



Topic Five: Triangle Networks and Geodesic Budget

5.1 Introduction:

The horizontal positions of points is a network developed to provide accurate control for topographic mapping, charting lakes, rivers, and ocean coastlines, and for the surveys required for the design and construction of public and private works of large extent.

Triangulation is the method of surveying based on the trigonometric proposition that if one side and two angles of a triangle are known, the remaining sides can be computed. Furthermore, if the direction of one side is known, the directions of the remaining sides can be determined. A triangulation system consists of a series of joined or overlapping triangles in which an occasional side is measured and the remaining sides are calculated from angles measured at the vertices of the triangles. The vertices of the triangles are known as triangulation stations. The side of the triangle, whose length is predetermined, is called the baseline.

A trilateration system: consists of a series of joined or overlapping triangles.

5.2 Degrees of Triangle Networks

5.2.1 First-degree triangle networks:

They are also called geodesic triangles because they are the most accurate types of triangles and their side lengths range between 16-150 km, while the baseline length is taken within the range of 8-12 km. Geodesic triangles are those on which the rest of the triangle degrees are built, and therefore the greatest amount of accuracy must be taken into account when taking measurements and calculations for this type of triangular network and the average. The permissible error in the triangle lock is 1 "while the maximum triangle lock does not exceed 3". To measure the length of the baseline, the permissible relative error does not exceed 1: 1,000,000, and the angles are monitored using a theodolite of 1 "accuracy, where the maximum error is the permissible limit not exceeding 0.5.



5.2.2 Second-degree triangle networks:

They are connected to the first-degree network and are inferior to it in terms of accuracy and side lengths, as their coast lengths vary between 10 - 25 km, while the length of the baseline is approximately 5-2 km, and the average permissible error in the triangle lock is “3”, while the maximum for the triangle lock is not more than “8”. With regard to measuring the length of the base line, the permissible relative error does not exceed 1: 500,000 and the angles are monitored using a precise theodolite “10”, where the maximum permissible error in any arc does not exceed 5 ”.

5.2.3 Third-degree triangle networks:

They are linked to the first and second degrees with the aim of dividing the area and condensing the points, and their side lengths range between 2-10 km, and their base line length ranges from 100-500 m and the average permissible error in the triangle lock is 12, while the maximum triangle lock does not exceed 15.

5.2.4 Fourth degree triangle networks:

It is used in mountainous lands or when its purpose is to create new triangle points, and it is linked to the third degree. This type of triangle is the least accurate degree and its side lengths are chosen according to the conditions and nature of the land.



A comparison table between the degrees of triangle networks:

1.	Characteristics	First-order Triangulation	Second-order triangulation	Third-order triangulation
2.	Length of base lines	8 to 12 km	2 to 5 km	100 to 500 m
3.	Lengths of sides	16 to 150 km	10 to 25 km	2 to 10 km
4.	Average triangular error (after correction for spherical excess)	less than 1"	3"	12"
5.	Maximum station closure	not more than 3"	8"	15"
6.	Actual error of base	1 in 50,000	1 in 25,000	1 in 10,000
7.	Probable error of base	1 in 10,00,000	1 in 500,000	1 in 250,000
8.	Discrepancy between two measures (k is distance in kilometer)	$5 \sqrt{k} \text{ mm}$	$10 \sqrt{k} \text{ mm}$	$25 \sqrt{k} \text{ mm}$
9.	Probable error of the computed distances	1 in 50,000 to 1 in 250,000	1 in 20,000 to 1 in 50,000	1 in 5,000 to 1 in 20,000
10.	Probable error in astronomical azimuth	0.5"	5"	10"