠C = F.B of CD − B.B of BC
= 306°15′ − 48°0′
= 258°15′ (Exterior)

∠C = 360° − 258°15′ = 101°45′ (Interior)

(IV) ∠D = F.B of DE − B.B of CD
= 298°0′ − 127°45′ = 170°15′ (Exterior)

∠D = 360° − 170°15′ = 189°45′ (Interior)

$\angle E$ = B B of DE − F B of EA

= $120^\circ 0' - 49^\circ 30' = 70^\circ 30'$

ACt sum of the angles is

= $\angle A + \angle B + \angle C + \angle D + \angle B$

= $79^\circ 30' + 99^\circ 30' + 101^\circ 45' + 189^\circ 45' + 70^\circ 30'$

= $541^\circ 0'$

ACt sum of interior $\angle$s should be 540°.

error = $541^\circ - 540^\circ = 1$

Correction = 1°

1 should be distributed ammong 5 angle

= $\frac{1^\circ}{5}$ or $\frac{60'}{5} = 12'$

correct value

$\angle A = 79^\circ 30' - 12' = 79^\circ 18'$

$\angle B = 99^\circ 30' - 12' - 12' = 99^\circ 18'$

$\angle C = 101^\circ 45' - 12' = 101^\circ 33'$

$\angle D = 189^\circ 45' - 12' = 189^\circ 33'$

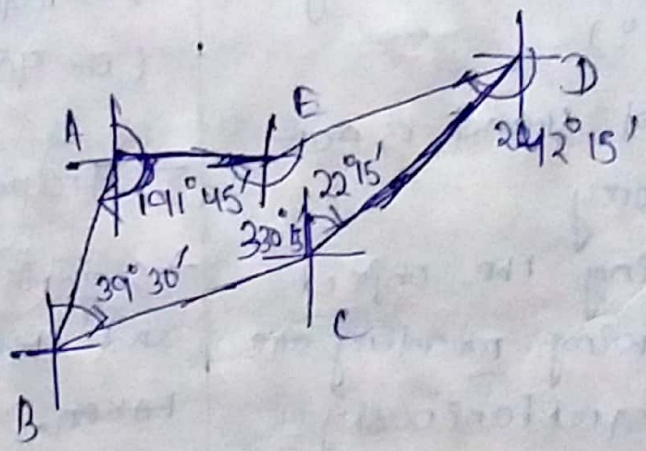
$\angle E = 70^\circ 30' - 12' = 70^\circ 18'$.

Difference both prismatic compass and surveyor's compass.

Prismatic compass	Surveyor's compass.
→ Magnetic Needle of Broad type needle is used.	→ Magnetic Needle of Edge bar type needle is used.
→ Graduated circle is not attached to the compass box.	→ Graduated circle is attached to the compass box.
→ Here the reading are written in inverted type.	→ Here the reading are written in not inverted type. (direct reading)
→ It is used to measure whole circle Bearing (0-360°)	→ It is used to measured quardantal Bearing (0-90°)
→ Tripod stand is not mandatory	→ Tripod stand is must.
→ sighting the object and taking reading are done simultaneously or at a time.	→ sighting is done fast and then reading is taken.

Q- The following are the readings of a line while conducting a traverse on AB, CD, EA with a compass. In a place where local attraction was present.

Line	FB	BB
AB	191° 45'	13°.
BC	39° 30'	222° 30'
CD	22° 15'	200° 30'
DE	242° 45'	62° 45'
EA	330° 15'	147° 45'.



(i) $\angle A$ = FB of AB − BB of EA

= 191° 45' − 147° 45'

= 44° 00' (Interior)

(ii) $\angle B$ = FB of BC − BB of AB

= 39° 30' − 13°

= 26° 30'

(III) $\angle C$ = BB of BC − FB of CD

= 222° 30′ − 22° 15′

= 200° 15′ (Exterior)

$\angle C$ = 360° − 200° 15′ = 159° 45′

(IV) $\angle D$ = FB of DE − BB of CD

= 242° 45′ − 200° 30′

= 42° 15′

(V) $\angle E$ = FB of EA − BB of DE

= 330° 15′ − 62° 45′ = 267° 30′

Sum of the angles = 44° 00′ + 26° 30′ + 159° 45′ + 42° 15′ + 267° 30′

= 540° 00′

Q In a closed traves a local attraction was observed find the correct bearings of the following lines

Line	FB	BB
AB	68° 15′	248° 15′
BC	148° 45′	326° 15′
CD	224° 30′	46°
DE	217° 15′	38° 15′
EA	327° 45′	147° 45′

(i) On verifying the observed bearing it is found that that difference of FB and BB of the line AB is exactly 180°.

So, A and B are free from local attraction

(ii) The observed FB of BC is also correct
There fore, the actual BB of BC should be

$(148°45' + 180°0') = 328°45'$

But the observed bearing is 326°15'
So, a correction of $(328°45' - 326°15')$
$= +2°30'$ should be applied at C.

(iii) Correct FB of CD $= 224°30' + 2°30' = 227°0'$
Therefore, the actual BB of CD should be

$227°0' - 180°0' = 47°00'$

But observed bearing of CD = 46°0'
So, a correction of $(47°0' - 46°0') = +1°0'$ should be applied at D.

(iv) Correct FB of DE $= 217°15' + 1°0' = 218°15'$
Therefore the correct BB of DE should be

$218°15' - 180°0' = 38°15'$

which is equal to the observed BB of DE.
So, station E is also free form local attraction.

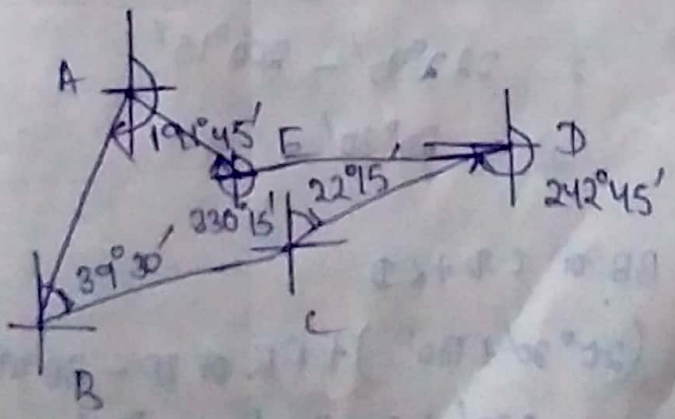
(v) Since stations A and E are both free form local attraction, the FB and BB of EA are correct.

Angle	Calculated value	Correction	Correct value
∠A			
∠B			
∠C			
∠D			
∠E			

Q- Find the corrected bearing of the following lines.

Line	FB	BB
AB	191°45′	13°
BC	39°30′	222°30′
CD	22°15′	200°30′
DE	242°45′	62°45′
EA	330°15′	147°45′.

Ans 2—



FB of DE = 242°45' (correct)

FB of EA = 330°15' (correct)

FB of AB = BB of EA + ∠A

= (330°15' − 180°) + FB of AB − BB of EA

= 150°15' + 191°45' − 147°45'

= 150°15' + 44°

= 194°15'

FB of BC = BB of AB + ∠B

= (194°15' − 180°) + FB of BC − BB of AB

= 14°15' + 39°30' − 13°.

= 14°15' + 26°30' = 40°45'

FB of CD = BB of BC − ∠C (exterior)

= (40°45' + 180°) − (BB of BC − FB of CD)

= 220°45' − (229°30' − 22°15')

= 220°45' − (207°15')

= 222°45' − 200°15'

= 20°30'

FB of DE = BB of CD + ∠D

= (20°30' + 180°) + FB of DE − BB of CD

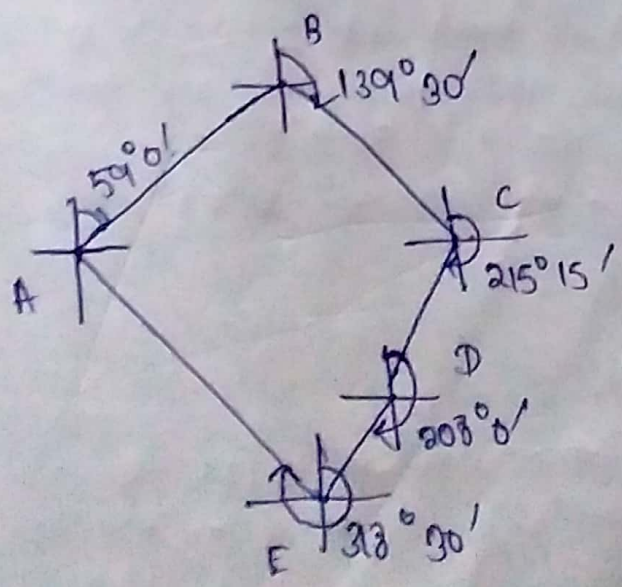
= 200°30' + 242°45' − 200°30'

= 200°30' + 42°15' = 242°45'

Angle	Line	FB	BB
	AB		
∠A		194°15′	14°15′
	BC		220°45′
∠B		40°45′	
∠C	CD	20°30′	200°30′
∠D	DE	242°45′	62°45′
∠E	EA	330°15′	150°15′

Find the correct bearing of the following closed traves where local attraction was expected.

Line	F.B	B.B
AB	59° 0′	239° 0′
BC	139° 30′	317° 0′
CD	215° 15′	36° 30′
DE	208° 0′	29° 0′
EA	318° 30′	138° 45′



Levelling :— ch-5

* The aim of levelling is to determine the relative hights of different object on or below the surface of the earth.

1. Level surface :—

It is a curve surface parallal to the means Spheroidal of a earth.

⇒ the true difference in elevation between two points is the difference in elevation between the level surface through those points.

2. Level line :—

Any line lying on the level surface is called level line.

3. Horizontal surface :—

It is a plane tengential to the level surface at a point.

⇒ A line on the horizontal surface is horizontal line.

D- 06.feb.2020

5. Vertical line :—

the direction indicated by a plumb line is known as the vertical line. this line is perpendicular to the horizontal line.

7. Vertical plane :—

Any plane passing through the vertical line is known as the vertical plane.

8. Datum surface or line :-
this is an imaginary level surface or level line from which the vertical distance of difference point are measured in india the datam adopted for the great trigonometrical survey is the mean sea level at karachi.

9. Reduced level (RL) :-
the vertical distance of a point above or below the datum line is known as the Reduced level of that point. the RL of a point may be posetive or negative according as the point is above or below the datum.

10. Line of collimation :-
It is imaginary line passing through the intersection of the cross-hairs at the diaphragm and optical center of the object glass and its continuation. It is also known as the line of sight.

11. Axis of the telescope :-
this axis is an imaginary line passing through the optical centre of the object glass and the optical centre of the eyepiece.

12. Axis of Bubble tube :-
It is an imaginary line tangential to the longitudinal curve of the bubble tube it's middle point.

13. Bench-marks (BM) :-
these are fixed points or marks of known

⇒ It is done by plane surveying so it less accurate than GTS Bench-marks.

* Arbitary Bench-marks:—

⇒ when the RL of some fixed point are assumed It is called Arbitary Bench-marks.

→ It is done when we have to conduct survey an small areal.

* Temporary Bench-marks:—

when the bench-marks are established temporarily at the end of a day's works their called as temporary Bench work.

eg:- Root of a tree,
parapet of a building etc.

10-07-Feb-2020

Mean sea level (M.S.L):—

⇒ It is the avarage level of sea over a period of 19 years.

⇒ currently the MSL for india is at mombai airport. which as RL value of 0.00m.

Instrument use in leveling:—

(1) Levelling staff
(2) level

1. Levelling staff:—

the leveling staff is a graduated wooden rod for measuring vertical distancence

bet^n the point on the ground and line of collimation.

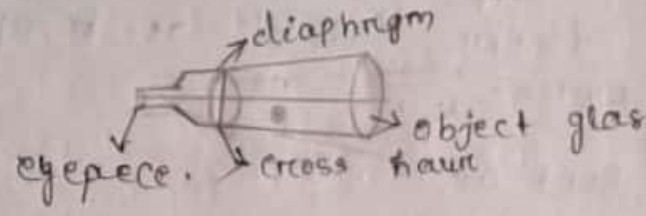
⇒ the foot of the staff represent zero mark.

⇒ the least count of the staff is 5mm

⇒ It can be 4 to 5m of height.

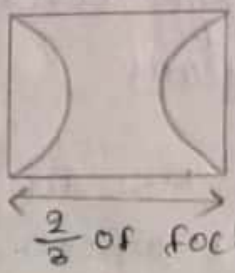
2. level :-

⇒ It is a telescope of internal focussing type known as Keplen's telescop



→ the eyepece used in Ramsden type eyepece.

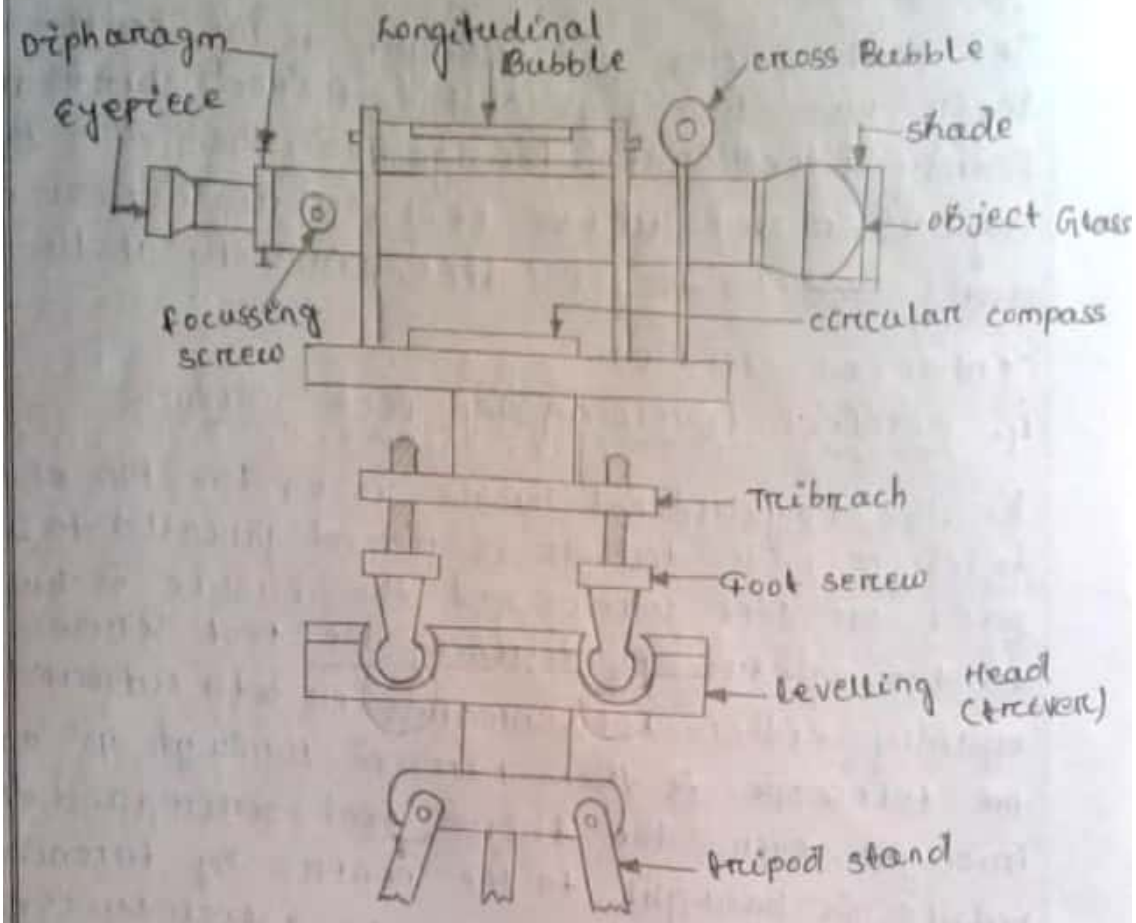
→ It consist of two plano-convex lens.



Object glass :-

⇒ It is an achromatic lens.

⇒ the only design practical for telescope each elemenaction of abberation



:- Dumpy level

1. selection of suitable position :-

A suitable position is selected for setting the level. from this position, it should be possible to take the greatest number of observations without any difficulty. the ground should be fairly level and firm.

2. fixing level with tripod stand :-

the tripod stand is placed at the required position with its legs well apart, and pressed firmly into the ground.

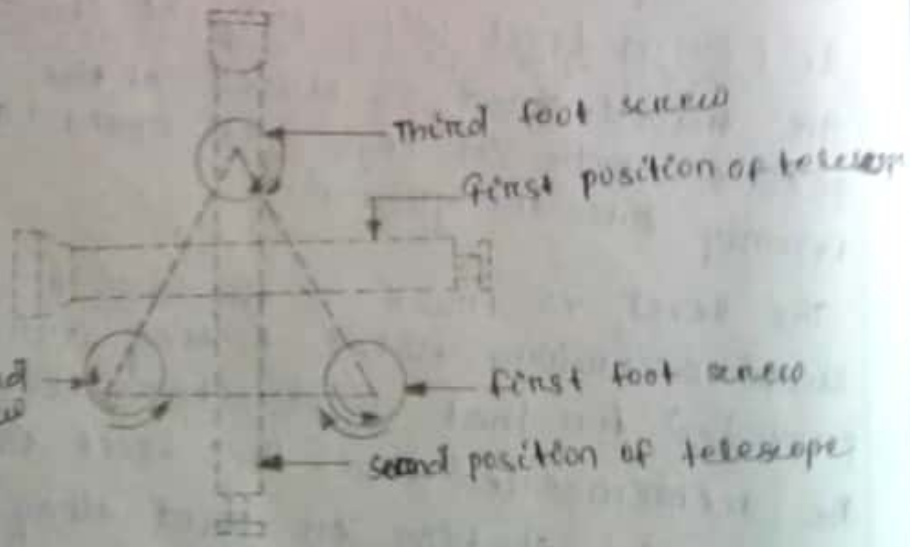
The level is fixed on the top of the tripod stand according to the fixing arrangement provided for that particular level. It should be remembered that the level is not be set up at any station or point along the alignment

3. Approximate levelling by legs of tripod stand :-

The foot screws are brought to the centre of their run. Two legs of the tripod stand are firmly fixed into the ground. Then the third leg is moved to the left or right in or out until the bubble is approximately at the centre of its run.

4. Perfect levelling by foot screws :-

If the longitudinal bubble is on the top of the telescope, the latter is placed parallel to any pair of foot screws and the bubble is brought to the centre by turning the foot screws equally either both inwards or both outwards. The telescope is then turned through 90° and brought over the third foot screw, and the bubble is brought to the centre by turning this foot screw clockwise or anticlockwise. The telescope is again brought to its original position and the bubble is brought to the centre. The process is repeated several times until the bubble remains in the central position in the first as well as the second position. Then the telescope is turned through.



: LEVELLING OF FOOT SCREWS

180° If the bubble still remains in the central position, the temporary adjustment is perfect and so is the permanent adjustment. But if the bubble is deflected from its central position, the permanent adjustment is not perfect and needs to be modified.

5. Focussing the Eyepiece :—

A piece of white paper is held in front of the object glass and the eyepiece is moved in or out by turning it clockwise or anticlockwise until the cross-hairs can be seen clearly.

6. Focussing the object glass :—

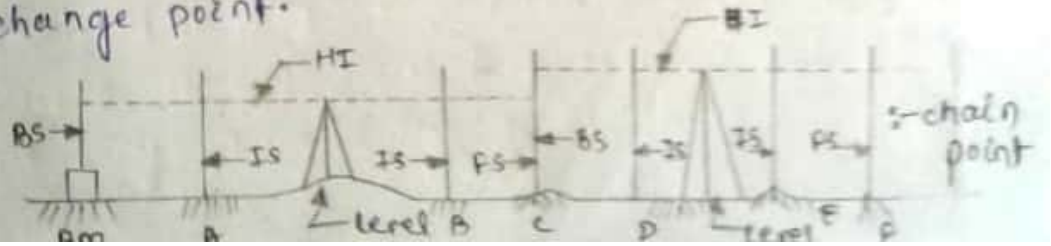
The telescope is directed towards the levelling staff. Looking through the eyepiece, the focussing screw is turned clockwise or anticlockwise until the graduation of the staff is distinctly visible and the parallax is eliminated. To eliminate the parallax, the eye is moved up and down to verify whether the graduation of the staff remains fixed relative to the cross-hairs.

7. taking the staff Readings :—

Finally, the levelling of the instrument is verified by turning the telescope in any direction - when the bubbles remain in the central position for any direction of the telescope, the staff readings are taken.

* Backsight Reading :— (BS)

This is the first staff reading taken in any set-up of the instrument after the levelling has been perfectly done. This reading is always taken on a point of known RL on a bench-mark or change point.



(*) Foresight Reading :— (FS)

It is the last staff reading in any set-up of the instrument ~~after the Levelling is perfectly done. this reading is always taken on a point of which~~ and indicates the shifting of the latter.

(16) Intermediate sight Reading (IS) :—

It is any other staff reading between the BS and FS in the same set-up of the instrument.

(17) change point (CP) :—

this point indicates the shifting of the instrument. At this point, an FS is taken from one setting and a BC from the next setting.

(18) Height of Instrument (HI) :—

when the levelling instrument is properly levelled, the RL of the line of collimation is known as the height of the instrument this is obtained by adding the BC reading to the RL of the BM or CP on which the staff reading was taken.

10.02.2020

The following consecutive readings where taken with the help of a level.

1.905, 2.652, 3.245, 4.195, 1.154, 1.750, 7.550, 1.350, 1.815, 2.850, 3.145 and 1.725.

The instrument was taken on staff held on bench mark (BM) having RL of 100m. Cultural the RL of other point.

Ans:-

station	B.S	I.S	F.S	Rise	fall	R.L	Remark
1	1.905	—	—	—	—	100	B.M
2	—	2.652			0.747	99.253	
3	—	3.245			0.593	98.66	
4	1.854		4.195		0.880	97.78	C.P
5		1.750		0.104		97.884	
6	1.550		1.550	0.2		98.084	
7					0.465	97.619	C.P
8		1.815			0.235	97.384	
9		2.050			1.095	96.289	
10		3.145	1.725	1.42		97.709	
	5.109		7.4				

★ $\Sigma B.S - \Sigma F.S = \Sigma Rise - \Sigma fall$
$= last\ R.L - 1st\ R.L$

The following consective readings where taken with a levelling instrument at interval of 40m.

2.375, 1.730, 0.615, 3.450, 2.835, 2.070, 1.835, 0.985, 0.435, 1.630, 2.55, 3.630.

The instrument shifted at the 4th and 8th reding. If the RL of 1st point is 0.2620 find the R.L of all other points.

Ans:-

Station	B.S	I.S	F.S	Rise	Fall	R.L	Remarks
1	2.375					113.400	
2		1.730		0.645		113.345	
3		0.615		1.115		114.38	
4	2.835		3.450		2.835	111.545	
5		2.070		0.765		112.31	
6		1.835		0.235		112.545	
7	0.435		0.985			111.395	
8		1.630			1.195	112.2	
9		2.955			0.625	111.515	
10			3.630		1.375	110.2	
	5.645		8.065	3.61	6.03	-2.40	

Q. T

∴ Error = $A a_1 - Aa = a a_1 = D \tan \alpha$

So, True reading $Aa - aa_1 = Aa_1 - D \tan \alpha$

Similarly Bb = true reading

∴ Error $= Bb_1 - Bb = bb_1 = D \tan \alpha$

So, True reading $Bb = Bb_1 - bb_1 = Bb_1 - D \tan \alpha$

from (5.1) & (5.2)

True difference of level between A and B

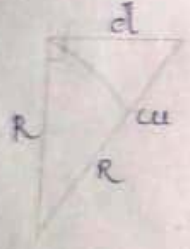
$= Aa - Bb$ (Fall from B to A)

$= Aa_1 - D \tan \alpha - Bb_1 + D \tan \alpha$

$= Aa_1 - Bb_1$

Thus it is seen that the error due to inclination of the collimation line is completely eliminated and the apparent difference is equal to the true difference.

Corrections:—



$R^2 + d^2 = (R + \text{curvature})^2$

$R^2 + d^2 = R^2 + cur^2 + 2R\,cur$

$km \leftarrow \frac{d^2}{2R \rightarrow 6370} = cur$

$0.785 d^2 = \text{curvature}$

↓

km

R = Radius of earth and

$R = 637$ km.

d = distance bet^n instrument and staff.

⇒ due to curvature of earth the staff reading and will increased, the of earth

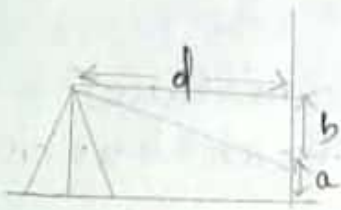
Staff reading are always with respect to level lines.

→ due to curveture the point on earth will appear lowear than it actually each.

correction of Refraction:—

→ Refraction is atmospheric fenomena due to refraction the light lines will bend from dencer miblimum to ranker midimum.

It is observed that due refraction the line of sight will bend towards the earth surface. that is the staff reading reduces it makes point appear higher than the actual.



- true reading = ab

observed reading = 0.9

· ab + error = true

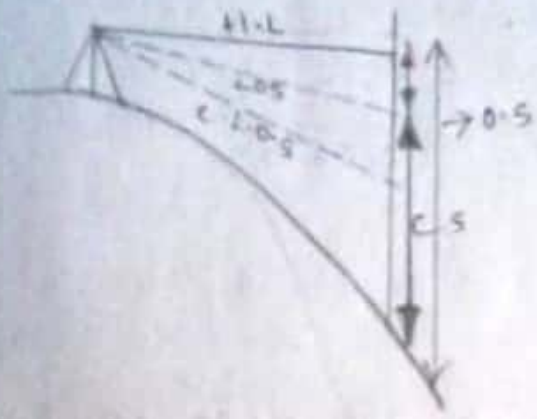
$+\frac{1}{7} \times \frac{d^2}{R}$ = crep (correction of refraction)

$= 1.121 \times 10^{-5} d^2$ km = crep

$= +0.01121\ d^2$ m = crep

Combined correction:—

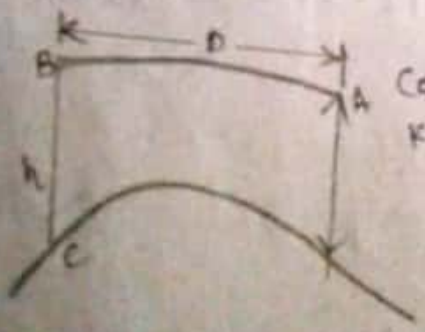
It is the combination of correction for curvature (-ve) and correction for refraction (+ve)



$$C_{comb} = C_{curr} + C_{ref}$$
$$= -0.785d^2 + 0.0112d^2$$
$$= 0.0675d^2 \rightarrow km$$

Distance to visible Horizon: — (1)

Horizon is the point of intersection of sky and earth surface as observed from a distance.



C_{curv} km $\quad h = 0.0673 D^2 \rightarrow d$

$D = \sqrt{\frac{h}{0.0673}} \rightarrow mtr$

D = visible horizon distance in kilometers

h = height of the point above mean sea level, in meters.

Q1/ What is the distance to the visible horizon for an observer standing on the deck of ship having his line of sight 12m above sea level.

Ans:- los = 12m = h

D = ?

$$D = \sqrt{\frac{h}{0.0673}} = \sqrt{\frac{12}{0.0673}}$$

↓ km

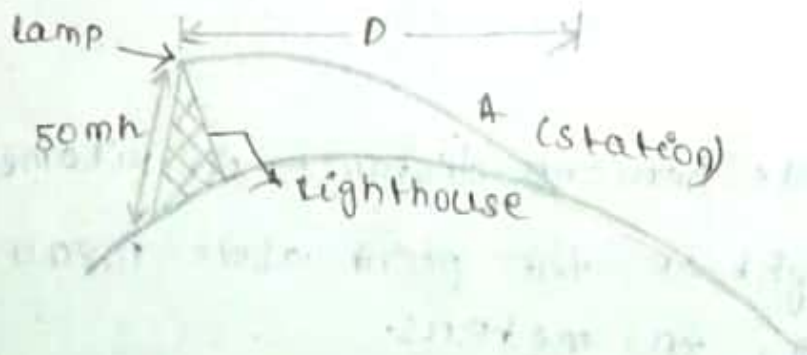
$$= 13.35 \text{ km}$$

Q2/ A man standing on the deck of ship observes a luminous object which is 50m above sea level if the man's eye level is 10m above sea level find the distance between him and the object.

Ans:- $D_1 = \sqrt{\frac{50}{0.0673}} = 27.25 \text{ km}$

$$D_2 = \sqrt{\frac{10}{0.0673}} = 12.18 \text{ km}$$

$$D_1 + D_2 = 27.25 + 12.18 = 39.93 \text{ km}$$



D - 13.02.2020

Reciprocal Levelling :-

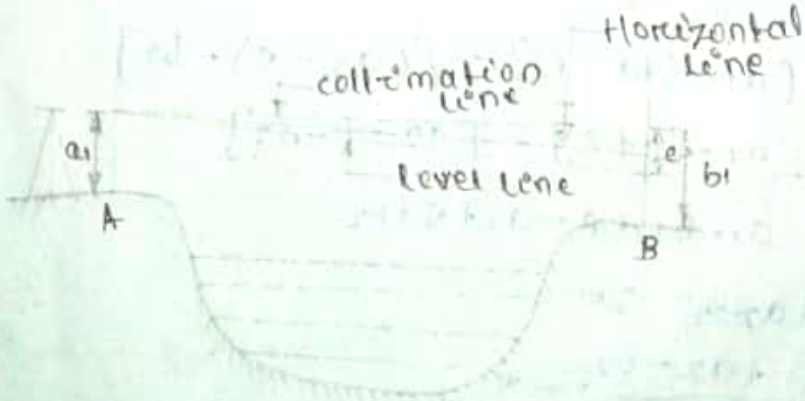
→ when ever it is not possible to balance the side due to field condition we adopt reseprocal levelling by doing reseiprocal levelling the following errors are eliminated

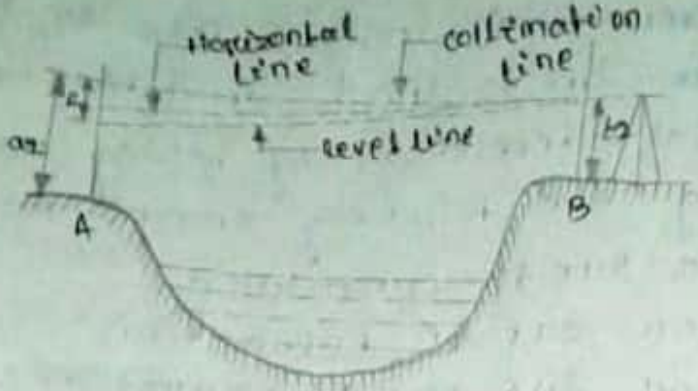
(i) error due to curvature
(ii) error due to refraction
(iii) error due to polimanation

procedure :—

1. suppose A and B are two points on the opposite banks of a river. the level is set up very near A and after proper temporary adjustment, staff readings are taken A & B. suppose the readings are a1 and b1.

2. the level is shifted set up very near B and after proper adjustment staff readings are taken at A and B. suppose the readings are a2 & b2.





:- Reciprocal levelling

Note

we assume point A is at layer elevation than point B.

$h = a_1 - (b_1 - e)$ —(i)

$h = (a_2 - e) - b_2$ —(ii)

adding eqn (i) and (ii)

$h + h = [a_1 - b_1 + e] + [a_2 - e - b_2]$

$2h = (a_1 - b_1) + (a_2 - b_2)$

$$\boxed{h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}}$$

Two difference of level between A and B

substanting eqn (1) and (2)

$h - h = [a_1 - (b_1 - e)] - [(a_2 - e) - b_2]$

$0 = [a_1 - b_1 + e] - [a_2 - e - b_2]$

$0 = a_1 - b_1 + e - a_2 + e + b_2$

$-a_1 + b_1 + a_2 - b_2 = 2e$

$$\frac{-a_1 + b_1 + a_2 - b_2}{2} = e$$

$$e = \frac{(a_2 - b_2) - (a_1 - b_1)}{2}$$

$$e = \left[-\frac{(a_2 - b_2) + (a_1 - b_1)}{2} \right]$$

$$\boxed{e = -\left[\frac{(a_4 - b_4) - (a_2 - b_2)}{2} \right]}$$

→ combine error due to curveture, refraction collimation.

Q. the following observation were taken while conducting reciprocal levelling.

Instrument at	Staff reading on A	Staff reading on B	Remarks
A	1.155	2.595	dist AB = 500 m
B	0.985	2.415	R.L of A = 525.5m

(i) find the R.L of B

(ii) combined correction for curveture and refraction.

(iii) collimation error.

Ans:- $h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}$

$= \frac{(1.155 - 2.595) + (0.985 - 2.415)}{2}$

$= 1.485$

$= 525.5 - 1.485$

R.L of B = 524.065 m

$C_{comb} = 0.0675 d^2$

$= 0.0675 (0.5)^2$

$= 0.0168$ m

dist AB = 500m

R.L of A = 525.5m

$e = e_{can} + e_{col} + e_{ref}$

$e = e_{com} + e_{col}$

$e = -\left[\frac{(a_1 - b_1) - (a_2 - b_2)}{2}\right]$

$= \left[\frac{(1.155 - 2.595) - (0.985 - 2.45)}{2}\right]$

$= 5 \times 10^{-3}$

$e = e_{com} + e_{col}$

$5 \times 10^{-3} = (+0.0168)\,\phi - e_{ref}$

$= 5 \times 10^{-3} - 0.0168 = +C_{REF}$

$= 0.0118$.

Instrument at	staff reading A	staff reading B	Remarks
A	1.725	2.245	RL of A = 450m
B	2.145	3.045	RL of B = ?

find the RL of B

Ans:- $h = \left[\frac{(a_1 - b_1) - (a_2 - b_2)}{2}\right] = -0.71$

= R.L of A = 450 + (-0.7) = 449.29

D - 14.02.2020

Instrument at	staff reading A	staff reading B	Remarks.
A	1.725	1.370	R.L of A = 120.3
B	1.560	1.235	dist AB = 600m

→ find R.L of B.

→ combind correction for refraction and curvature.

Ans:- $h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}$

$= \frac{(1.725 - 1.370) + (1.560 - 1.235)}{2}$

$= 0.34$

R.L of B = 120.3 + 0.34

= 120.64

(ii) $C_{com} = -0.0675 \times d^2$

$= -0.0675 \times (0.6)^2$

$= -0.0243$

Sensitivity of (bubble tube) Air spirit level :—

→ sensitevity of bubble tube means the effect cosed by the deviation of bubble per division of gradiation of bubble tube.

→ sensitiveness is expressed in terms of radeous of curveture of upper surface of the tube or by angle through each axis is tilted for the diflection of one division.

* For small angle of α

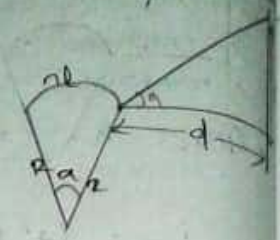
$\tan\alpha \simeq \sin\alpha \simeq \alpha$

$\tan 5' = \sin 5' = 5' = \frac{\pi}{180} \times 5$

$\alpha = \frac{nl}{R}$, $\alpha = \frac{s}{d}$

$\frac{nl}{R} = \frac{s}{d}$

$$R = \frac{nlD}{s}$$



R = radious of curvature
n = no of division shifted by bubble
l = length bet^n two consecutive divisi
D = difference bet^n los when l.o.s is horizontal and inclined.

$$\alpha = \frac{nl}{R} = \frac{s}{D}$$

$$\alpha' = \frac{\alpha}{n} = \frac{nl}{nR} = \frac{s}{nD}$$

Collimation system	Rise-and-fall system
1. It is rapid it involves few calculations.	It is laborious, involving several calculations.
2. there is no check on the RL of intermediate points.	there is a check on the RL of intermediate.
3. Errors in intermediate RLs can't be detected.	Errors in intermediates RLs can be detected as all the points are correlated.
4. there are two checks on the accuracy of RL calculation,	there are three checks on the accuracy of RL calculation.
5. this system is suitable for longitudinal leveling where there are a number of intermediate sights.	this system is suitable for dry levelling where there are no intermediate sights.

Contouring :— D-15.Feb.2020

→ What is contouring?

Ans:- Contouring line are imaginary line joining points to equal elevation (R.L)

→ the elevation of contour lines are expressed with respect to means sea level (m.s.l)

→ A zero meter contour line represent coastal line of a country.

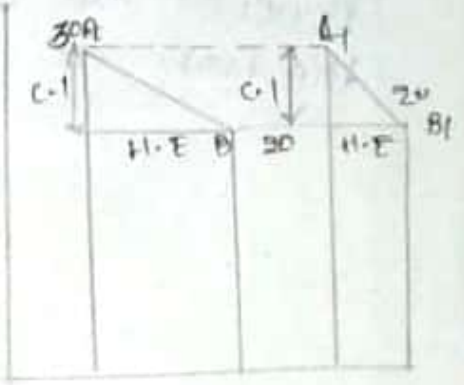
→ contour line gives the topographical feature of a ground

Contour Internal (C.I):—

→ It is the difference in elevation of two consicutive controls lines.

→ It is measure in vertical plane only.

→ It is always constant for a map.



Horizontal equivalent :- (H.E).

→ It is the horizontal distance between two consicutive controls lines. It is measurable horizontal plane.

→ It is not constant it may vary.

Control gradient:- (C.G)

It is a line on the ground making constant inclination with the horizon

→ roads are build with constant contr gradient.

$$C.G = \frac{CI}{H.E}$$

USES OF CONTOUR MAP:-

~~The nature of the ground surface of country can be understood by studying~~

ID-17-02-20207

CHARACTERISTICS OF CONTOURS:-

1. the contour lines are closer near the to of a hill or high ground and wide apart the foot. this indicates a very steep slope towards the peak and a flatter slope ~~towards the peak and a~~ toward the foot.

Fig:- Hill

2. the contour lines are closer near the bank of a pond, or depression and wide apart towards the centre. this indicates a steep slope near the bank and flatter

slope at the centre.

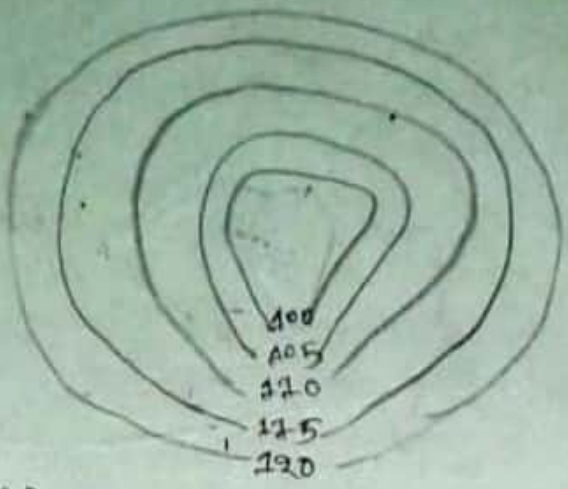


fig :- Depression

3. uniformly spaced lines indicate a uniform slope.

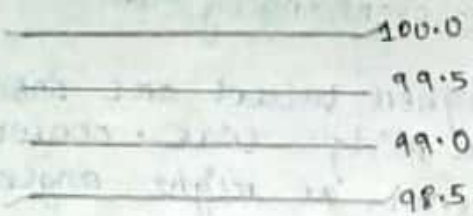


fig :- uniform slope

4. contour lines always form a closed circuit. But these may be within or outside the limits of the map.

fig :- contour closed within map

5. contour lines cannot cross any another, except in the case of an overhanging cliff. But the overlapping portion must be shown by a dotted line.

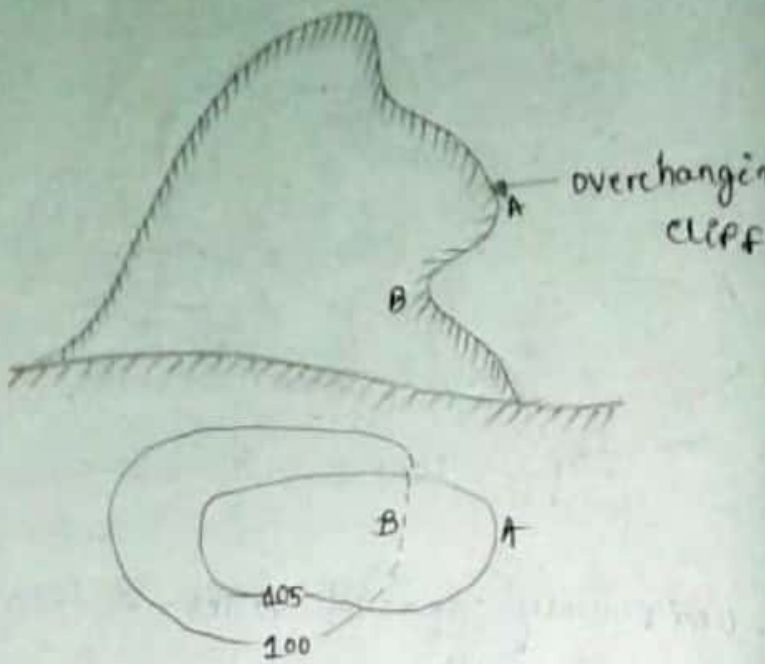


fig:— overhanging cliff

6. when the higher values are enscole the loop, it indicates a ridge line. contour lines cross ridge lines at right angles.

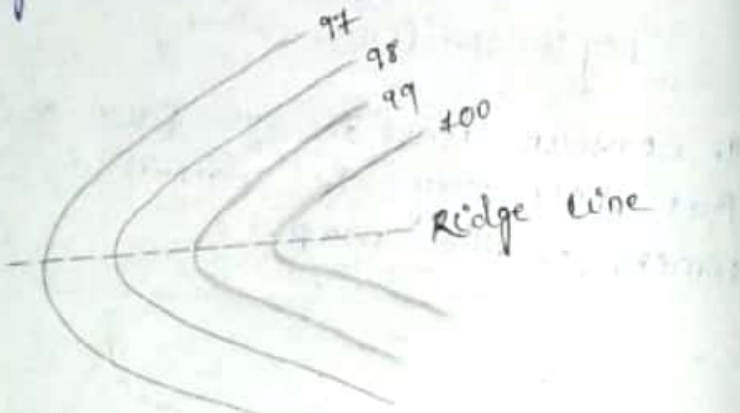


fig:— ridge line.

7. when the lower values are enscole the loop. it indicates a valley line. contour lines cross the valley line at right angles.

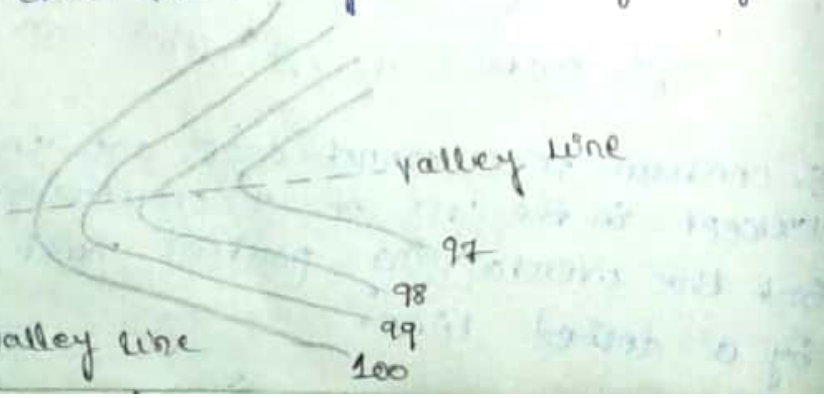
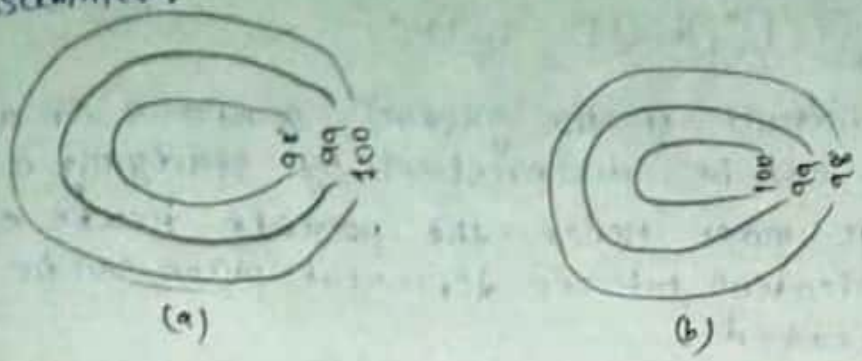
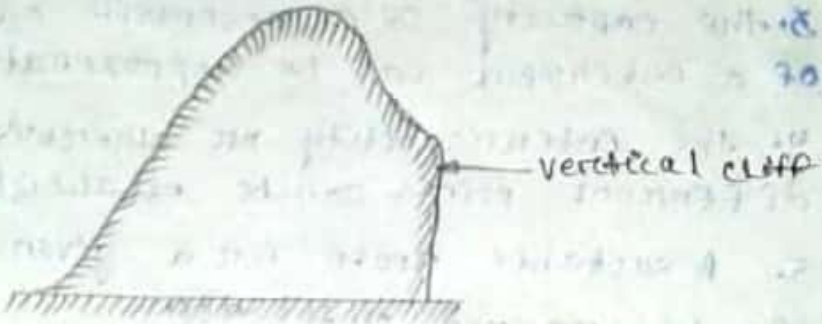


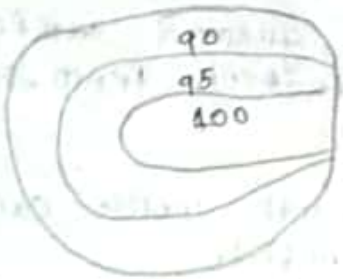
fig:— valley line

8. A series of closed contours always indicates a depression or summit. the lower values being inside the loop indicates a depression and the highest values being inside the loop indicates a summit.

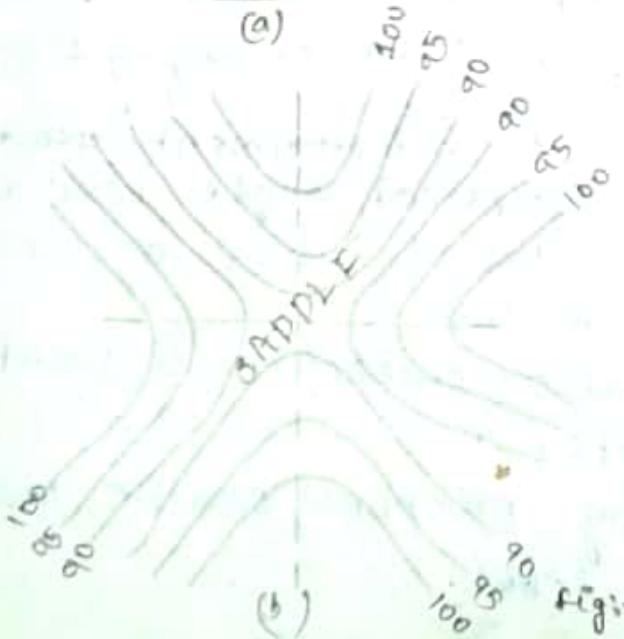


figs- (a) depression (b) summit





(a)



(b)

fig:- (a) vertical cliff
(b) saddle

(8) depressions between summits are called saddle.

(9) contour lines meeting at a point indicate a vertical cliff.

Uses of contour map:—

1. the nature of the ground surface of a country can be understood by studying a contour map. Hence, the possible route of communication between different place can be demarcated.

2. A suitable site or an economical alignment can be selected for any engineering project.

3. the capacity of a reservoir or the area of a catchment can be approximately computed.

4. the intervisibility or otherwise of different points can be established.

5. A suitable route for a given gradient can be marked on the map.

6. A section of the ground surface can be drawn in any direction from the contour map.

7. quantities of earth work can be approximately computed.

Theodolite Traversing :— ch-9

→ theodolite is an instrument use to measure horizontal & vertical angle equivately.

→ the least count of this instrument is 10 sec and 20 sec.

→ It is also called as universion instruments.

→ following prepose can be measure using theodolite.

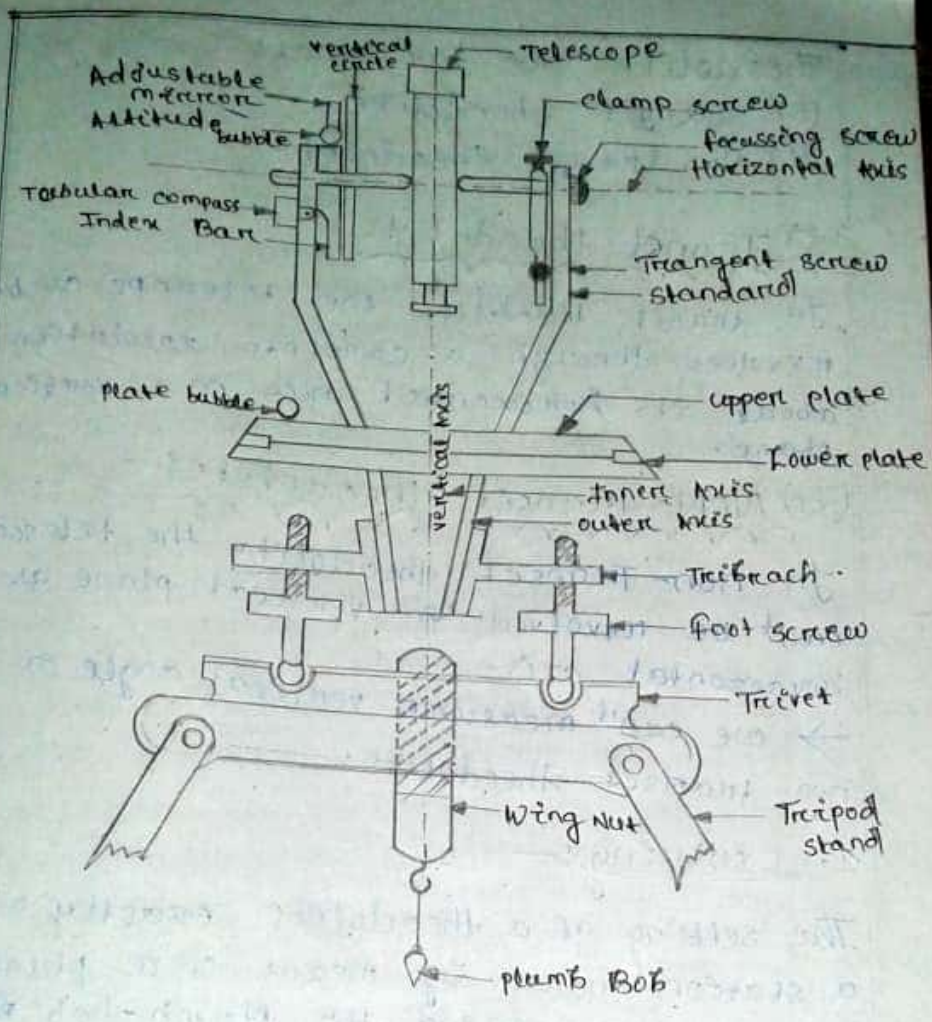


Fig:- TRANSIT THEODOLITE

~~Sc~~ ~~Landboarding~~

⇒ (i) measuring horizontal angle
(ii) measuring vertical angle
(iii) measuring diflection angle
(iv) measuring horizontal distance bet^n two point.
(v) finding height of an object.
(vi) Ranging of a line.

Theodolite are two types:—
(i) Transit theodolite
(ii) Non-transit theodolite

(i) Transit theodolite:—

In transit theodolite the telescope can be revolved through a complete revolution about its horizontal axis in a vertical plane.

(ii) NON-Transit theodolites:—

In non-Transit theodolite the telescope can't be revolved in vertical plane about horizontal axis.

→ we can't measure vertical angle in non-transit theodolite.

1. Centring:—

The setting of a theodolite exactly over a station mark by means of a plumb-bob is known as centring. the plumb-bob is suspended from a hook fixed below the vertical axis.

2. Transiting:—

The method of turning the telescope about its horizontal axis in a vertical plane through 180° is termed as transiting. In other words, transiting result in a change in face.

3. face left / bubble up / Telescope normal

'face left' means that the vertical circle of the theodolite is on the left of the observer at the time of taking readings.

The observation taken in the face left position is called face-left observation.

⇒ the face left position is known as 'telescope normal' or telescope direct'. It is also referred to as bubble up.

4. face right / bubble down / Telescope Inverted

This refers to the situation when the vertical circle of the instrument is on the right of the observer when the reading is taken. the observation taken in the face right position is known as face-right observation.

⇒ The face right position is called 'telescope inverted' or 'telescope reversed'. It is also termed bubble down.

5. Changing face :-

The operation of bringing the vertical circle from one side of the observer to the other is known as changing face.

6. Swinging the Telescope :-

this indicates turning of the telescope in a horizontal plane. It is called 'right swing' when the telescope is turned clockwise and left swing when the telescope is turned anticlockwise.

7. Line of collimation :-

It is an imaginary line passing through the intersection of the cross-hairs at the diaphragm and the optical centre of the object glass and its continuation.

8. Axis of the Bubble tube :—
It is an imaginary line tangential to the longitudinal curve of the bubble tube at the middle point.

9. Axis of the telescope :—
this axis is an imaginary line passing through the optical centre of the object glass and the optical centre of the eyepiece.

10. Vertical Axis :—
It is the axis of rotation of the telescope in the horizontal plane.

11. Horizontal Axis :—
It is the axis of rotation of the telescope in the vertical plane. It is also known as the transition axis.

12. Temporary Adjustment :—
the setting of the theodolite over a station at the time of taking any observation is called temporary adjustment. this adjustment is necessary for every set up of the instrument.

13. ~~Least count of the vernier :—~~

13. Permanent Adjustment :—
When the desired relationship between the fundamental lines of a theodolite is disturbed then some procedures are adopted to establish this relationship. this adjustment is known as permanent adjustment.

TRANSIT THEODOLITE :-

1. Trivet :-

It is a circular plate having a central, threaded hole for fixing the theodolite on the tripod stand by a wing nut. It is also called the base plate. three foot screws are secured to this plate by means of a ball-and-socket arrangement.

2. foot screws :-

these are meant for levelling the instrument. the lower part of the foot screws are secured in the trivet by means of a ball-and socket arrangement, and the upper threaded part passes through the threaded hole in the tribrach plate.

3. Tribrach :-

It is a triangular plate carrying three foot screws at its ends.

TEMPORARY ADJUSTMENT OF THEODOLITE

1. Setting the theodolite over the station :-

The tripod stand is placed over the required station. the theodolite is then lifted from the box and fixed on top of the stand by means of a wing nut or according to the fixing arrangement provided along with the instrument.

2. Approximate Levelling by tripod stands :-

the legs of the tripod stand are placed well apart and firmly fixed on the ground then, approximate levelling is done using this stand. to do this, two legs are kept firmly fixed on the ground and the third is moved in or out clock-wise or anticlockwise, so that the bubble is approximately at the centre of its run.

3. Centring:—

Centring is the process of setting the instrument exactly over a station. At the time of approximate levelling by means of the tripod stand, it should be ensured that the plumb bob suspended from the hook under the vertical axis lies approximately over the station peg.

then, with the help of the shifting head, the centering is done accurately so that the plumb bob is exactly over the nail of the station peg.

4. Levelling:—

Before starting the levelling operation, all the foot screws are brought to the centre of their run. then the following procedure is adopted.

(a) the plate is placed parallal to any pair of foot screws. by turning both these screws equally, inwards or outwards, the bubble is brought to the centre.

(b) the plate bubble is turned through 90° so that it is perpendicular to the line joining the first and second foot screws. then by turning the third foot screw either clockwise or anticlockwise the bubble is brought to the centre.

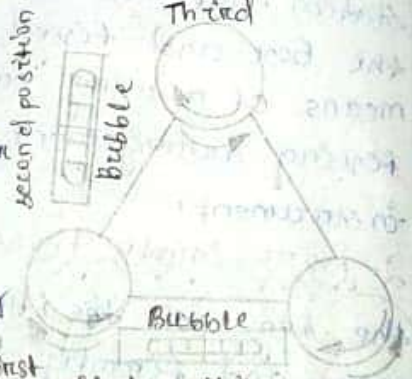


fig:- levelling.

Some instruments may have two plate bubbles perpendicular to each other. In such

a case, one bubble is kept parallel to any pair of foot screws, the other plate bubble will automatically be perpendicular to the position of the first bubble. Here, the instrument need be turned. the first bubble can be brought to the centre by turning the first and second foot screws, and the second bubble can be brought to the centre by turning the third foot screw.

(c) the process is repeated several times, so that the bubble remains in the central position of the plate bubble, both directions, perpendicular to each other.

(d) the instrument is rotated through 360°, about its vertical axis. If the bubble still remains in the central position, the adjustment of the bubble is perfect and the vertical axis is truly vertical.

5. focussing the eyepiece:—

the eyepiece is focussed so that the cross-hairs can be seen clearly. to do this the telescope is directed towards the sky or a piece of white paper is held in front of the object glass, and the eyepiece is moved in or out by turning it clockwise or anticlockwise until the cross-hairs appear distinct and sharp.

6. focussing the object Glass:—

this is done to bring a sharp image of the object or target in the plane of cross-hairs and to eliminate parallax. to do this, the telescope is directed towards the object or target and the focussing screw is turned clockwise or anticlockwise until the image

appears clear and sharp and there is no relative movement between the image and the face. the absence of relative movement can be verified by moving the eye up and down

7. Setting the vernier :—

the vernier A is set to 0° and vernier B to

Reiteration method

this method is suitable when several angles are measured from a single station. In this method all the angles are measured successively and finally the horizon is closed (that is the angle between the last station and first station is measured).

first set :—

1. the thodolote is perfectly centred over O and levelled properly in the usual manner. suppose, the observation is taken in the face left position and the telescope is turned clockwise

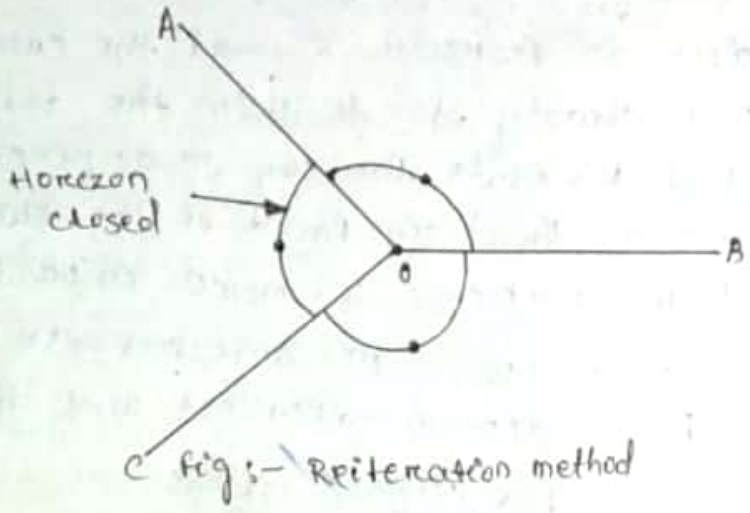


fig :— Reiteration method

2. vernier A is set to 0° and vernier B to 180°
3. the upper clamp is fixed and the lower one loosened the ranging rod at A is perfectly bisected, Now, the lower clamp is tightened.
4. the upper clamp is loosened, and the ranging rod on object at B is bisected properly by

by turning the telescope clockwise. the reading on both the vernier are taken ∠AOB is noted.

5. similarly, the object C is bisected properly and the readings on the verniers are noted ∠BOC is recorded.

6. Now the horizon is closed that is the last angle ∠COA is measured.

Second set :-

1. the face of the instrument is changed. Again the verniers are set their initial position. this time the angles are measured anticlockwise (left swing)

2. the upper clamp is fixed, and the lower one loosened then the object A is perfectly bisected.

3. the lower clamp is tightened. the telescope is turned anticlockwise, and the object c bisected by loosening the upper clamp screw. the readings on both the verniers are taken. ∠COA is noted.

4. then the object B is bisected by turning the telescope anticlockwise, and the readings on the verniers are taken. ∠BOC is recorded.

5. finally, the horizon is closed i.e the object A is bisected.

D - 25.02.2020

the lattitude and diparature of a Line are 3 and -4 respectively find the length and bearing of a line.

Ans:- $l = \sqrt{l^2 + D^2}$

$= \sqrt{3^2 + (-4)^2}$

$= 5$

$\theta = \tan^{-1}\left(\frac{-4}{3}\right) = 53.13°$

N $53.13°$ W

WCB $= 360° - 53.13°$

$= 306.87°$

Q.2 → the latitude and diparature of a line are -6 and -8 respectively find the length and bearing of a line.

$= L = \sqrt{L^2 + D^2}$

$= \sqrt{(-8)^2 + (-6)^2}$

$= 10$

$\theta = \tan^{-1}\left(\frac{8}{6}\right) = 53.13°$

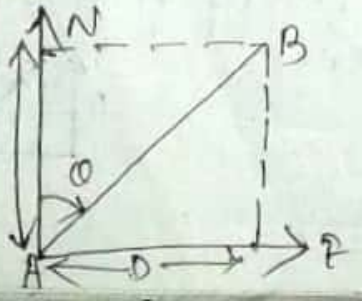
$= 180° + 53.13° = 233°13'$

(2) co-ordenate method

closing errores can be detected prior to plotting and can be corrected for.

Traverse compactation:-

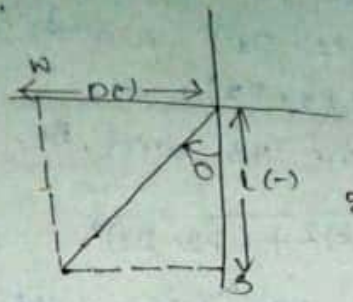
traverse computation are latitude 'L' and departure 'D' latitude is the projection of a line on to the north south axis and departure is the projection of a line on to the east west axis.

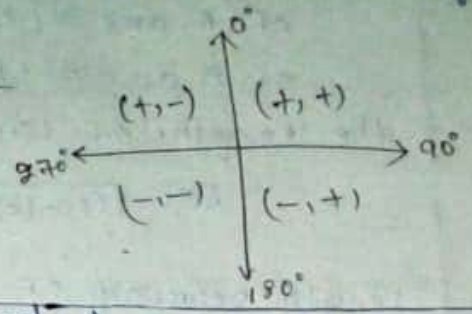


$L = L\cos\theta$

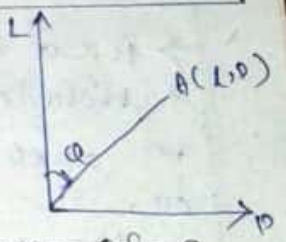
$D = L\sin\theta$

If latitude are projected on north end line are northing (+) and if they are projected on southend, they are southing (-). similarly departature can be easting (+) and westing (-ve).





If the latitude and departature line is (L, D).
then the length of line = $\sqrt{L^2+D^2}$
and bearing 'θ' = $\tan^{-1}\left(\frac{D}{L}\right)$

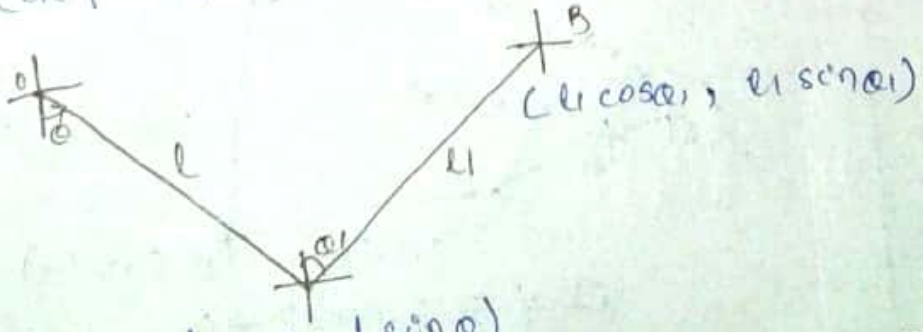


~~If the latitude and departature of a line were 3 and~~

ID - 26.02.2020

Consecutive coordinate :—

→ these are the latitude and departature of the forecoord line with respect to previous line (or point).



Length of a line by using latitude and departure:-

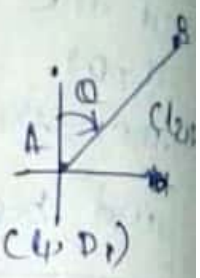
Let, we have two point A & B co-ordinate of A are = (L_1, D_1) co-ordinate of B are = (L_2, D_2).

the length of line AB will be,

$$AB = \sqrt{(L_2 - L_1)^2 + (D_2 - D_1)^2}$$

Length bearing of the line will be.

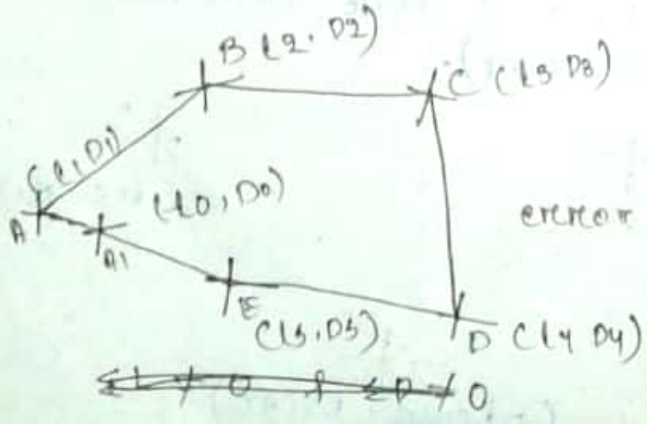
$$\theta = \tan^{-1}\left(\frac{D_2 - D_1}{L_2 - L_1}\right)$$



→ for a close traverse the algebraic sum of latitudes and departure must be equal to zero then the have no closing error. or,

the sum of nothings must be equals to sum of southings and sum of eastings must be equals to sum of weastings.

+L = northing	+D = eastting
−L = southing	−D = westhing



$l_1 + l_2 + l_3 + l_4 + l_5 \neq 0$

$D_1 + D_2 + D_3 + D_4 + D_5 \neq 0$

$\boxed{\Sigma L \neq 0 \text{ \& } \Sigma D \neq 0}$

In fig ABCDEA1A

$\Sigma L = 0$ and $\Sigma D = 0$

Let ΣL be the algebraic sum of latitude of all point except A1A and ΣD be the algebraic sum of all lines except A1A.

Let,

the co-ordinate of A1A be l_0 and D_0

$-\Sigma L + l_0 = 0 \qquad \Sigma D + D_0 = 0$

$\Rightarrow l_0 = -\Sigma l \qquad \Rightarrow D_0 = -\Sigma D$

$\boxed{A1A = \sqrt{(-\Sigma L)^2 + (-\Sigma D)^2}}$

Q. In a travers the algebraic sum of latitude and departure 3 and -4 respectively calculate the closing error.

Ans:- $\Sigma L = 3$

$\Sigma D = -4$

$e = -\Sigma L = -3$

$-\Sigma D = -4$

$e = A1A = \sqrt{(-\Sigma L)^2 + (-\Sigma D)^2}$

$e = \sqrt{(-3)^2 + (-4)^2} = 5$

Q:- The latitude and departures of closing errors are 1m and -2m respectively. Find the length of closing error.

Ans:- $e = -\Sigma L = 1$

$e = -\Sigma D = -2$

$e = \sqrt{(1)^2 + (-2)^2} = \sqrt{1+4} = \sqrt{5}$

D-27.7.2020

the latitude and departures of closing errors as 1m & -2m respectively. Find the length of closing error.

Ans:— $e = -\Sigma L = 1$

$e = -\Sigma D = -2$

$e = \sqrt{(1)^2 + (-2)^2}$

$= \sqrt{1+4} = \sqrt{5}\,m = 2.23\,m$

→ In actual pritice always closing error is present while calculating latitude and departure of a travers.

→ these errors is then distributed among different travers section. their distribution action are of two type.

(1) Bowditch Rule

(2) transit rule.

1. Bowditch rule:—

In this rule the total error (in latitude and dipasature) is distributed on proportion to the length of the travers. Legs.

→ heari angular mesurement are considered less preses compare to lenior measurement. ~~Is correction to latitude of any side.~~

(a) correction to latitide of any side.

$$\left(\frac{\text{length of that side}}{\text{perimeter of traverse}}\right) \times \text{total error in latitude of a traverse.}$$

(b) Correction to departure of any side

$$= \left(\frac{\text{length of that side}}{\text{perimeter of travers}}\right) \times \text{total error in departure.}$$

Transit rule :—

Here,

angular measurement are consider more precise than liner measurement.

(a) correction to latitude of any side.

$$\left(\frac{\text{latitude of that side}}{\text{arithmetic sum of latitude in a traverse}}\right) \times \text{total error in latitude of traverse.}$$

(b) correction to latitude of any side.

$$\left(\frac{\text{departure of that side}}{\text{arithmetic sum of departure in a traverse}}\right) \times \text{total error in departure of traverse.}$$

		consecutive co-ordinate		correction		corrected consecutive co-ordinate	
Line	Length	latitude	departure	L	D	L	D
AB	70	+21.500	−65.45	0.071	0.063	21.500 to 0.071 = 21.571	−65.45 − 0.063 = −65.513
BC	80	−80.755	−5.250	0.082	−0.072	−80.673	= −5.322
CD	43	−41.000	+13.550	0.044	−0.039	−40.956	13.511
DE	38	−14.250	+35.150	0.038	−0.035	−14.212	35.116
EA	115	+114.150	+22.315	0.118	−0.104	114.268	22.211
	total = Σl = 346	ΣL = −0.355	ΣD = 0.315				

Σlength = 40 + 80 + 43 + 38 + 115 = 346

EL = +21·500 − 80·755 − 41·000 − 14·250 + 114·150

= −0·355

EO = −65·45 − 5·250 + 13·550 + 35·150 + 22·

= 0·1315

Q. the following records are obtained in a traverse survey. the length and bearing of last line were not noted.

Line	Length	Bearing	L	D
AB	75.5	30° 24'	65.12	38.205
BC	180.5	110° 36'	-63.507	168.95
CD	60.25	210° 30'	-51.91	=-30.57
DA	?	?	$\Sigma l\cos\theta$ = 50.297 $+\Sigma l\cos\theta$	$\Sigma l\sin\theta$ = 176.585 $+\Sigma l\sin\theta$

ID - 02.08.2020

Q. An incomplete traverse table is given below..

Line	Length	bearing
AB	100	?
BC	80.5	140° 30'
CD	60	220° 30'
DA	?	310° 15'

calculate the length of DA and bearing AB.

Ans:- For closed traverse

$\Sigma L = 0$ and $\Sigma D = 0$

Let,

Bearing of line AB be = θAB

Length of line DA be = L_{DA}

$\Sigma L = 0$

$100 \cos \theta_{AB} + 80.5 \cos 140^\circ 30' + 60^\circ \cos 220^\circ 30' + \angle DA \cos 310^\circ 15' = 0$

$= 100 \cos \theta_{AB} - 62.15 - 45.624 + 0.646 \angle DA$

$= 100 \cos \theta_{AB} + 0.646 \angle DA = 107.75$

$\Sigma D = 0$

$100 \operatorname{sen} \theta_{AB} + 80.5 \operatorname{sen} 140^\circ 30' + 60 \operatorname{sen} 220^\circ \angle DA \operatorname{sen} 310^\circ 15' = 0$

$\Rightarrow 100 \operatorname{sen} \theta_{AB} + 51.20 - 38.96 - 0.76 \angle DA = 0$

$\Rightarrow 100 \operatorname{sen} \theta_{AB} - 0.76 \angle DA = +12.24$

$= 100 \cos \theta_{AB} + 0.646 \angle DA = 107.75$

$\Rightarrow 100 \operatorname{sen} \theta_{AB} - 0.76 \angle DA = -12.24$

$\Rightarrow 100 \operatorname{sen} \theta_{AB} = 0.76 \angle DA - 12.24$

$\Rightarrow (100 \operatorname{sen} \theta_{AB})^2 = (0.76 \angle DA - 12.24)^2$

$\Rightarrow 100 \cos \theta_{AB} = 107.75 - 0.646 \angle DA$

$\Rightarrow (100 \cos \theta_{AB})^2 = (-0.646 \angle DA + 107.75)^2$

$\Rightarrow 100^2 \cdot \operatorname{sen}^2 \theta_{AB} = 0.76^2 L^2 DA + (12.23)^2 - 2 \times 0.76 \angle DA (12.23)$

$\Rightarrow 100^2 \cos^2 \theta_{AB} = (-0.646)^2 \cdot L^2 DA + (107.75) + 2 \times (-0.64 \angle DA) * (107.75)$

$\Rightarrow 100^2 \operatorname{sen}^2 \theta_{AB} = 0.57 L^2 DA + 149.27 - 11.$

$\Rightarrow 100^2 \cos^2 \theta AB = 0.41 L^2 DA + 11610.0 - 137.92 LDA$

$2100 \sin^2 \theta AB + 100^2 \cos^2 \theta AB = 0.57 L^2 DA$

$+0.41 L^2 DA + 149.27$

$+ 11010.0 - 87.58$

$LDA - 137.92 LDA$

$\Rightarrow 100^2 (\sin^2 \theta AB + \cos^2 \theta AB) = 0.98 L^2 DA + 11759.57$

$-156.5 LDA$

$\Rightarrow 100^2 \times 1 = L^2 DA - 11759.57 - 156.5 LDA$

$\Rightarrow LDA^2 + 1759.57 - 156.5 LDA = 0$

$\Rightarrow x1 = 144.80 \quad , x2 = 12.19$

$\Rightarrow 100 \cos\theta AB + 0.64 LDA = 107.75$

$\Rightarrow 100 \cos\theta AB + 0.64 \times 114.3 = 107.75$

$\Rightarrow 100 \cos\theta AB = 107.75 - 92.352$

$= 15.39$

$$\cos\theta AB = \frac{15.39}{100} = 0.153$$

$100 \sin\theta AB - 0.76 LDA = -12.24$

$\Rightarrow 100 \sin\theta AB - 0.76 \times 144.3 = -12.24$

$\Rightarrow 100 \sin\theta AB = 97.428$

$\Rightarrow \sin\theta AB = 0.97.$

:Area of Valume:

(i) Area of the triangle of the 3 side are given $\Delta = \sqrt{s(s-a)(s-b)(s-c)}$

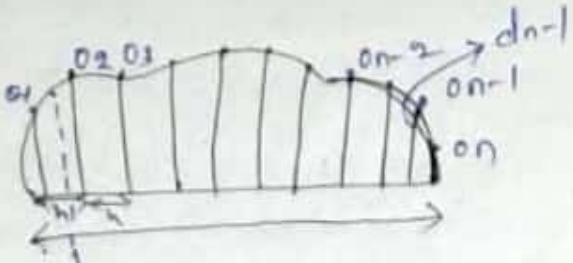
$s = \frac{a+b+c}{2}$

(ii) Area of the rectangular $= a \times b$

(iii) Area of the square $= a^2$

(iv) Area of the traingle $= \frac{1}{2} \times b \times h$

Mid-ordinate method:—

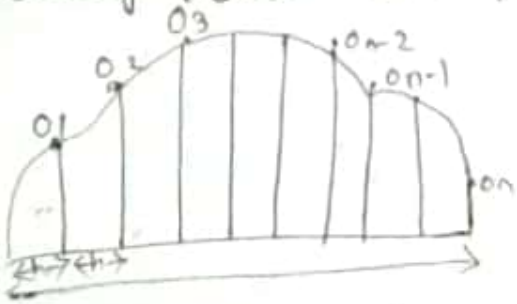


$d1 = \frac{o_1+o_2}{2}$ $A = d_1h + d_2h + \cdots + d_{n-1} \times h$

$d_2 = \frac{o_2+o_3}{2}$ $A = h(d_1+d_2+\cdots+d_{n-1})$

$d_{n-1} = \frac{o_{n-1}+o_{n-2}}{2}$

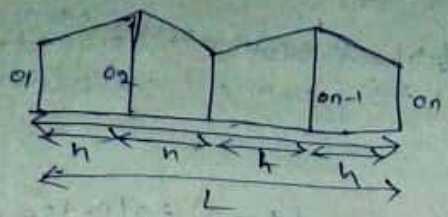
avarage ordinate method:—



$A = \left(\frac{o_1+o_2+o_3+\cdots+o_{n-1}+o_n}{n}\right)$

D-04.03.2020

Trapezoidal rule:-



$L = (n-1)h$

$A_1 = \frac{1}{2}(o_1+o_2)h$

$A_2 = \frac{1}{2}(o_3+o_3)h$

$A_3 = \frac{1}{2}(o_3+o_4)h$

$A_{n-1} = \frac{1}{2}(o_{n-1}+o_n)\times h$

$A_1+A_2+\cdots+A_{n-1} = \frac{1}{2}\times h\,(o_1+o_2+o_3+\cdots+o_{n-1}+o_n)$

$A_1+A_2 = \frac{1}{2}h\,(o_1 + o_2+o_2+o_3)$

(o_1: 1st, o_3: last)

$A_1+A_2+A_3 = \frac{1}{2}h\,(o_1+o_2+o_2+o_3+o_3+o_n)$

total area:-

$$A_1+A_2+\cdots A_{n-1} = \frac{h}{2}\{o_1+o_n+2(o_2+o_3+\cdots+o_{n-1})\}$$

$h = \frac{\text{Internal dist}}{2}\{(\text{1st ordinate} + \text{last ordinate}) + 2(\text{other ordinate}.$

Simpson's Rule:-

→ In this rule the boundaries bet^n the ends of ordinates are assume to from an arc of parabolola the assume to be (curve line).

→ It is also called as parabolic rule

total Area :- $\frac{\text{common interval}}{3}$ (1st ordinate

+ last ordinate + 4 (sum of e
ordinate
+ 2 (sum of odd ordinate

$= \frac{h}{3}(O_1 + O_n + 4(O_2 + O_4 \cdots + O_{n-2}) + 2(O_3 + O_5 \cdots O_n$

Note

the rule is applicable only when the No. of ordinates are odd

Q.1) the following offsets were taken from a chain line to an irregular chain line at an interval of 10m.

0, 2.5, 3.5, 5.0, 4.6, 3.2, 0m.

compute the area between chain line the irregular boundary line and the offsets by (i) mid ordinate method
(ii) average rule
(iii) trapezoidal rule
(iv) simpson's rule

Ans:- $h = 10$

(i) mid ordinate method :-

$A_1 = \frac{0 + 2.5}{2} \times 10 = 12.5$

$A_2 = \frac{2.5 + 3.5}{2} \times 10 = 30$

$A_3 = \frac{3.5 + 5}{2} \times 10 = 42.5$

$A4 = \frac{5+4.6}{2} \times 10 = 48$

$A5 = \frac{4.6+3.2}{2} \times 10 = 39$

$A6 = \frac{3.2+0}{2} \times 10 = 16$

$A1+A2+A3+A4+A5+A6 = 188\ m^2$

$= 12.5 + 30 + 42.5 + 48 + 39 + 16 = 188\ m^2$

(2) Average ordinate methods—

$\text{total Area} = \frac{(O1+O2+O3+\ldots\ldots+On-1+On)}{n} \times l$

$= \frac{0+2.5+3.5+5+4.6+3.2+0}{7} \times 50$

$= 161.14\ m^2$

(3) trapezoidal rule :—

$A = \frac{h}{2}(O1+On+2(O2+O3+\ldots\ldots On-1))$

$= \frac{10}{2}(0+0+2(2.5+3.5+5+4.6+3.2))$

$= 188\ m^2$

(4) Simphson's rule :—

$T.A = \frac{10}{3} \times (0+0+4 \times (2.5+5+3.2)+2(3.5+4.6))$

$= 196.66\ m^2.$

Q. the following offset were taken at 15m intervals from a survey line to an irregular boundary lines.

3.5, 4.3, 6.75, 5.25, 7.5, 8.80, 7.90, 6.4, 3.25, calculate the area by

(i) trapezoidal rule.
(ii) simpson's rule.

Ans:- trapezoidal rules →

$= h/2 \,(o_1 + o_n + 2(o_2 + o_3 + \cdots o_{n-1}))$

$= \frac{15}{2}(3.5 + 3.25 + 2(4.3 + 6.75 + 5.25 + 7.5 + 8.80 + 7.90 + 6.4 +$

$= 820.125 m^2$

(ii) Simpson's rule :—

$\frac{15}{2} \times$.

Problem-4

the following offsets are taken from a survey line to a curved boundary line

Distance(m) - 0.5, 10, 15, 20, 30, 40, 60, 80

offset(m) 2.50, 3.00, 4.60, 5.20, 6.10, 4.70, 5.80, 3.90, 2.20,

Ans: trapezoidal rule

(i) $h/2 [o_1 + o_n + 2(\text{other})]$

$= 5/2 [2.5 + 6.1 + 2(3.8 + 4.6 + 5.2)]$

$= 89.5$

(ii) $10/2 [6.1 + 5.8 + 2(4.7)]$

$= 106.5$

(iii) $20/2 [5.8 + 2.2 + 2(3.9)]$

$= 158$

$\Rightarrow 89.5 + 106.5 + 158 = 354.00 m^2$

Simpson's rules

(i) $h/3 [o_1 + o_n + 4(\text{sum of even ord}) + 2(\text{sum of odd ord})]$

$= 5/3 [2.5 + 6.1 + 4(3.8 + 5.2) + 2[4.6]]$

$= 89.66$

(ii) $10/3 [6.1 + 5.8 + 4(4.7)]$

$= 102.33$

(iii) $20/3 [5.8 + 2.2 + 4(3.9)]$

$= 157.33$

$\Rightarrow 89.66 + 102.33 + 157.33$

$= 349.32 m^2.$

Calculation of Area using Double-meridian distance :-

A is the most westerly station, and the reference meridian is assumed to pass through it.

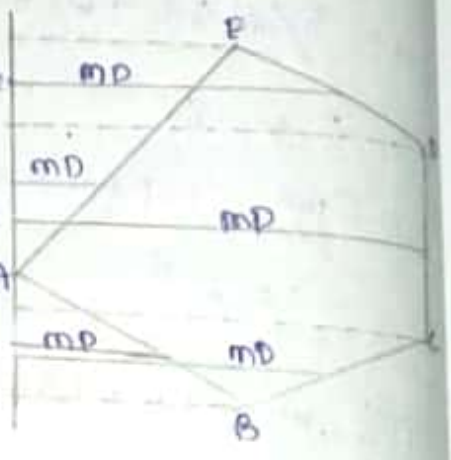
Meridian distance is the perpendicular distance between the midpoint of any line and the reference meridian.

The double meridian distance, or double longitude of a line, is the distance equal to the sum of the meridian distance of the two ends of the line.

Methods of finding DMD :-

1. DMD of first line = Departure of first line

2. DMD of second line = DMD of first line + departure of first line + departure of second line.



3. DMD of any succeeding line = DMD of preceding line + Departure of preceding line + Departure of line itself.

Fig:- latitude and d

4. DMD of last line = Departure of last li with opposite sign.

Procedure for calculating Area :-

1. Each DMD is multiplied by the latitude of that line.
2. the algebraic sum of these products is worked out.

3. this sum is equal to twice the area.
4. Half of this sum gives required area of the traverse.

~~Points to Remember:—~~

~~1. the reference meridian should pass through the most westerly station.~~

Calculate the area of the following traverse using DMD:—

Side	Latitude	Depth	D.m.D of Lines	Area (DMD x l)
AB	+22.5	+120.5	120.5	2717.75
BC	-245.0	+210	451	-110495
CD	-150.5	-110.5	550.5	-82950.25
DA	+170.0	-220	220	37400
	0	0	total = 1287	72.5 ⇒ -1287 / 2 ⇒ 614356.28

D.m.D of AB = 0+0+120.5 = 120.5

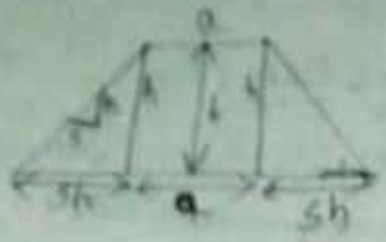
D.m.D of BC = 120.5 + 120.5 + 210 = 451

DmD of CD = 451 + 210 + (-110.5) = 550.5

DmD of DA = 550.5 - 110.5 - 220 = 220.

D- 12.08.2020

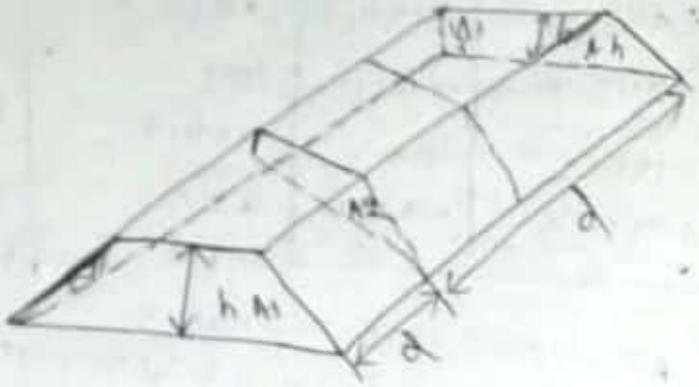
Q. Calculate the area of this figure



$\frac{1}{2}(a(a+2sh)h$

$= \frac{1}{2}(2a+2sh)h = \boxed{(a+sh)h}$

formula for calculation of volu



(1) Trapezoidal $= \frac{d}{2}(A_1 + A_n + 2(\text{other area}))$

(2) prismoidal $= \frac{d}{3}(A_1 + A_n + 4(\text{sum of even area}) + 2(\text{sum of add area}))$

Q. An embankment of 10m width and side slopes 1½:1 is required to be made on a ground which is level in a direction transverse to the cent line.

The central height at 40m interval are given bellow.

0.9, 1.25, 2.15, 2.5, 1.85, 1.35 & 0.85 calculate the volume of earth

work by trapizoidal method and prismoidal method

Ans:- $A_1 = (10 + 1.5 \times 0.9)0.9$

$A_2 = (10 + 1.5 \times 1.25)1.25$

$A_3 = (10 + 1.5 \times 2.15)2.15$

$A_4 = (10 + 1.5 \times 2.5)2.5$

$A_5 = (10 + 1.5 \times 1.85)1.85$

$A_6 = (10 + 1.5 \times 1.35)1.35$

$A_7 = (10 + 1.5 \times 0.85)0.85$

Collimation of errors:—

when even the line of side is horizontal the difference bet^n staff readings and the difference bet^n there R.L must be equal. If not collimation error is present.

That is line of side is not horizontal even if the bubble is at center.

Balling of sight:—

The error due to polimation can be eliminated by placing the instrument in bet^n staff station by making the side distance equal the true difference in elevation will be equals to the difference in observed staff reading. this is called as Balling of side.

Case:1—

Let A and B be two points whose true difference of level is required. the level is set up at O, exactly midway between A and B.

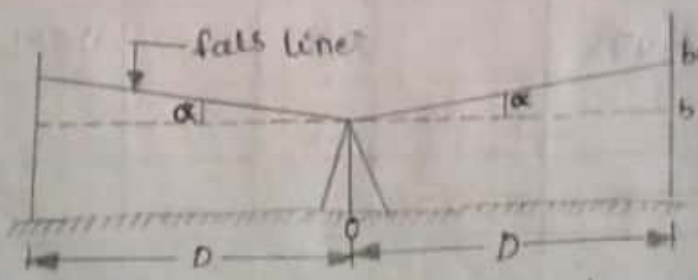


Fig: line of collimation inclined upwards

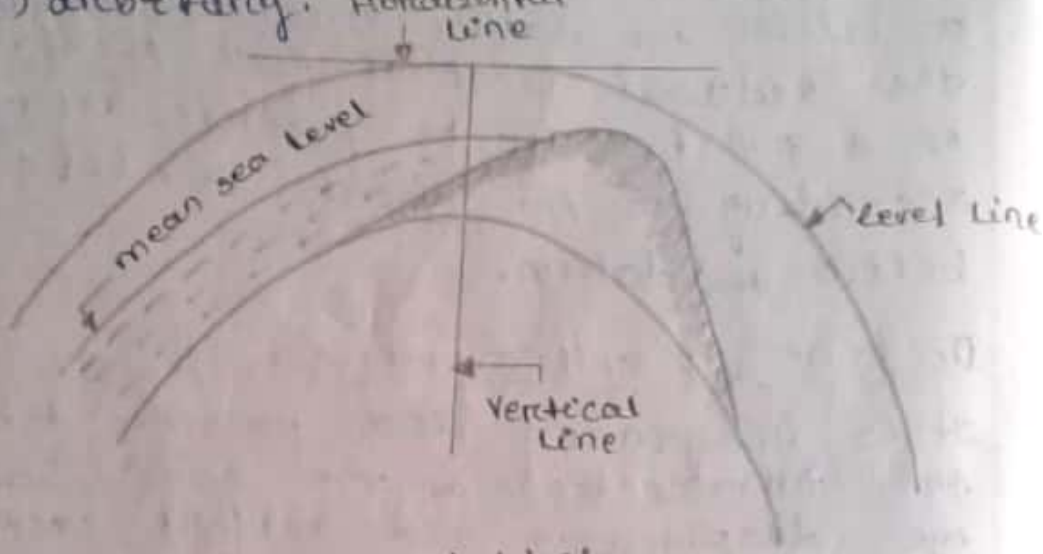
Let α = angle of inclination line

Aa = true reading

Aa$_1$ = observed staff reading on A

RL determined with reference to the datum line. these are very important marks. they serve as reference point, for fending the RL of new points or for conducting levelling operations in project involving roads, railways, etc.

Bench-marks may be of four type (a) GTS, (b) permanent (c) temporary and (d) arbitrary.



Different Lines.

* GTS Bench-marks :—

It is a also known as great trigonometric survey. It was conducted it 1802 in Indian sub-continent.

→ they Geodetic nature and there highly accurate.

⇒ It now under the protection of survey of India.

* permanent Bench-marks :—

these are established by state Govt with respect to GTS Bench-marks.