ii- TRIANGULATION

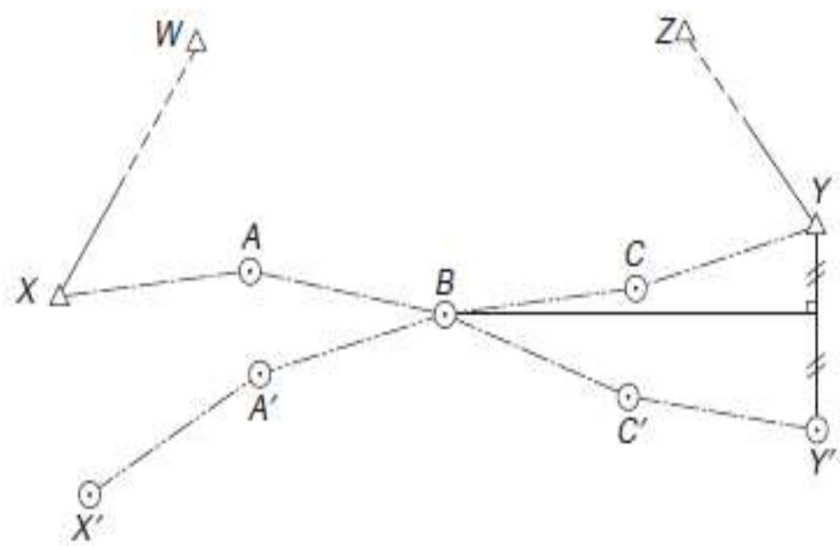
Because, at one time, it was easier to measure angles than it was distance, triangulation was the preferred method of establishing the position of control points.

Many countries used triangulation as the basis of their national mapping system. The procedure was generally to establish primary triangulation networks, with triangles having sides ranging

30 to 50 km in length. The primary trig points were fixed at the corners of these triangles and the sum of the measured angles was correct to ±3″ These points were usually established on the tops of mountains to afford long, uninterrupted sight lines. The primary network was then densified with points at closer intervals connected into the primary triangles. This secondary network had sides of 10–20 km with a reduction in observational accuracy. Finally, a thirdorder net, adjusted to the secondary control, was established at 3–5-km intervals and fourth-order points fixed by intersection. *Figure 2* illustrates such a triangulation system established by the Ordnance Survey of Great Britain and used as control for the production of national maps. The base line and check base line would be measured by invar tapes in catenary and connected into the triangulation by angular extension procedures. This approach is classical triangulation, which is now obsolete. The more modern approach would be to measure the base lines with EDM equipment and to include many

more measured lines in the network, to afford greater control of scale error.

Although the areas involved in construction are relatively small compared with national surveys (resulting in the term ‘microtriangulation’) the accuracy required in establishing the control surveys is frequently of a very high order, e.g. long tunnels or dam deformation measurements.



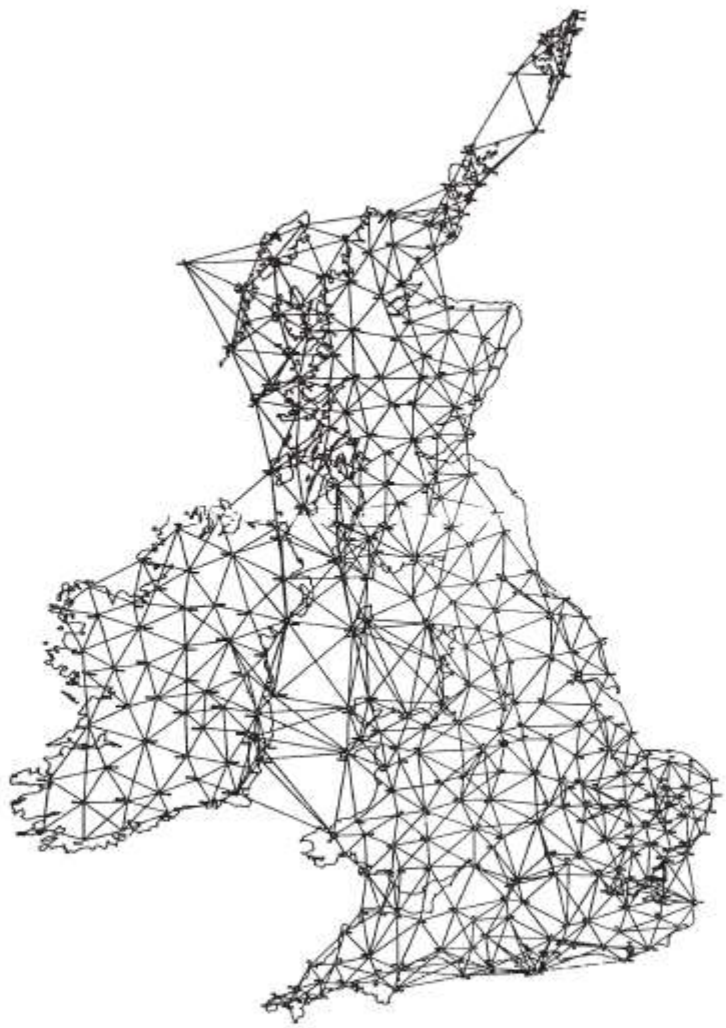


Fig 2 An example of a triangulation

The principles of the method are illustrated by the typical basic figures shown in Figure 3. If all the angles are measured, then the scale of the network is obtained by the measurement of one side only, i.e. the base line. Any error, therefore, in the measurement of the base line will result in scale error throughout the network. Thus, in order to control this error, check base lines should be measured at intervals. The scale error is defined as the difference between the measured and computed check base. Using the base line and adjusted angles the remaining sides of the triangles may be found and subsequently the coordinates of the control stations.

Triangulation is best suited to open, hilly country, affording long sights well clear of intervening terrain. In urban areas, roof-top triangulation is used, in which the control stations are situated on the roofs of accessible buildings.

- *Shape of the triangle*

The sides of the network are computed by the sine rule. From triangle ABC in Figure 3 (a):

$$\log b = \log c + \log \sin B_1 - \log \sin C_1$$

The effect on side b of errors in the measurement of angles B and C is found in the usual way.

Consider an error ð b in side b due to an angular error ð B in the measurement of angle B; then

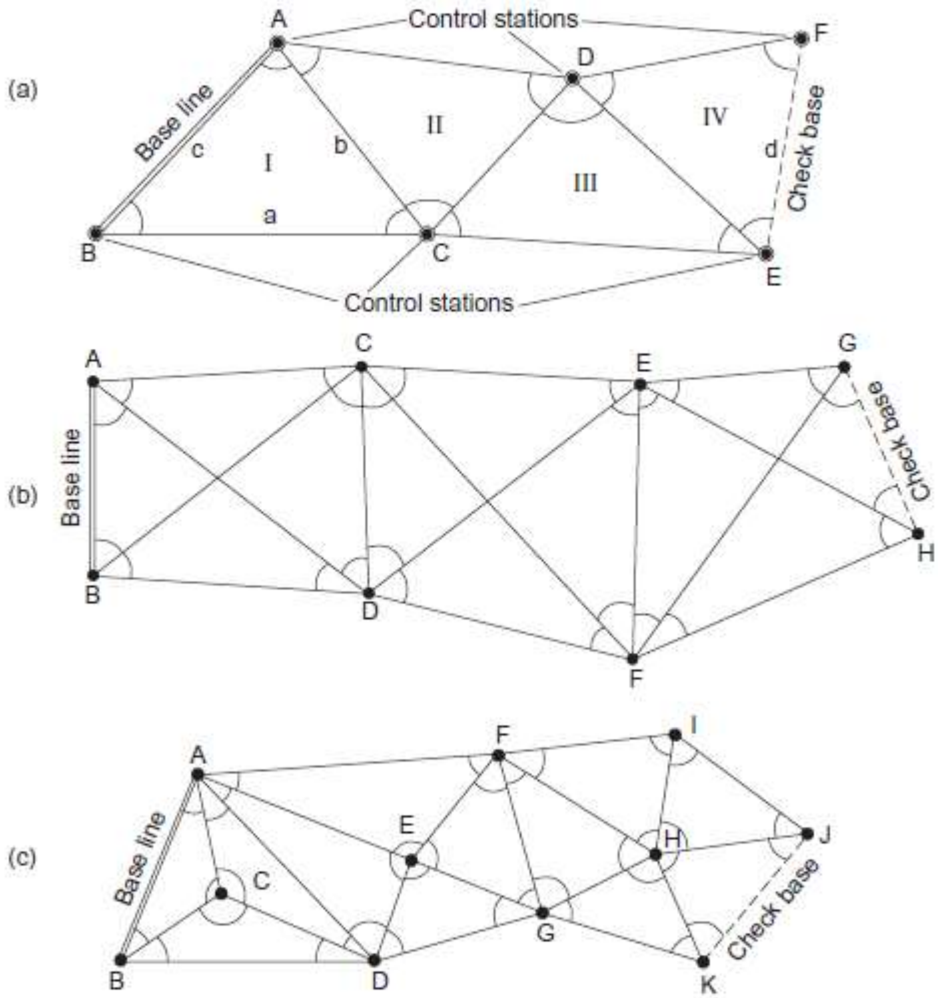


Fig. 3 (a) Chain of simple triangles, (b) braced quadrilaterals and (c) polygons with central points