# Chapter 2
# SURVEYING

## 2.1 INTRODUCTION [Nov, Dec 2010, 2011]

Surveying is the art of determining the relative positions of distinctive features on the earth's surface. This is achieved by the measurement of distances, directions and elevations.

In general, surveying is limited to operations concerned with the representation of ground features in plan. A branch of surveying which deals with the measurement of the relative heights of the features is known as levelling.

## 2.2 IMPORTANCE OF SURVEYING

The knowledge of surveying is advantageous in many phases of engineering. Every engineering project such as water supply and irrigation schemes, rail roads and transmission lines, mines bridges and buildings etc require surveys. Before plans and estimates are prepared, boundaries should be determined and the topography of the site should be ascertained. After the plans are made, the structures must be stated out on the ground. As the work progresses, lines and grades must be given.

## 2.3 OBJECTIVES OF SURVEYING

The main object of any survey is the preparation of a plan or a map showing all the features of the area under consideration. A plan may be defined as a projection of the ground and the features upon it on a horizontal plane. So, a plan is the representation to some scale of the area and the objects contained in it. The representation is called a map if the scale adopted is small, while it is called a plan if the scale is large. For example, a map of India, a plan of a building.

## 2.4 TYPES OF SURVEYING [Nov, Dec 2010]

The surveying may be primarily divided into two types: plane surveying and geodetic surveying.

### 2.4.1 Plane Surveying [May, June 2009; Nov, Dec 2010]

The surveying in which earth surface is assumed as a plane and the curvature of the earth is ignored is known as *plane surveying*. As the plane survey extends only over small areas, the line connecting two points on the earth is considered as a straight line and the angle between any two lines is considered as plane angle.

Surveys covering an area up to 260 $km^2$ may be treated as plane surveys. Such plane surveys are carried out for engineering projects and for geographical, geological, navigational and military purposes.

Plane surveys are used for the layout of highways, railways, canals, construction of bridges, dams, buildings, etc. The scope and use of plane surveying is wide. In order to have proper, economical and accurate planning of projects plane surveys are basically needed.

### 2.4.2 Geodetic Surveying [Nov, Dec 2010]

The surface of the earth is not plane but spheroidal. Therefore, the line connecting any two points on the earth's surface is not a straight line but a curve.

The surveying in which curvature of the earth is taken into account for all measurements is known as *geodetic surveying*.

The result obtained from the above surveying will possess a high degree of accuracy as it considers the effect of curvature of the earth also. This surveying extends over large areas and so any line connecting two points on the earth's surface is considered as an arc. The angle between any two such arcs is treated as a spherical angle. To undertake this method of surveying, a through knowledge in spherical trigonometry is required.

Geodetic surveys need sophisticated instruments and accurate methods of observations. In order to eliminate the errors in observations due to atmospheric refraction, angular observations are generally taken only in nights and arc lamps are used as signals on survey stations.

In India, geodetic surveys are carried out by the Department of the Survey of India under the direction of the Surveyor General of India.

## 2.5 CLASSIFICATION OF SURVEYS

Depending on the use and the purpose of the finished work, surveys are classified under the following heads:

**1. Classification Based Upon the Nature of the Field**

**(a) Land surveying**

(i) Topographical surveys To locate horizontal and vertical points by linear and angular measurements. For determining the natural features of a country such as streams, lakes, forests etc., and artificial features such as roads, railways, canals, towns & villages etc.

(ii) Cadastral surveys Cadastral surveys are made incident to the fixing of property lines, the calculation of land area, or the transfer of land property from one owner to another. It is also done to fix the boundaries of municipalities and of state & federal jurisdictions.

(iii) City surveying City surveying is done in connection with the construction of streets, water supply systems, sewers and other works.

**(b) Marine (or) hydrographic surveys** It deals with the bodies of water for purpose of navigation, water supply, harbour works or for the determination of mean sea level. The work consist in measurement of discharge of streams, making topography survey of shores and banks, taking and locating soundings to determine the depth of water and observing the fluctuations of the ocean tide.

**(c) Astronomical survey** It offers the surveyor means of determining the absolute locations of any point or the absolute location and direction of any line on the surface of the earth. This consists of observation of heavenly bodies such as sun or any fixed star.

**2. Classification Based Upon the Objective of Survey** **[Nov, Dec 2010]**

**(a) Engineering surveys** These are carried out for the determination of quantities which will be useful for the designing of engineering works.

**(b) Military or defence surveys** These are carried out for the preparation of maps of important military areas.

**(c) Geological surveys** These are carried out to ascertain the composition of the earth's crust.

**(d) Mine surveys** These are conducted for exploring the mineral wealth below the earth surface.

**(e) Archaeological surveys** These are executed to prepare maps of ancient cultures.

**3. Classification Based Upon Methods Employed**

**(a) Triangulation surveys**

**(b) Traverse surveys**

The framework in traverse survey consists of series of connected lines. The lengths and directions of these lines are measured with a chain or tape and with an angular measurement respectively.

A traverse is divided into two categories: *closed traverse normal open traverse.* A description of the two types of traverse is provided in this section.

1. Closed Traverse A traverse is said to be closed if a complete circuit is made, i.e. the origin and end point are one and the same thereby the circuit forms a closed polygon. This is particularly suitable for locating a building, boundaries of lakes, wooded lands, etc. A closed traverse is shown in Fig. 2.1.

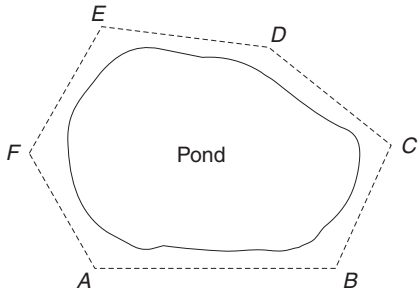


**Fig. 2.1** *Closed traverse*

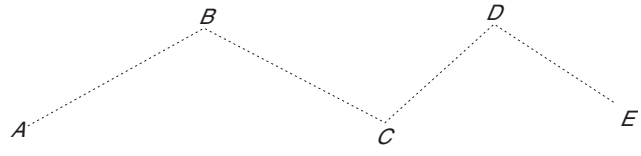


**Fig. 2.2** *Open traverse*

2. Open Traverse A traverse is said to be open if it does not form a closed polygon. It consists of a series of survey lines extending in one general direction but never returning to the starting point as shown in Fig. 2.2.

**4. Classification Based Upon the Instruments Used** **[May, June 2009, 2011; Nov, Dec 2012]**

(a) Chain surveying
(b) Compass surveying
(c) Plane table surveying
(d) Theodolite surveying
(e) Tacheometric surveying
(f) Aerial surveying
(g) Photographic surveying

## 2.6 PRINCIPLES OF SURVEYING **[May, June 2009, 2010; Nov, Dec 2009; Apr, May 2015]**

The two main principles of surveying are (i) working from the whole to the part, and (ii) fixing new points by at least two independent processes.

**1. Working from the whole to the part** Whether it is a plane surveyor or a geodetic survey, the main principle adopted is to work from the whole to the part. In the case of surveying of extensive areas, such as a town or a big estate, the survey is started by establishing a system of control points with high precision. The line joining these points will form the boundary lines of the area, otherwise, this is the main skeleton of the survey. The above control points may be established by triangulation or by running a traverse surrounding the area. The main triangles and traverses are then broken into smaller ones and measured using less laborious methods. The main reason to work from the whole to the part is to avoid the accumulation of errors and to control any localised errors. If, on the other hand, the survey is carried out from the part to the whole, the errors will be magnified in each and every step and will become uncontrollable at the end. The above principle is also fit to the levelling also.