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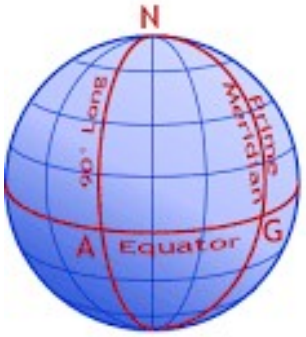
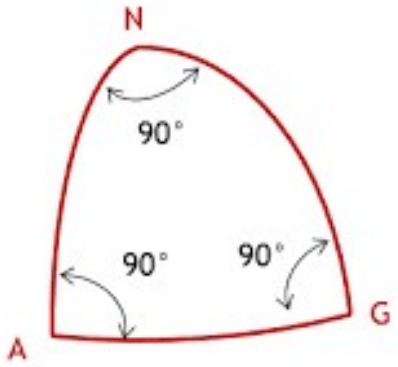
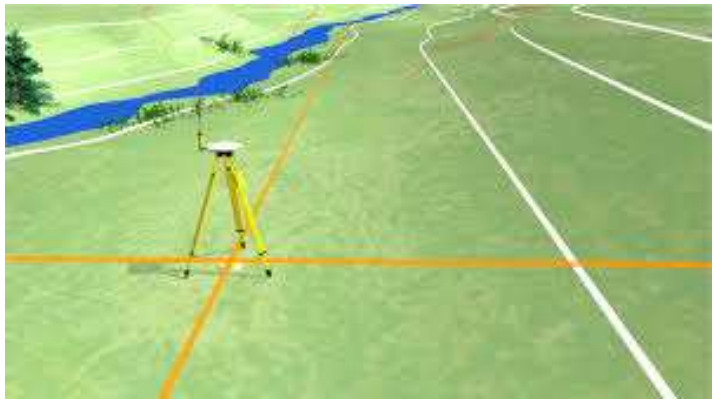
Module - 7
Geodetic Survey

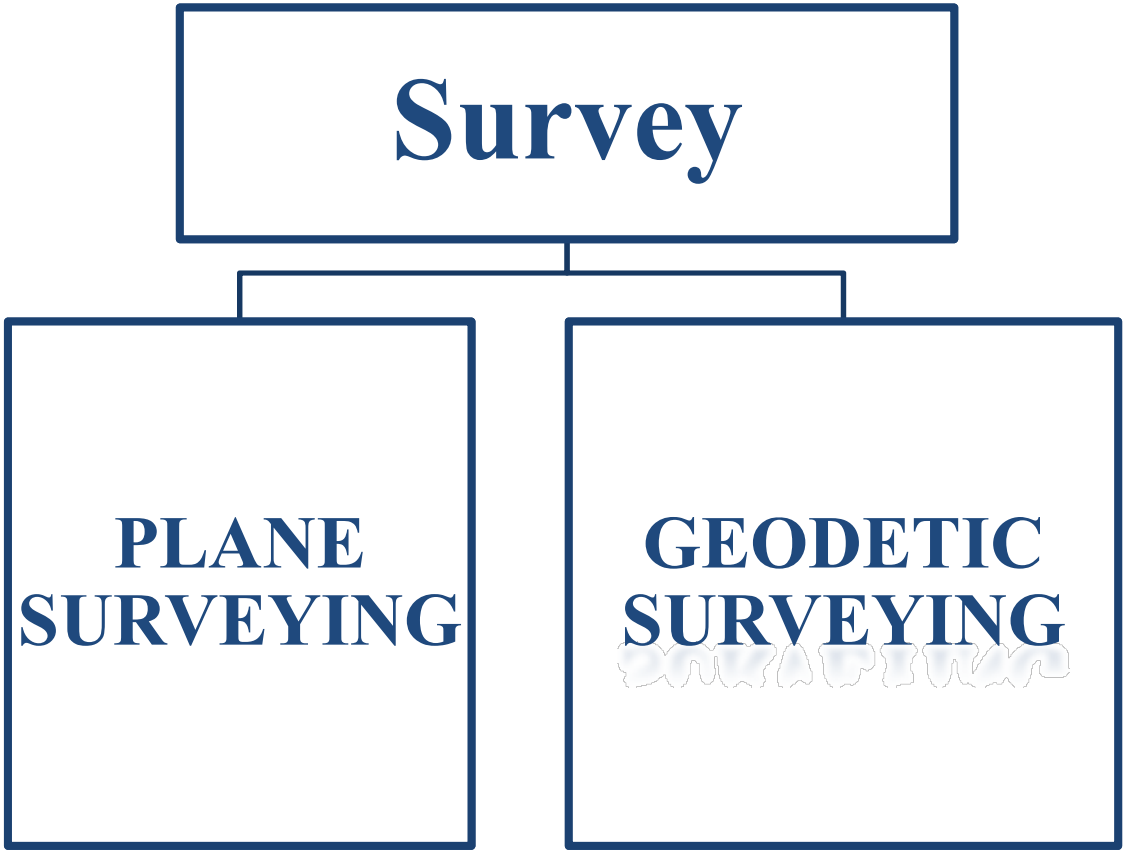






Subject:- Surveying **Code:-3140601**	**Prepared by:** **Asst.Prof. Nutan Patel** **(Civil Department, ACET)**	AMIRAJ COLLEGE OF ENGINEERING & TECHNOLOGY

Division of the Survey



Plane Surveying

- The Plane surveying is that type of the surveying in which earth surface is consider as a plane and the curvature of the earth surface is ignored.
- Line of the two joining any two station or a point consider as a straight line.
- The triangle formed by any three point is consider as a plane
- Carried out for a small area less than 250 sq.km

Geodetic Surveying

- The Plane surveying is that type of the surveying in which curvature of the earth surface is considered.
- Line of the two joining any two station or a point consider as a curved line.
- The triangle formed by any three point is consider as a spherical.
- Carried out for a large area greater than 250 sq.km

Difference

Plane Survey

- ✓ The earth surface is considered as plane.
- ✓ The curvature of the earth is ignored.
- ✓ Line joining any two station are considered to be straight line.
- ✓ The triangle formed are considered as a plane.

Geodetic Survey

- ✓ The earth surface is considered as curved surface.
- ✓ The curvature of the earth is taken in to account.
- ✓ Line joining any two station are considered to be curve line.
- ✓ The triangle formed are considered as a Spherical.

Difference

Plane Survey

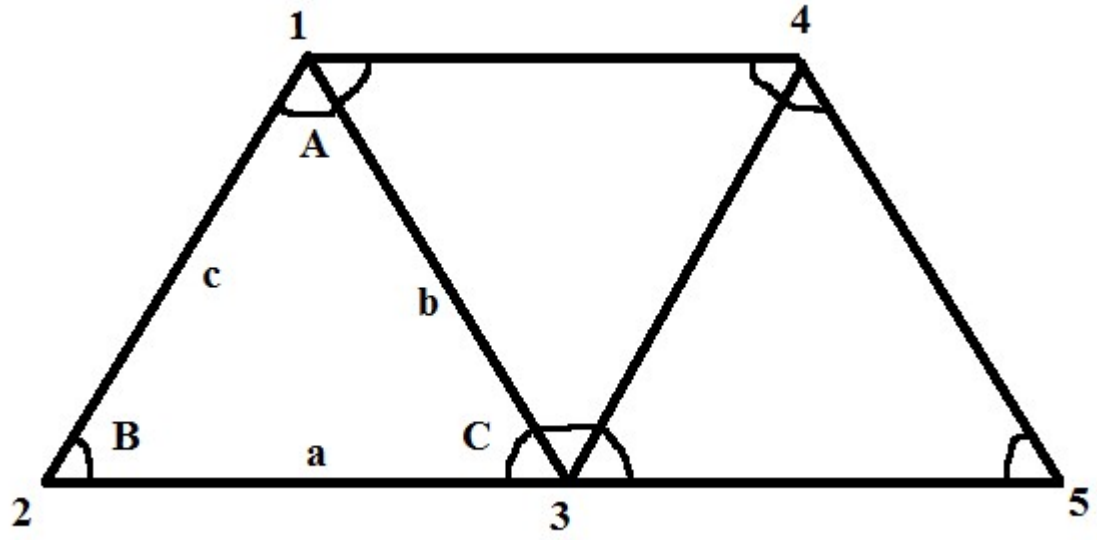
- ✓ The angle of triangle considered as plane angle.
- ✓ Carried out for small area < 250 m^2.

Geodetic Survey

- ✓ The angle of triangle considered as Spherical angle.
- ✓ Carried out for large area > 250 m^2.

Principle of Triangulation

- ✓Entire survey area is covered by the triangle.
- ✓Three angle and one line is measured.
- ✓The length of the first line is measured is called base line.



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$$\frac{a}{Sin\ A} = \frac{b}{Sin\ B} = \frac{c}{Sin\ C}$$

This gives

$$b = \frac{a\ Sin\ B}{Sin\ A}$$

$$C = \frac{a\ Sin\ C}{Sin\ A}$$

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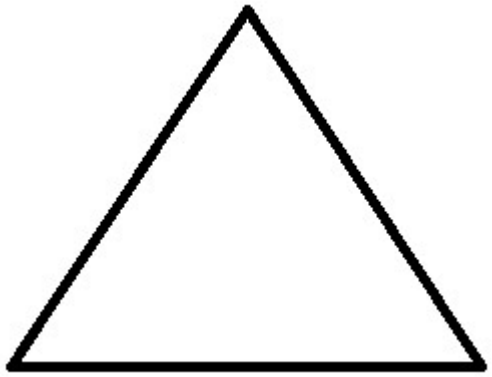
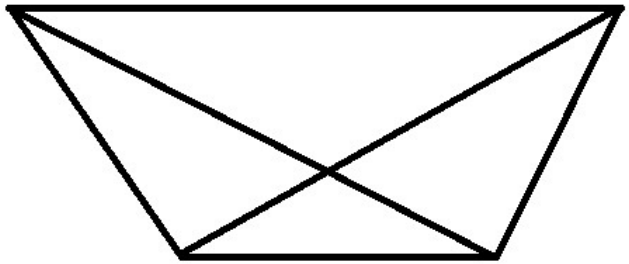
Uses of Geodetic Survey

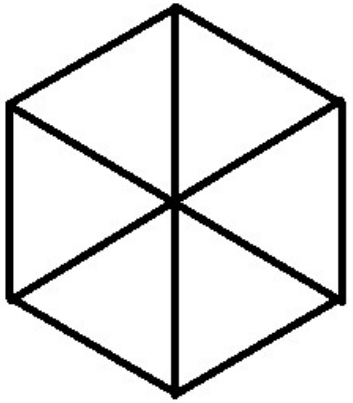
- ✓ Marking the horizontal control points for plane and geodetic survey.
- ✓ Mark the points for aerial photography.
- ✓ Find out the accurate location of engineering.
- ✓ Transfer the control points across the large water bodies.
- ✓ Find out the size and the shape of the area.

Triangulation Figures or system

- ✓ The arex of the triangles are known as triangulation stations.
- ✓ Whole figure is known as triangulation figure.
- ✓ Arrangement of the various triangulation system are known as the layout of triangulation.







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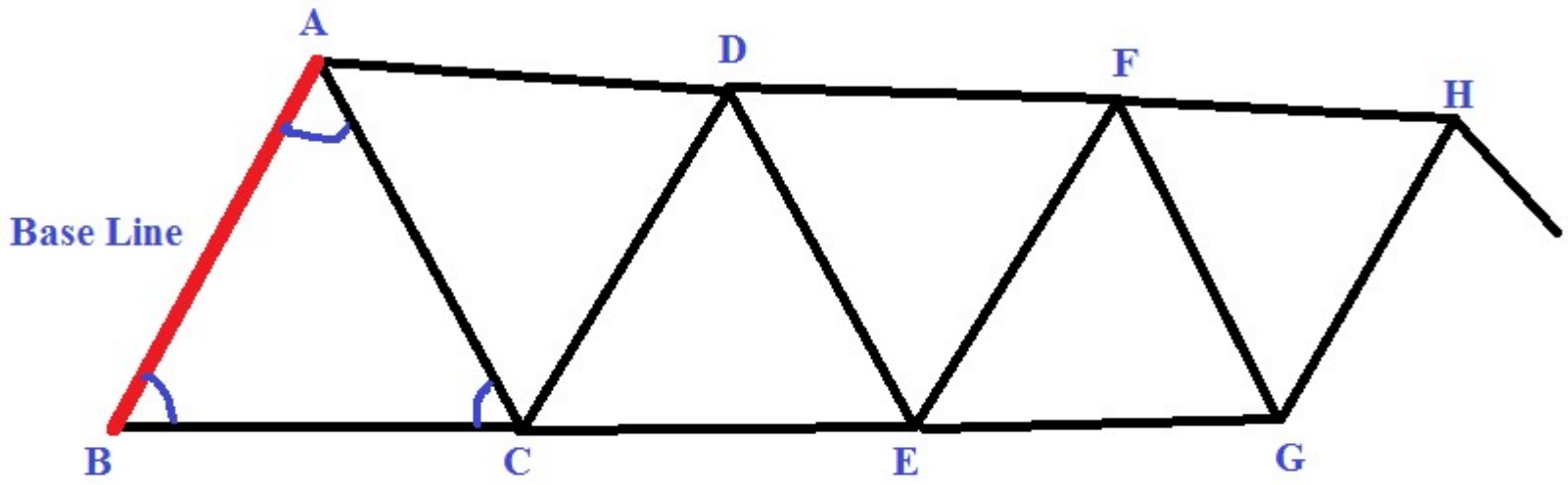
Common figures of triangulation system

1) Single chain of triangle
2) Double chain of triangle
3) Braced quadrilaterals in chain
4) Centered triangles polygons
5) Grid iron system
6) Central system

1. Single chain of triangle

- ✓Narrow strip of land is covered.
- ✓System is economical and rapid.



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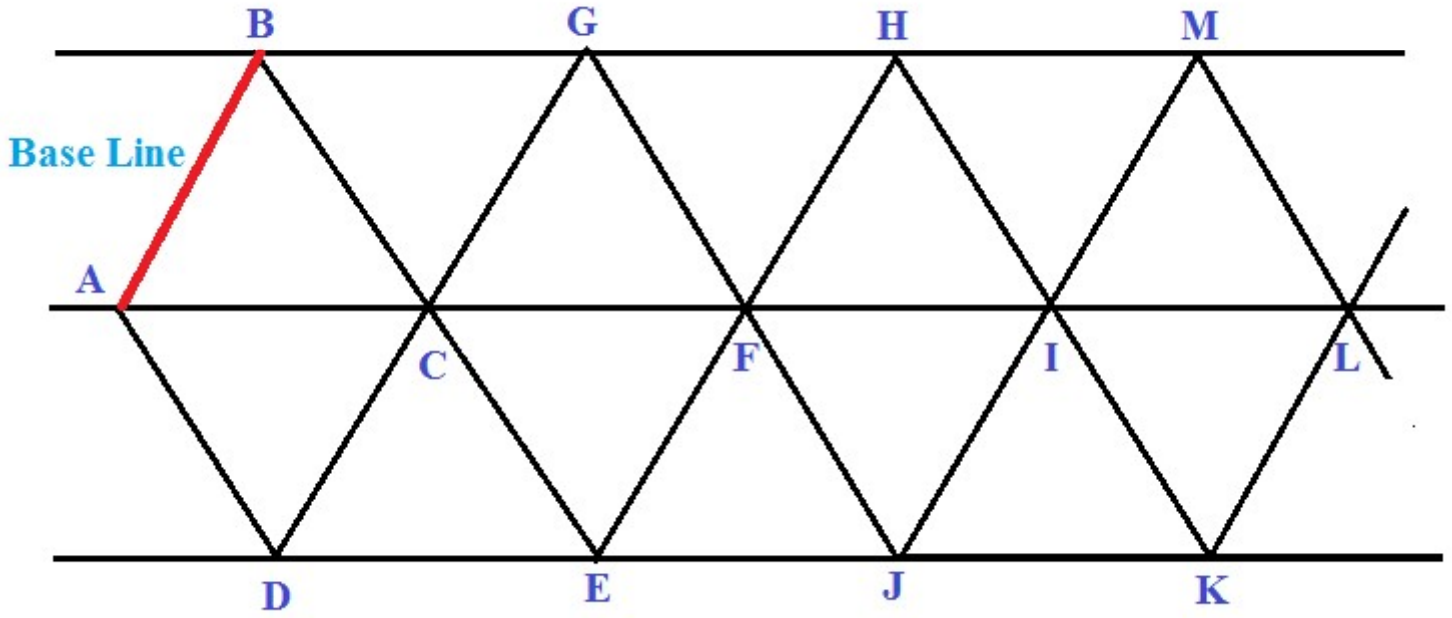
2. Double chain of triangle

- ✓Cover large area.
- ✓If the width is large so this method is used.



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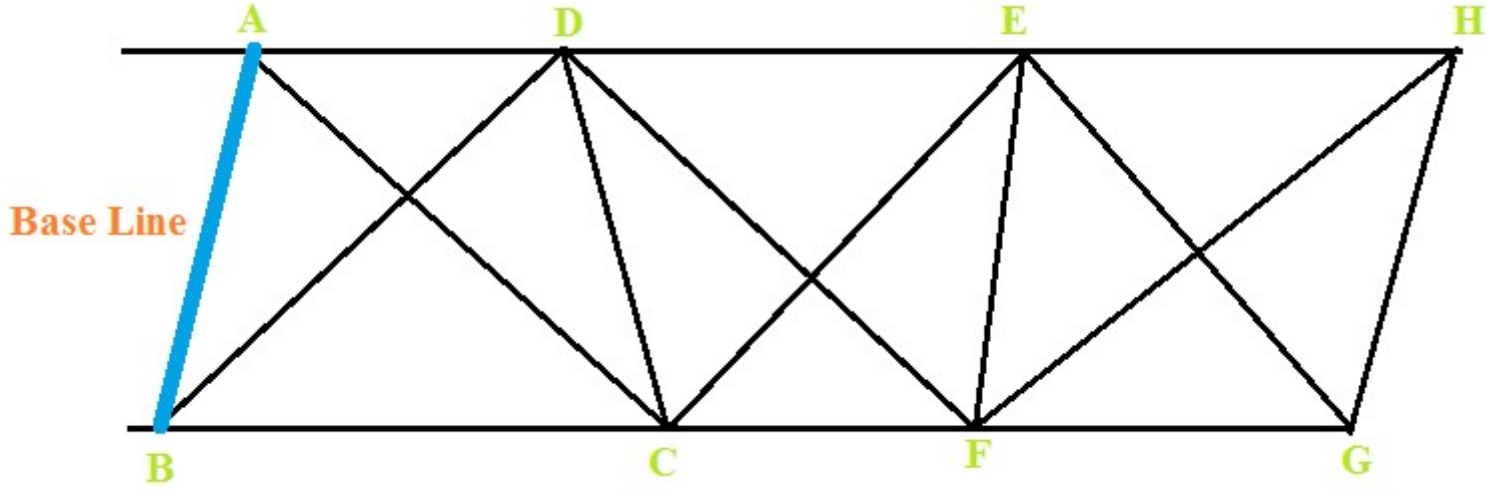
3. Braced quadrilaterals in chain

- ✓Used for hilly area.
- ✓Four station and two observer diagonals in each quadrilateral.
- ✓No station at the intersection.
- ✓Its overlapping triangles.



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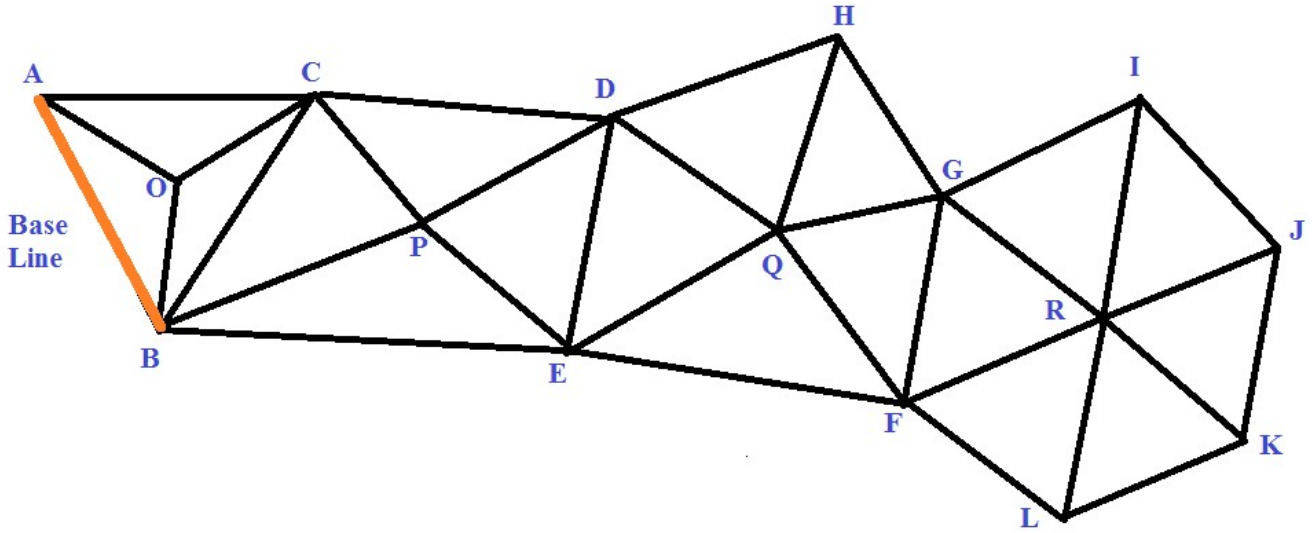
4. Centered triangles polygons

- ✓This method is used to measure the vast area.
- ✓The centered figures generally are triangles, quadrilateral triangles, pentagons or hexagon with central station.
- ✓Centered station is called vertex to all triangle.



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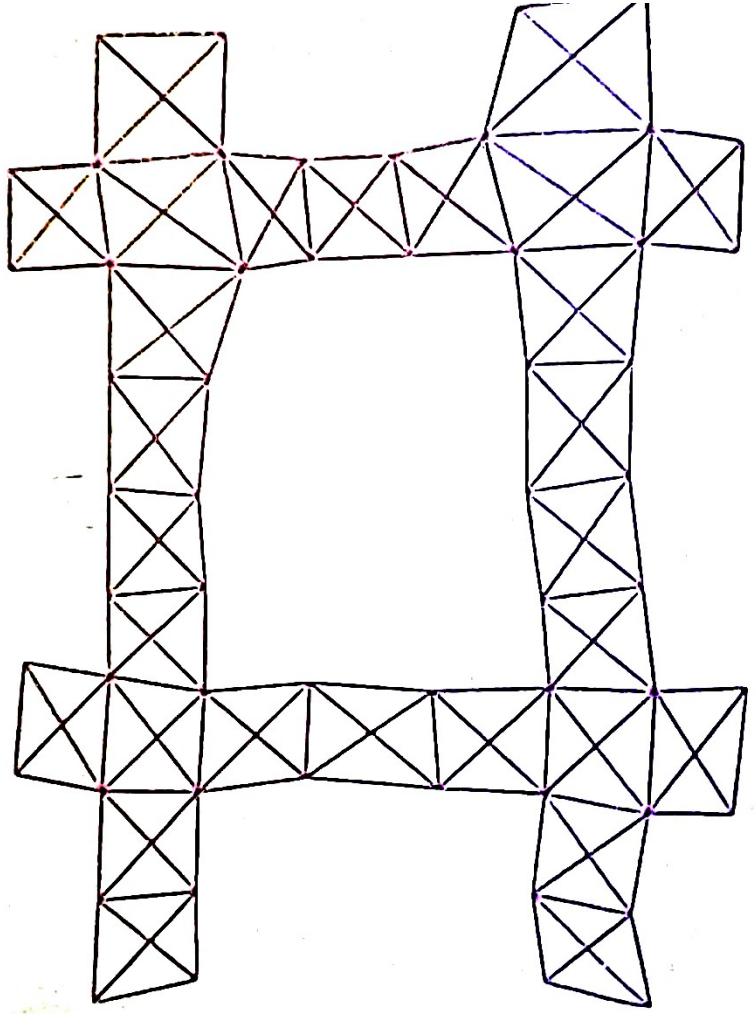
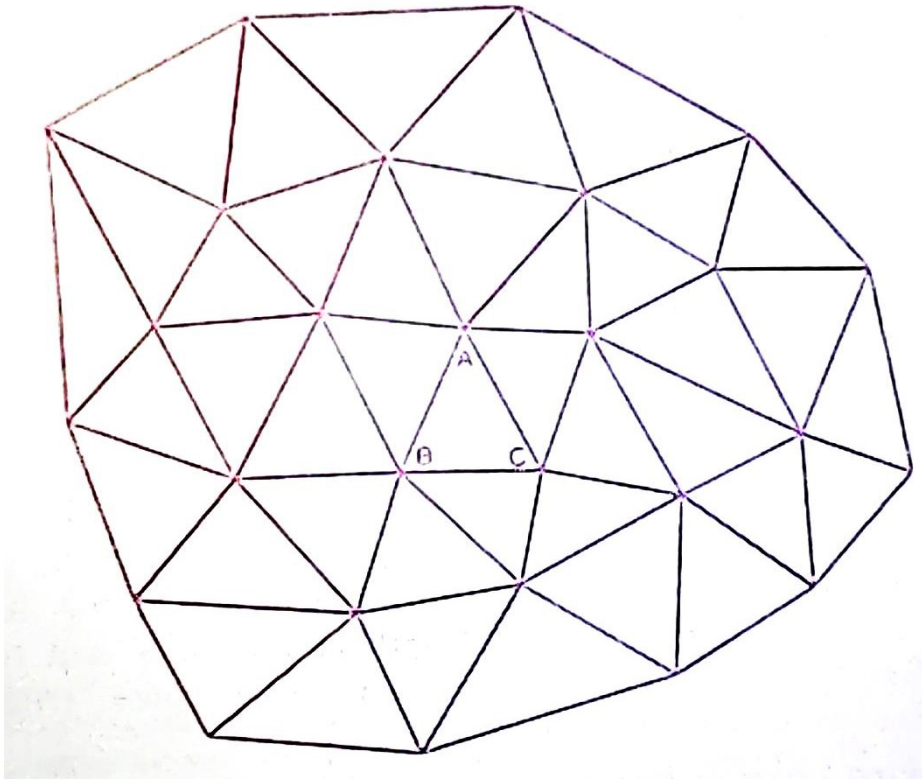
5. Grid iron system

- ✓ System is used for the large area.
- ✓ Primary triangulation is laid in series of the chain.
- ✓ Generally run in two approximately perpendicular direction, generally east-west and north south direction.



6. Central system

- ✓ Method is used for the survey area which is extended.
- ✓ Whole area is covered by the net work.



Base line

- Accuracy of any triangular is depend on measurement of the base line.
- Length of the base line is one-third or two third of the side.
- Primary triangulation system of india, 9 base line of length varying from 10.30 km to 12.55 km

Site selection for the base line

- Site should be firm and leveled.
- Site should be free from obstruction.
- Line should be indivisible.
- Selected site should be such that well-condition triangle.
- Take minimum length of the base line.
- Cost of the clearing of the ground should be minimum.
- Base line should pass through the Centre of the area.

The base net

- Base is connected through the triangulation system by the base net.
- The connection between the base and the main network is achieved through the small network called base net.

Extension of the base line

- Usually length of the base line is much shorter.
- Base line select shorter length by two reasons

1) Not get possible site for longer base.
2) Difficult to measure long length.

Points to be kept in mind for selecting base net

- Small angle opposite the known sides must be avoided.
- A ratio of the base length and the side length should be at least 0.5.
- The net should have sufficient redundant line.
- Length of the base line should be long a possible so the quickest extension by few station.

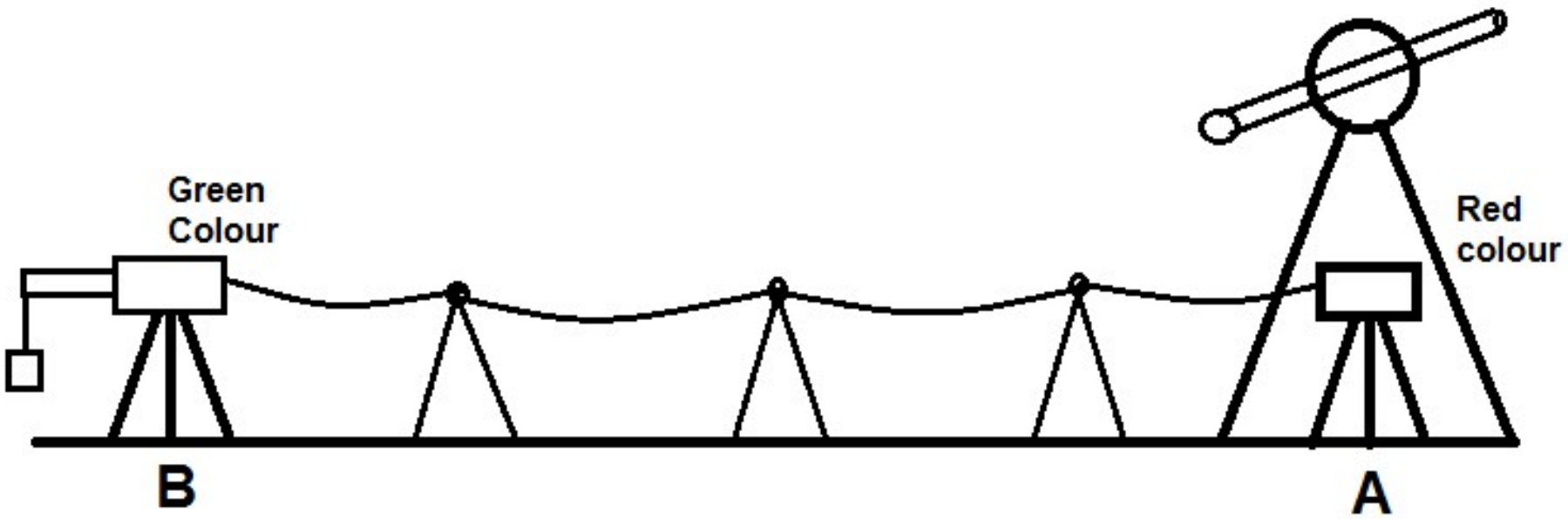
Two ways of connecting the selected base to the triangulation stations.

- Base extension by prolongation
- Bas extension by double sighting

Hunter short base

- ✓ Short base is called hunter's short base by Dr. Hunter who was director of the survey of the India.
- ✓ The short base consist of the four chain and each chain 20.117m long.
- ✓ Each chain support between two stand.
- ✓ There are main five stand and in this five stand there are three stand of the two legged and two main stand are three legged.

Hunter short base



- ✓ Three legged stand are fixed at the end.
- ✓ The end of the chain is fixed at the both end.
- ✓ The weight of 1kg is suspended at the end of the chain so all the chain are in the tensile form and make chain straight.
- ✓ The length of the joints between two chains at intermediate support are measured .
- ✓ To obtain correct length between the centers of the target usual correction for temperature ,sag, slope, tension, reduction to MSL. Etc. are applied.

Setting up Hunter's Short base

- ✓ Marked the station A and B.
- ✓ Station A marked with red colour and station B marked with green colour.
- ✓ The stand of A is centered on the marked ground A.
- ✓ The end of the base is hooked with the plate A.
- ✓ The another end is fixed at station B.
- ✓ At the stand B 1kg of the weight is attached at the end of the lever.
- ✓ Approximate alignment of the base line checked by eye judgment and finally is done by using a theodolite.

Correction to base line measurement

- ✓ The following correction to the base line measurement are apply to get the correct length of the base line.

i. Correction for absolute length
ii. Correction for temperature
iii. Correction for tension
iv. Correction for sag
v. Correction for slope
vi. Correction for alignment
vii. Correction for MSL (mean sea level)

Correction for absolute length

- ✓ Nature of the correction are +ve or –ve.
- ✓ If the actual length of the tap is not equal to the nominal or designated length, a correction will be applied to measure the line.
- ✓ If the actual length of the tap is greater than the nominal length the measured distance is too short and the correction will be additive.
- ✓ If the actual length of the tap is shorter than the nominal length the measured distance is too long and the correction will be negative.

- $Ca = (L * C) / l$

- Where Ca = Correction for actual length

  L = Measured length of line

  C = Correction per tap length

  l = designated length of the tap

Correction for temperature

- ✓ Nature of the correction are +ve or –ve.
- ✓ The length of the is increase or decrease with increase or decrease in temperature.
- ✓ $C_t = \alpha (T_m – T_s) L$
- ✓ Where C_t = correction of temperature in m

  α = Co-efficient of the thermal expansion

  T_m = Mean temperature during measurement

  T_s = standard temp. for tap

  L = length of the tap in m

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- ✓ The average value of the thermal expansion for steel 12 x 10^{-6} and for invar tape 0.9 x 10^{-6} per degree Celsius.
- ✓ C_t will be positive if $T_m > T_s$ and Ct will be negative if $T_m < T_s$

Correction for tension (Pull)

- ✓ **Nature of the correction are +ve or –ve.**
- ✓ **The correction of the pull is necessary when the pull applied during measurement differ from that at which tap is standardized.**
- ✓ $C_p = (P_m - P_s) * \frac{L}{AE}$
- ✓ **Where Cp = correction of pull**

  Pm = pull applied during measurement in N

  Ps = pull at which the tap is standardized in N

  L = length of the tap

  A = Cross section area of the tap in mm2

  E = modulus of elasticity

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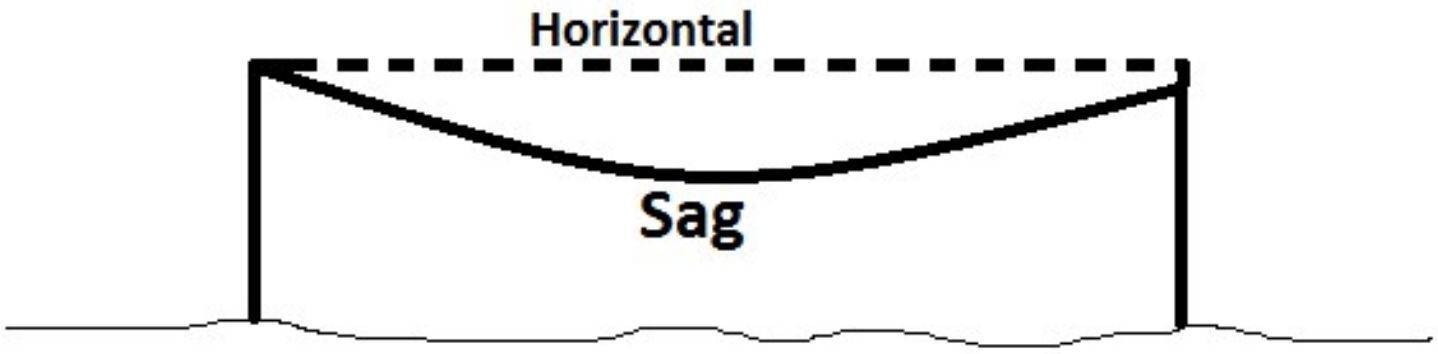
- ✓ E may be taken
- ✓ $E = 2.1 \times 10^7$ N/mm^2 for steel
- ✓ $E = 1.5 \times 10_7$ N/mm^2 for invar
- ✓ The correction may be positive or negative is according to pm is greater or less than P_s and P_m

Correction for sag

- ✓Nature of the correction is +ve or –ve
- ✓When a tap is stretched between two support, it takes the form of sag which is assumed to be parabolic curve.
- ✓I



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

Where C_{sg} = correction for sag in m

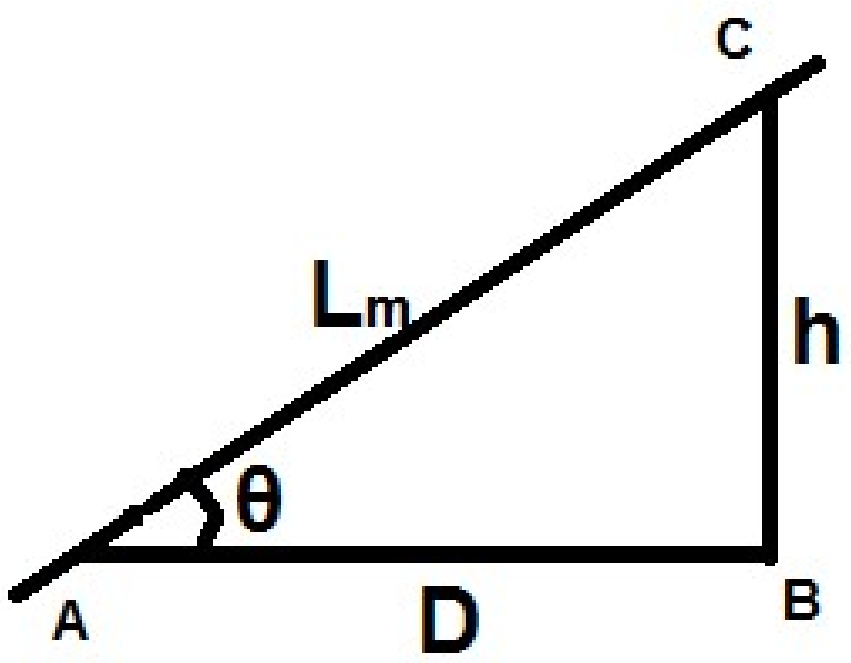
l_1 = distance between the support in m

w = weight on tap in N/m

P_m = Pull applied in N

Correction for slope

✓ The correction for the slope are required when the point of support are not at the same level.



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$C_{sl} = L_m (1 - \cos\theta)$

$$C_{sl} = \frac{h^2}{2L_m}$$

Where C_{sl} = correction for slope

L_m = measured length of slope

h = height difference between two point

θ = angle of slope

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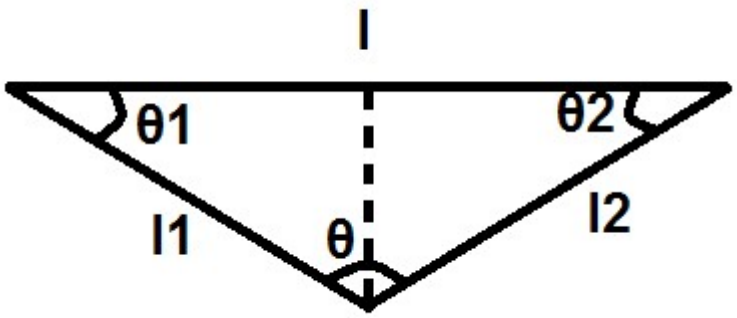
Correction for misalignment

- ✓Generally line is set out as a straight line.
- ✓But some time necessary to bent path due to an obstruction.
- ✓The bent line is composed of a two straight lines.



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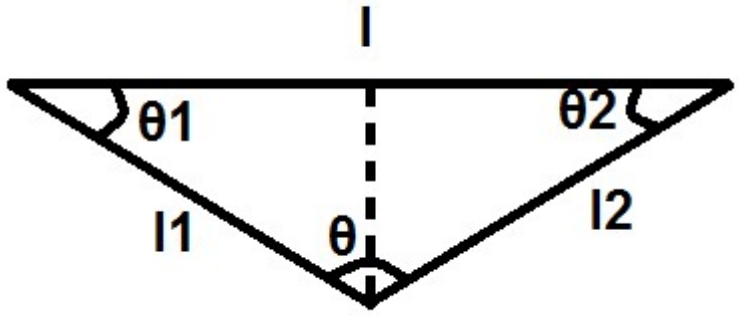
- AC = l_1 and CB = l_2
- BAC = θ1 and ABC = θ2
- AB = l_1 Cos θ_1 + l_2 Cos θ_2
- The require correction for alignment = Cm
- Cm = (l_1 + l_2) – (l_1 Cos θ_1 + l_2 Cos θ_2)



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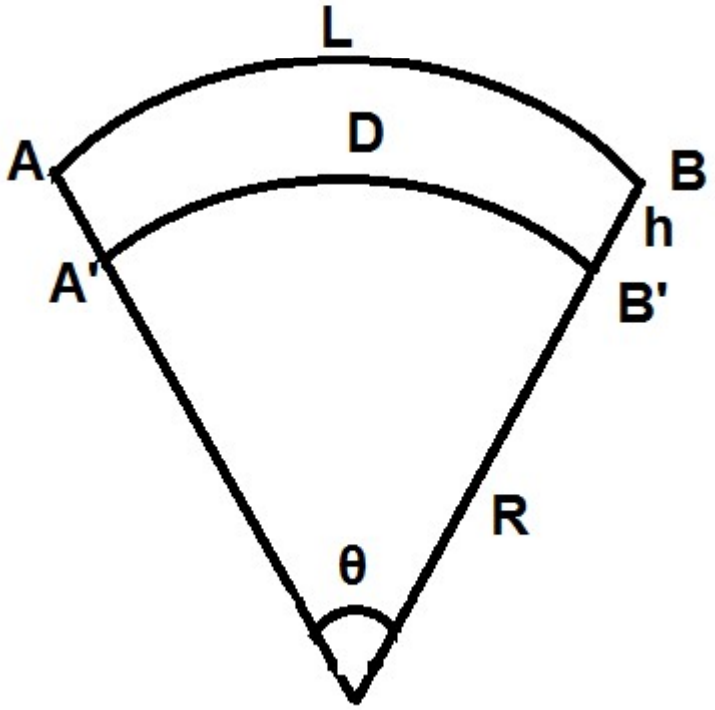
Reduction to mean sea level

- ✓ The measured length of a line at an altitude of h meter above the mean sea level will be more as compare to the corresponding line on the mean sea level.



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- Here;
- L = measured horizontal distance an altitude of h meter above the mean sea level.
- D = distance reduced to mean sea level
- h = altitude above the mean sea level
- R = Radius of Earth
- Θ = the angle subtended by line AB

- From the property of the circle
- $L = (R + h)\,\theta$
- $D = R\,\theta$

From above both the equation

$$\frac{L}{R+H} = \frac{D}{R}$$

$$D = \left(\frac{R}{R+h}\right) L$$

The altitude correction

$$C_r = L - D = L - L\left(\frac{R}{R+h}\right)$$

$$= L\left(1 - \frac{R}{R+h}\right)$$

$$= L\,\frac{h}{R+h}$$

The correction is negative

Measurement of the horizontal angle

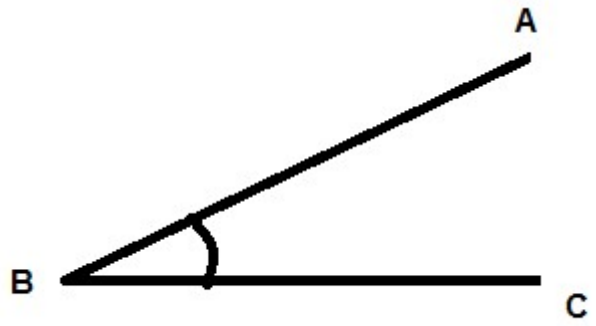
- ✓ After the base line measurement the next procedure is to make the triangle.
- ✓ For making the triangle the horizontal angle is required.
- ✓ Horizontal angle are also measured with the help of the electronic theodolite for primary and secondary triangle.
- ✓ For the tertiary triangle generally transit theodolite is used.
- ✓ There are main two method is used to find out the horizontal angle.

i. Method of repetition

ii. Method of reiteration

Method of repetition

- ✓ In this method the angle are measured in number of time repeatedly.
- ✓ Taking face left and face right reading.
- ✓ To measure the angle ABC, make six face left reading and angle measured in clockwise direction and find the average of the reading.
- ✓ To measure the angle ABC, make six face right reading and angle measured in anti clockwise direction and find the average of the reading.



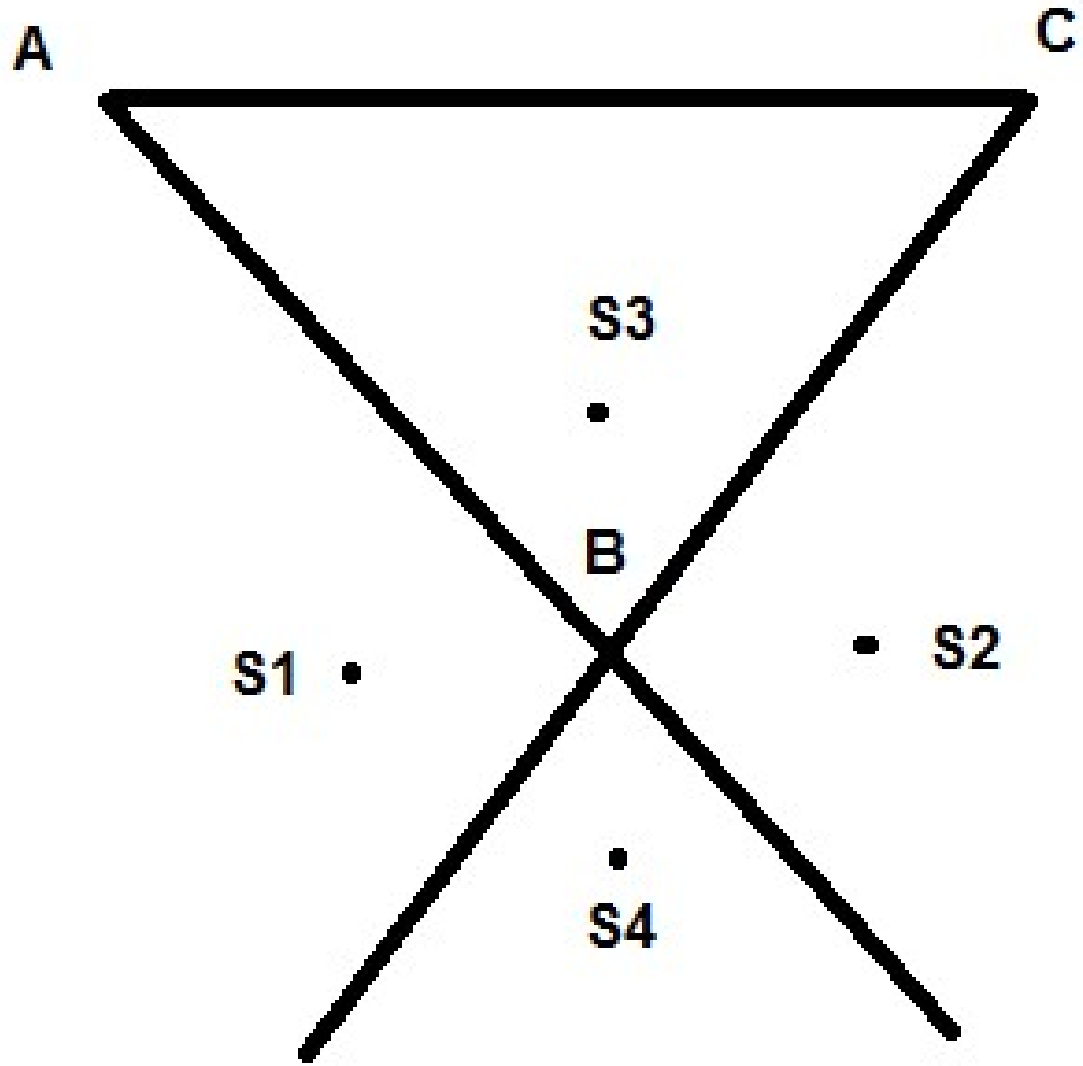
Method of reiteration

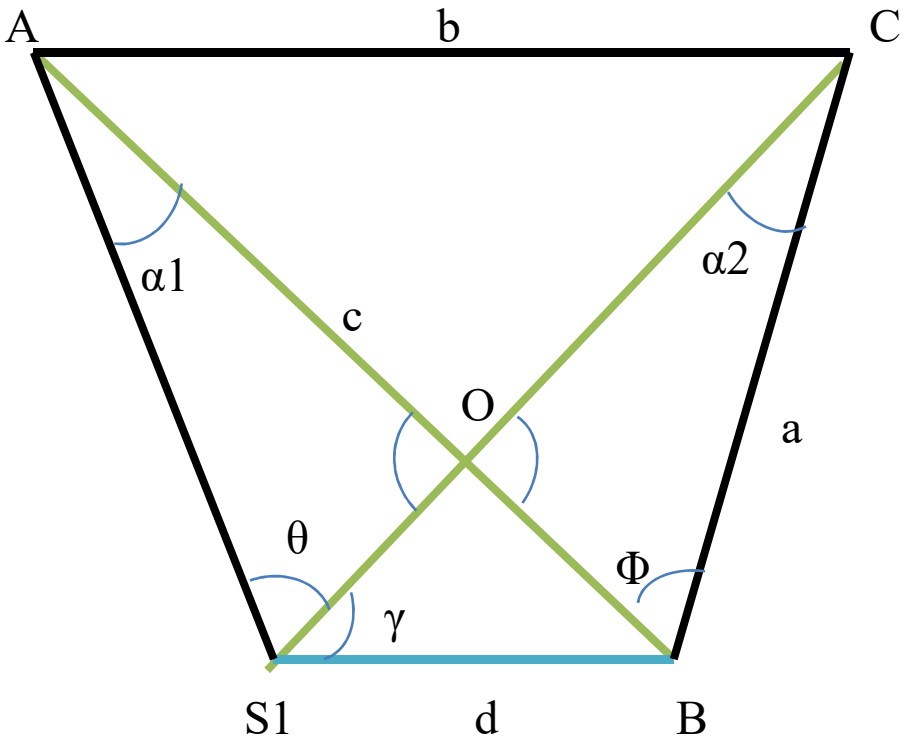
- ✓ The method of the reiteration is used when a number of angle are to be measured at a triangulation station.
- ✓ This method uses the principle of closing of horizon, the reading should be same as the initial reading.
- ✓ If any error seen so error is distributed in all the angle.
- ✓ One of the triangulation station, which is likely to be visible may be selected as a reference point.
- ✓ In this method face left and face right reading are taken in number of time and then after the average reading we get is the final reading.

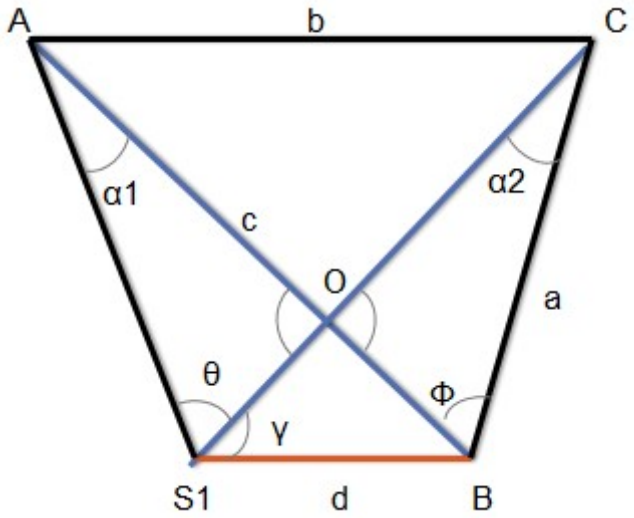
Satellite station and reduction to Centre

- ✓ For clearly seen the station and make well conditioned triangle, sometimes high objects like church spire, tower, temple, etc. are selected as a triangulation station.
- ✓ It is impossible to set the instrument exactly over or under the such station to measure the angle.
- ✓ In this case subsidiary station is selected near the main station as a instrument station and this subsidiary station are called satellite or eccentric station.
- ✓ Observation are taken to other station from the subsidiary station.
- ✓ The distance between the true station to satellite station is called satellite distance.

- ✓ The angle of the satellite station are measured same care taken no any type of the error done for taking reading.
- ✓ The operation of applying the correction due to the satellite station is generally known as reduction to centre.
- ✓ Fro each angle at the true station one additional angle at the satellite station must be measured.
- ✓ Satellite station must be avoided in primary triangulation.
- ✓ Fig shows the different cases that can be regarding the position of the satellite station relative to the true station.







Now apply the sine rule for the triangle BAS

$$\frac{c}{Sin(\theta + \gamma)} = \frac{d}{Sin\alpha_1}$$

$$Sin\alpha_1 = \frac{dSin(\theta + \gamma)}{c} \quad \text{.....(1)}$$

Now apply the sine rule for triangle BCS_1

$$\frac{a}{Sin\,\gamma} = \frac{d}{Sin\alpha_2}$$

$$Sin\alpha_2 = \frac{dSin\,\gamma}{c} \quad \text{.....(2)}$$

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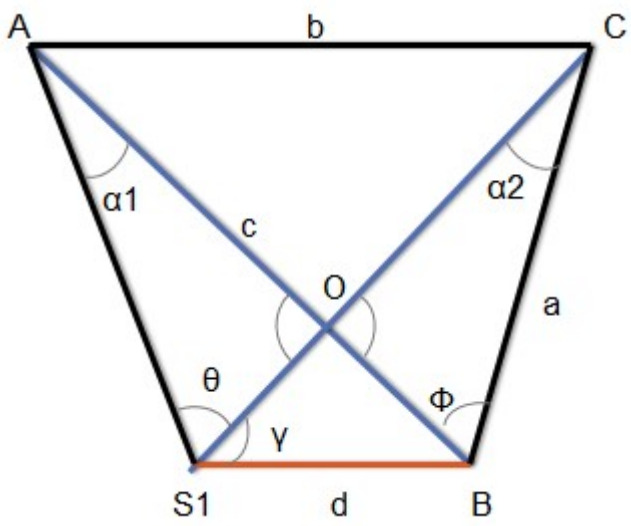
Multiplied both the side by Sin 1” for equation 1

$$\alpha_1 = \frac{Sin\alpha_1}{Sin\ 1"} = \frac{dSin\ (\theta + \gamma)}{c\ Sin\ 1"} = \frac{dSin\ (\theta + \gamma)}{c} \text{ X } 206265 \text{ second}$$

Multiplied both the side by Sin 1” for equation 1

$$\alpha_2 = \frac{Sin\alpha_2}{Sin\ 1"} = \frac{dSin\ \gamma}{c\ Sin\ 1"} = \frac{dSin\ \gamma}{c} \text{ X } 206265 \text{ secon}$$



From triangle OAS1 angle AOC = $\theta + \alpha_1$

From triangle OBC angle AOC = $\Phi + \alpha_2$

$$\theta + \alpha_1 = \Phi + \alpha_2$$

$$\Phi = \theta + \alpha_1 - \alpha_2$$

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