

CHAPTER 1

TOPOGRAPHIC SURVEYING

1.1 Introduction

What is topographic surveying?

Topography is generally known as the study of earth's surface, and its features. It also give the description of the features (such as surface, shape, vegetation cover, and elevation) depicted in map. Topographic surveying is the process of determining the positions, on the earth's surface, of the natural and artificial features of a given locality, and of determining the configuration of the terrain. The location of the features is known as planimetry and the configuration of the terrain is known as topography.

The outcome or the purpose of topographic surveying is the graphical representation of a given land features on a map using several techniques. In order to make the topographic maps easier to interpret, symbols and colors are used to represent various natural and man-made features.

The topographic map shows by means of suitable symbols

- ✓ The spatial configuration of the earth's surface, which includes such features as hills and valleys;
- ✓ Other natural features such as trees, streams, oceans, seas, etc. and
- ✓ Man-made features such as buildings, roads, canals, cultivation, etc.

The distinguishing feature of topographic map is that it represents terrestrial relief. The principal data required for topographic mapping are elevation and distance. Several ground methods that require the use of transit, theodolite, plane table, level, hand level, tape, and levelling rod in various combinations are available for furnishing data necessary for topographic mapping. Total station EDMs and photogrammetric methods are also employed where available.

Use of Topographic Maps

The purpose of Topographic surveying is to gather data necessary for the construction of the topographic map that displays both the planimeter and topographic feature: -

- Industrial Plants
- Rail ways & high ways
- Irrigation & drainage scheme
- Hydroelectric power station
- a building complex
- Bridges, tunnels and dams

The user of the map should be able to interpret the map *as a model of the ground*. They are necessary aids in the design of any engineering project that requires consideration of landforms, elevations or gradients.

They also furnish necessary data for economists, geologists, and others interested in the general development of natural resources.

Topographic surveying and the preparation of a topographic map of the terrain is therefore generally the first step in the planning and designing of a major civil engineering project.

1.2 Contouring

The process of tracing contour lines on the surface of the earth is called Contouring.

Purpose of Contouring

Contour survey is carried out at the starting of any engineering project such as a road, a railway, a canal, a dam, a building etc.

- For preparing contour maps in order to select the most economical or suitable site.
- To locate the alignment of a canal so that it should follow a ridge line.
- To mark the alignment of roads and railways so that the quantity of earthwork both in cutting and filling should be minimum.
- For getting information about the ground whether it is flat, undulating or mountainous.
- To find the capacity of a reservoir and volume of earthwork especially in a mountainous region.
- To trace out the given grade of a particular route.
- To locate the physical features of the ground such as a pond depression, hill, steep or small slopes.

1.2.1 Contours and Contour Interval

The graphical portrayal of the configuration of the land surface (relief) is most commonly done with contour lines. It is the most accurate method of representing relief today.

A contour line is a line that connects points of equal level on the surface of the earth. The shoreline of a body of still water (e.g. a lake) is an excellent illustration of a contour line. In addition, if it were possible to cut off the top of a mountain horizontally slice by slice, the edge of each slice would form a contour. They are drawn on the two-dimensional paper to give the impression of a third dimension.

The properties of contours

- ❖ an imaginary lines
- ❖ have fixed height interval
- ❖ represent known height

Contour interval: The constant vertical distance (height difference) between two consecutive contour lines is called the *contour interval or Vertical Interval (VI)*.

The proper choice of the contour interval depends on:

- ❖ **The nature of the ground:** In flat and uniformly sloping country, the contour interval is small, but in broken and mountainous region, the contour interval should be large otherwise, the contours will come too close to each other.

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- ❖ **The scale of the map:** The contour interval should be in the inverse ratio to the scale of the map i.e. the smaller the scale, the greater is the contour interval.
- ❖ **The purpose of the survey:** Contour interval is small if the area to be surveyed is small and the maps are required to be used for the design work or for determining the quantities of earthwork etc. while wider interval shall have to be kept for large areas and comparatively less important works.
- ❖ **Time and expense of field and office work:** the smaller the contour interval the more points have to be measured in the field and the more time consuming is the plotting. Because of that, the topographic map would become more expensive. In other word smaller the contour interval; the greater is the amount of fieldwork and plotting work.
- ❖ **The slopes of the terrain to be represented:** the terrain is very hilly and the contour interval is too small in relation to the scale, the contour lines become too crowded.

Table 1: gives an overview about which contour interval should be selected for the different map scales and terrain types:

Scale of the map	Type of terrain	Contour interval
Large 1:1000 or larger	Flat	0.2-0.5 m
	rolling	0.5-1.0 m
	hilly	1.5-2.0 m
Intermediate 1:1000-1:10000	Flat	0.5-1.5 m
	rolling	1.0-2.0 m
	hilly	2.0-3.0 m
Small 1:10000 or smaller	Flat	1.0-3.0 m
	rolling	2.0-5.0 m
	hilly	5.0-10.0 m
	mountainous	10, 25 or 50 m

A rolling terrain has got gently raising and falling slopes.

Table 2 shows common contour intervals for different purposes:

Purpose of survey	Map scale	Contour interval
building sites	1:1000 or larger	0.2-0.5 m
town planning and reservoir planning	1:5000-1:10000	0.5-2.0 m
survey of extensive area, earthwork, etc.	1:5000-1:20000	2.0-3.0 m

Generally, as we have seen the above two tables the smaller the scale having the larger the contour interval and vas versa.

1.2.2 Characteristics of Contours

The contours have the following characteristics:

1. All points in a contour line have the same elevation

2. The contour lines are closed lines. However, they may close either on the map itself or outside the map, depending upon the topography.
3. As the perpendicular distance between two contour lines is the shortest distance, contours are always perpendicular to the direction of the steepest slope. Therefore, surface water always runs downhill at right angle to the contour lines. These contour lines form U's, pointing downhill.
4. In case of a valley lines or streams, the contours run roughly parallel to the valley line or stream and form ^'s pointing uphill where they cross the valley line or stream.
5. If the spacing between the contour lines is small the slope is steep, but for gentle slopes the spacing is large.
6. Contour lines never cross one another or branch into two contour lines of the same elevation because a point on the ground cannot have two elevations; they may overlap and appear to meet only at vertical walls and overhanging cliffs are two examples where this condition is violated.
7. Depression contours form closed loop contours around the lowest point. The elevations of the contours decrease from outside to inside.
8. Summit contours form closed loop contours around the highest point. The elevations of the contours increase from outside to inside.
9. Contours do not have sharp turnings.
10. Contours are not shown going through buildings.
11. Contours crossing a man-made horizontal surface (roads, railway track) will be straight parallel lines as they cross the facility.
12. Horizontal distance between contours is inversely proportional to the ground slope. Hence, on a steep slope, contour lines run close to each other.
13. A uniform slope is indicated when the contour lines are uniformly spaced.

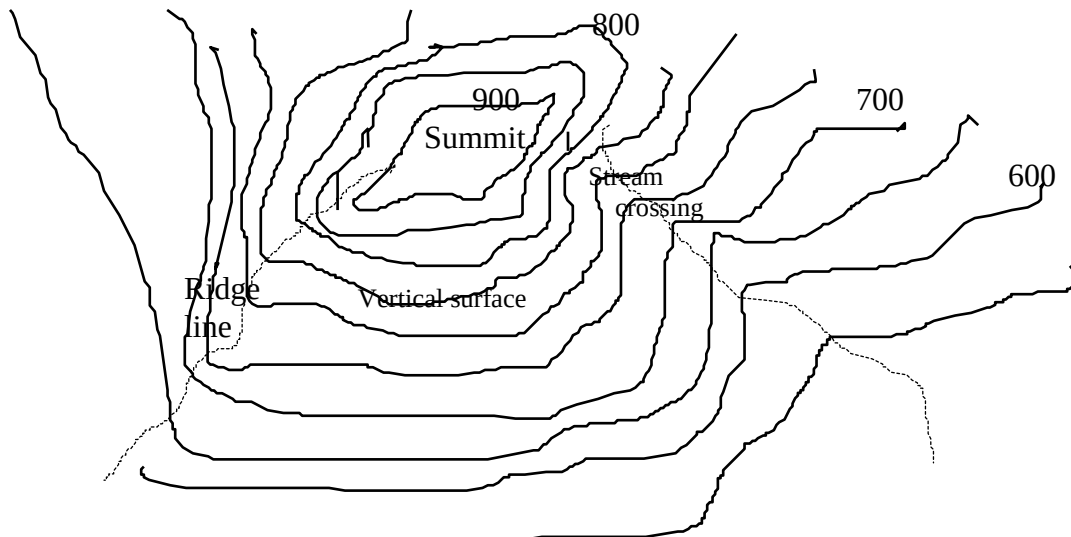


Fig 1.1 Contour lines

1.2.3 Methods of Contouring

There are mainly two methods of locating contours:-

- (1) Direct Method and
- (2) Indirect Method

1) Direct Method: In this method, the contours to be located are directly traced out in the field by locating and marking a number of points on each contour. These points are then surveyed and plotted on plan and the contours drawn through them.

- This method is most accurate but very slow and tedious as *a lot of time is wasted* in searching points of the same elevation for a contour.
- This is suitable for small area and where great accuracy is required

2) Indirect Method: In this method the points located and surveyed are not necessarily on the contour lines but the spot levels are taken along the series of lines laid out over the area. The spot levels of the several representative points representing hills, depressions, ridge and valley lines and the changes in the slope all over the area to be contoured are also observed. Their positions are then plotted on the plan and the contours drawn by interpolation. This method of contouring is also known as contouring by spot levels.

This method is commonly employed in all kinds of surveys as this is cheaper, quicker and less tedious as compared to direct method. There are mainly three method of contouring in indirect method:

1. **By Squares:** In this method, the whole area is divided into number of squares. the corners of the squares are pegged out and the reduced levels of these points are determined with a level. the square need not be of the same size throughout.
2. **By Cross-Sections:** This method is most suitable for the survey of long narrow strips such as a road, railway or canal etc. Cross sections are run transverse to the centre line of the work and representative points are marked along the lines of cross-section. The spacing of the cross-sections depends upon the topography of the country and the nature of the survey.

1.2.4 Uses of Contour

- ❖ A contour map furnishes information regarding the features of the ground, whether it is flat, undulating or mountainous.
- ❖ From a contour map, sections may be easily drawn in any direction
- ❖ Inter visibility between two ground points plotted on map can be ascertained
- ❖ It enables an engineer to approximately select the most economical or suitable site for an engineering project such as a road, a railway, a canal or a pipeline etc.
- ❖ A route of a given grade can be traced on the map.
- ❖ Catchment area and capacity of a reservoir may be determined from the contour map.
- ❖ Contour map may be used to determine the quantities of earthwork.