1.1 DEFINITION

Surveying may be defined as an art to determine the relative positions of points on, above or beneath the surface of the earth, with respect to each other, by measurements of horizontal and vertical distances, angles and directions. Surveying may also be defined as the science of determining the position, in three dimensions, of natural and man-made features on, above or beneath the surface of the earth.

CLASSIFICATION OF SURVEY

I. BASED ON ACCURACY DESIRED

1. Plane Survey

Survey in which the mean surface of earth is regarded as plane surface and not curved as it really is, is knownas plane surveying. The following assumptions are made:

(a) A level line is considered a straight line and thus the plumb line at a point is parallel to the plumb line atany other point.

(b) The angle between two such lines that intersect is a plane angle and not a spherical angle.

(c) The meridians through any two points are parallel.

2. Geodetic survey

Survey in which the shape (curvature) of the earth's surface is taken into account and a higher degree of precision is exercised in linear and angular measurements is termed as geodetic surveying. Such surveys extend over large areas. The measurements must be made to the highest possible standard.

II. BASED ON PURPOSE OF SURVEY

1. Engineering Survey

Surveys which are done to provide sufficient data for the design of engineering projects such as highways,railways, water supply, sewage disposal, reservoirs, bridges, etc., are known as engineering surveys.

2. Defence survey

Surveys have a very important and critical application in the military. They provide strategic information that can decide the course of a war. Aerial and topographical maps of the enemy areas indicating important routes,airports, ordnance factories, missile sites, early warning and other types of radars, anti-aircraft positions andother topographical features can be prepared.

3. Geological Survey

In this both surface and subsurface surveying is required to determine the location, extent and reserves of different minerals and rock types. Different types of geological structures like folds, faults and

unconformities may help to locate the possibility of the occurrence of economic minerals, oils, etc.

4. Geographical survey

Surveys conducted to provide sufficient data for the preparation of geographical maps are known as geographical surveys. The maps may be prepared depicting the land use efficiency, sources and intensity of irrigation, physiographic regions and waterfalls, surface drainage, slope height curve and slope profile and contours.

5. Mine survey

In this both surface and underground surveys are required. It consists of a topographic survey of mine property and making a surface map, making underground surveys to delineate fully the mine working and constructing the underground plans, fixing the positions and directions of tunnels, shafts, drifts, etc., and preparation of a geological map.

6. Archaeological survey

These are done to unearth the relics of antiquity, civilisations, kingdoms, towns, villages, forts, temples, etc., buried due to earthquakes, landslides or other calamities and are located, marked and identified. Excavationsof the surveyed area lead us to the relics, which reflect the history, culture and development of the era. Theseprovide vital links on understanding the evolution of the present civilisation as well as human beings.

7. Route Survey

These are undertaken to locate and set out the adopted line on ground for a highway or railway and to obtainall the necessary data. The sequence of operations in a route survey is as follows:

(a) Reconnaissance Survey

A visit is made to the site and all the relevant information is collected. It includes collection of existing maps of the area; tracing the relevant map portion over a paper; incorporating the details of the area, if missing, by conducting rough survey.

(b) Preliminary Survey

It is the topographical survey of the area in which the project is located. Sometimes an aerial survey is done if the area is extensive. It includes the depiction of the precise locations of all prominent features and fixing the position of the structure on the map.

(c) Control Survey

It consists in planning a general control system for preliminary survey which may be triangulation or traversing. For location survey, it consists of triangulation.

III. Based on place of survey

1. Land Survey

It consists of re-running old land lines to determine their lengths and directions, subdividing the land intopredetermined shapes and sizes and calculating their areas and setting monuments and locating their positions. Topographical, city and cadastral surveys are some of the examples of land surveying.

(a) Topographical survey

This is a survey conducted to obtain data to make a map indicating inequalities of land surface by measuringelevations and to locate the natural and artificial features of the earth, e.g., rivers, woods, hills, etc.

(b) City Survey

An extensive survey of the area in and around a city for fixing reference monuments, locating and improving property lines, and determining the configuration and features of the land, is referred to as a city survey.

(c) Cadastral survey

This is referred to extensive urban and rural surveys made to plot the details such as boundaries of fields, houses and property lines. These are also known as public land surveys.

2. Hydrographic Survey

It deals with the survey of water bodies like streams, lakes, coastal waters and consists in acquiring data to chart the shore lines of water bodies. It also determines the shape of the area underlying the water surface to assess the factors affecting navigation, water supply, subaqueous construction, etc.

3. Underground Survey

This is referred to as the preparation of underground plans, fixing the positions and directions of tunnels, shafts and drifts, etc. This consists in transferring bearings and coordinates from a surface base line to an underground baseline. An example of this kind of survey is mine surveying.

4. Aerial Survey

When the survey is carried out by taking photographs with a camera fitted in an aeroplane, it is called aerial or photogrammetric surveying. It is extremely useful for making large-scale maps of extensive constructional schemes with accuracy. Though expensive, this survey is recommended for the development of projects in places where ground survey will be slow and difficult because of a busy or complicated area.

IV. Based on Instrument used

1. Chain Survey:

When a plan is to be made for a very small open field, the field work may consist of linear

measurementsonly. All the measurements are done with a chain and tape. However, chain survey is limited in its adaptability because of the obstacles to chain like trees and shrubs. Also, it cannot be resorted to in densely built-up areas. It is recommended for plans involving the development of buildings, roads, watersupply and sewerage schemes.

2. **Traverse Survey:**

When the linear measurements are done with chain and tape and the directions or angles are measured with compass or transit respectively, the survey is called traversing. In traversing, speed and accuracy of the field work is enhanced. For example, the boundaries of a field can be measured accurately by a framework of lines along it forming an open traverse. On the other hand, in a densely populated area, the survey work can be carried out with a frame work of lines forming a closed traverse. A traverse survey is very useful for large projects such as reservoirs and dams.

3. **Tacheometry Survey:**

This is a method of surveying in which both the horizontal and vertical distances are determined by observing a graduated staff with a transit equipped with a special telescope having stadia wires and anallatic lens. It is very useful when the direct measurements of horizontal distances are inaccessible. It is usually recommended for making contour plans of building estates, reservoirs, etc.

4. **Levelling:**

This is a method of surveying in which the relative vertical heights of the points are determined by employing a level and a graduated staff. In planning a constructional project, irrespective of its extent, i.e., from a small building to a dam, it is essential to know the depth of excavation for the foundations, trenches, fillings, etc. This can be achieved by collecting complete information regarding the relative heights of the ground by levelling.

5. **Plane Table Survey:**

It is a graphical method of surveying in which field work and plotting are done simultaneously. A clinometer is used in conjunction with plane table to plot the contours of the area and for filling in the details. This method of surveying is very advantageous as there is no possibility of omitting any necessary measurement, the field being in view while plotting. The details like boundaries, shore lines, etc., can beplotted exactly to their true shapes, being in view. The only disadvantage of plane tabling is that it cannotbe recommended in humid climate.

6. **Triangulation Survey:**

When the area to be surveyed is of considerable extent, triangulation is adopted. The entire area is dividedinto a network of triangles. Any one side of any of the triangles so formed, is selected and is measured precisely. Such a line is called baseline. All the angles in the network are measured with a transit. The lengths of the sides of all the triangles are then computed, from the measured length of

the baseline and the observed corrected angles, using sine formula. a/ sin A = b/ sin B = b/ sin C

7. **Electro Magnetic Distance Measurement:**

   This is the electronic method of measuring distances using the propagation, reflection and subsequent reception of either light or radio waves. The examples of EDM instruments are tellurometer, geodimeter, distomat, etc.

8. **Total Station Survey:**

   The electronic theodolites combined with EDMs and electronic data collectors are called total stations. A total station reads and records horizontal and vertical angles, together with slopes distances. The instrument has capabilities of calculating rectangular coordinates of the observed points, slope corrections, remote object elevations, etc. The surveys carried out using total station are called total station survey.

9. **Satellite Based Survey:**

   Remote sensing and global positioning system (GPS) are the satellite-based surveys. Acquiring data for positioning on land, on the sea, and in space using satellite-based navigation system based on the principle of trilateration is known as GPS. Global positioning system uses the satellite signals, accurate time and sophisticated algorithms to generate distances in order to triangulate positions.

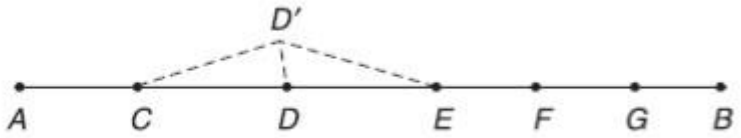
PRINCIPLES OF SURVEYING

There are two basic principles of surveying. These find their inherent applications in all the stages of a project, i.e., from initial planning till its completion.

1. To work from whole to part.
2. To locate a point by at least two measurements.

TO WORK FROM WHOLE TO PART

It is the main principle of surveying and a method violating the principle of working from whole to part should not be adopted until and unless there is no alternative. The main idea of working from whole to part is to localise the errors and prevent their accumulation. This can be explained by taking a simple example ofmeasuring a horizontal distance AB, say about 120 m with a 20 m chain Fig.(a) The process consists in measuring the distance in parts, as the length of chain is smaller than the distance to be measured and is accomplished by the process of ranging. There can be two alternatives as follows.



(Fig.(a))

In one of the method also called the direct method, various points such as C, D, and E are established independently at a distance of about 20 m each with respect to the two end control points and the distance AB can be measured. As C, D, E, etc., are established independently with respect to the main control points, error, if any, introduced in establishing any intermediate point will not be carried in establishing the other points. For example, suppose that point D has been established out of the line AB, as D (Fig.(a)) and E, F, etc., have been established correctly. The actual distances DC and DE will be in error (D C and D E) but all other distances AC, EF, FG, etc., will be correct. Therefore, the error in this procedure is localised at point D and is not magnified. This method observes the principle of working from whole to part.

In the other method, a part, say AC, of the whole distance AB to be measured is fixed.

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