Triangulation

- It is the system which consists of a number of inter-connected triangles in which the length of only one line, called the base line and the angles of the triangles are measured very accurately. Knowing the length of one side and the three angles, the length of the other two sides of each triangle can be calculated using trigonometric relation.
- The apexes of the triangles are known as the triangulation stations and the whole figure is known as triangulation system or triangulation figure.

Classification of Triangulation System

Triangulation System can be classified on the basis of accuracy with which the length and Azimuth (i.e direction of line in WCB) of a line of the triangulation are determined.

i. First order or Primary Triangulation

- Highest order of triangulation.
- Covers large area.
- Use either to determine earth's figure or to obtain the most precise control points.

ii. Second Order or Secondary Triangulation

- Consists of a number of points fixed within the framework of primary triangulation.
- Stations are fixed at close intervals so that the sizes of the triangles formed are smaller than the primary triangulation.
- Instruments used are less accurate than that of primary triangulation.

iii. Third Order or Tertiary Triangulation

- Consists of a number of points fixed within the framework of Secondary triangulation.
- Size of triangles are smaller than that of primary & Secondary triangulation.
- Instruments used are less accurate than the instruments which are used in Secondary triangulation.

Comparison

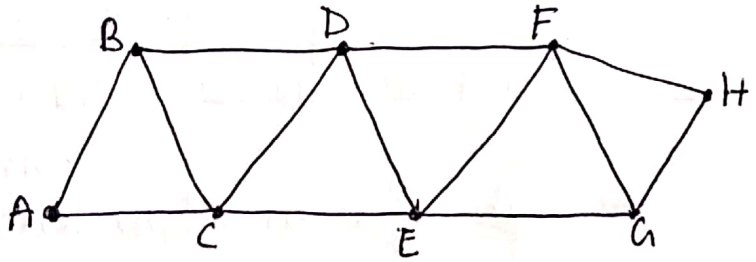
Features	First order Triangulation	Second Order Triangulation	Third Order Triangulation
Length of base line	5 to 15 Km	1.5 to 5 Km	0.5 to 3 Km
Length of Sides of Δ	30 to 150 Km	8 to 65 Km	1.5 to 10 Km
Average triangle closure	less than 1 second	3 Sec	6 sec
Maximum triangle closure	⩾ 3 Second	8 Sec	12 Sec
Probable error of in Computed distance	1 in 60,000 to 1 in 250,000	1 in 20,000 to 1 in 50,000	1 in 5000 to 1 in 20,000
Probable error in azimuth	0.5 seconds	2.0 seconds	5.0 seconds

TRIANGULATION FIGURES

It refers to the group or system of triangles, the triangles in a triangulation system can be arranged in a number of ways, some of the commonly used arrangements are:

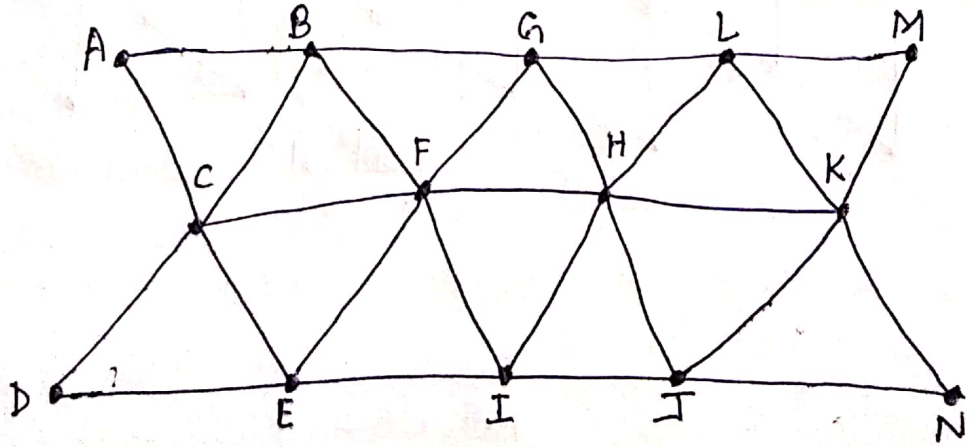
i. Single Chain of Triangles

- It is used where a narrow strip of land such as road is to be covered
- It is economical and less time taking.
- It is not so accurate for primary work because the number of conditions to be fulfilled in the figure is relatively small.



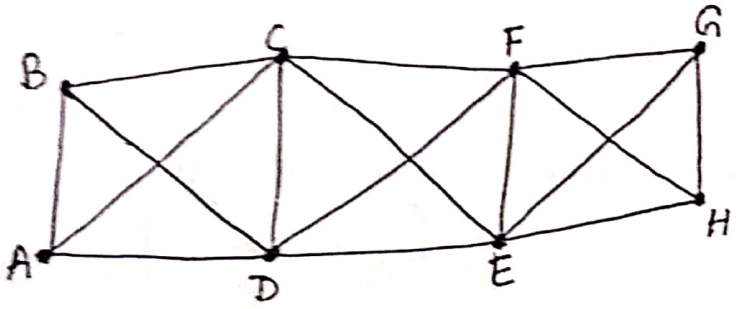
ii. Double chain of triangles

- Used where a wider strip of land such as 4-lane, 6 lane highway is to be covered
- Not so accurate for primary work.



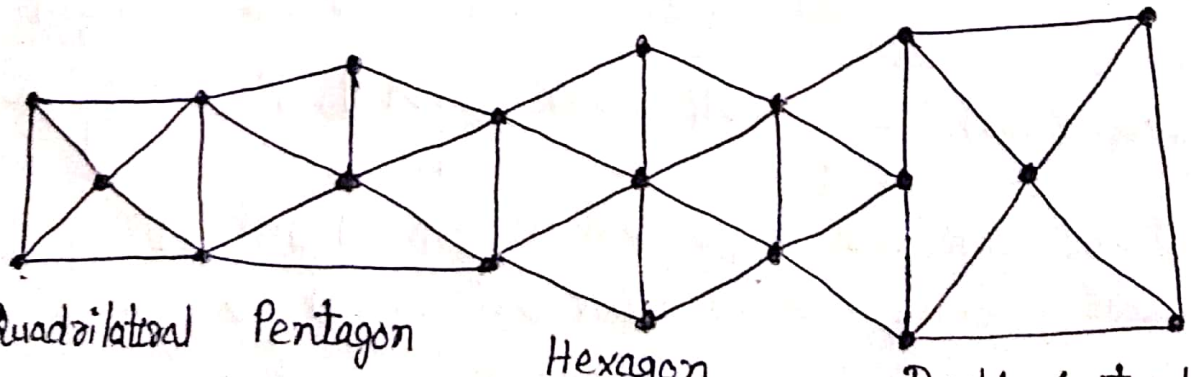
iii. Braced Quadrilaterals

- It consist of figures containing four corner stations and observed diagonals which is known as braced quadrilaterals
- Known as strongest and best figure of triangles.
- Most accurate
- Suitable for hilly country.



iv Centered figures

- It may be quadrilaterals, pentagons, or hexagon with central stations.
- Used when vast area in all directions is required to be covered.
- Suitable in flat Country.
- Not strong as the braced quadilateral figures.



Well-Conditioned Triangles

- The shape of the triangles in which any error in the measurement of angle have a minimum effect upon the lengths of the calculated side is known as well-conditioned triangle.
- The best shape of a triangle is isosceles with base angles equal to 56°14'. Practically equilateral triangle is the most suitable.
- Triangles having an angle smaller than 30° or greater than 120° should be avoided.

Strength of figure

- It is a factor to be considered in establishing a triangulation system to maintain the computations within a desired degree of precision. It plays an important role in deciding the layout of a triangulation system.
- The square of a probable error (L^2) that would occur in the sixth place of the logarithm of any side

$$L^2 = \frac{4}{3} d^2 R \quad \text{where} \quad R = \frac{D-C}{D} \Sigma(\delta_A^2 + \delta_A \delta_B + \delta_B^2)$$

- 'R' represents the terms in the equation affected by the shape of figure. Lower the value of R, stronger the figure

D = No of direction observed (forward & /or backward)

d = Probable error of an observed direction in seconds

δ_A, δ_B = Difference per second in the sixth place of a logarithms of the sine of the angle A & angle B respectively.