

# Methods, Maps and Uses of Contours in Surveying

## What is contouring in Surveying?

Contouring in surveying is the determination of elevation of various points on the ground and fixing these points of same horizontal positions in the contour map. To exercise vertical control leveling work is carried out and simultaneously to exercise horizontal control chain survey or compass survey or plane table survey is to be carried out. If the theodolite is used, both horizontal and vertical controls can be achieved from the same instrument. Based on the instruments used one can classify the contouring in different groups.

## Methods of Contour Surveying

There are two methods of contour surveying:

1. Direct method
2. Indirect method

### Direct Method of Contouring

It consists in finding vertical and horizontal controls of the points which lie on the selected contour line.

- For vertical control levelling instrument is commonly used. A level is set on a commanding position in the area after taking fly levels from the nearby bench mark. The plane of collimation/height of instrument is found and the required staff reading for a contour line is calculated.
- The instrument man asks staff man to move up and down in the area till the required staff reading is found. A surveyor establishes the horizontal control of that point using his instruments.
- After that instrument man directs the staff man to another point where the same staff reading can be found. It is followed by establishing horizontal control.
- Thus, several points are established on a contour line on one or two contour lines and suitably noted down. Plane table survey is ideally suited for this work.
- After required points are established from the instrument setting, the instrument is shifted to another point to cover more area. The level and survey instrument need not be shifted at the same time. It is better if both are nearby to communicate easily.
- For getting speed in levelling sometimes hand level and Abney levels are also used. This method is slow, tedious but accurate. It is suitable for small areas.

### Indirect Method of Contouring

In this method, levels are taken at some selected points and their levels are reduced. Thus in this method horizontal control is established first and then the levels of those points found.

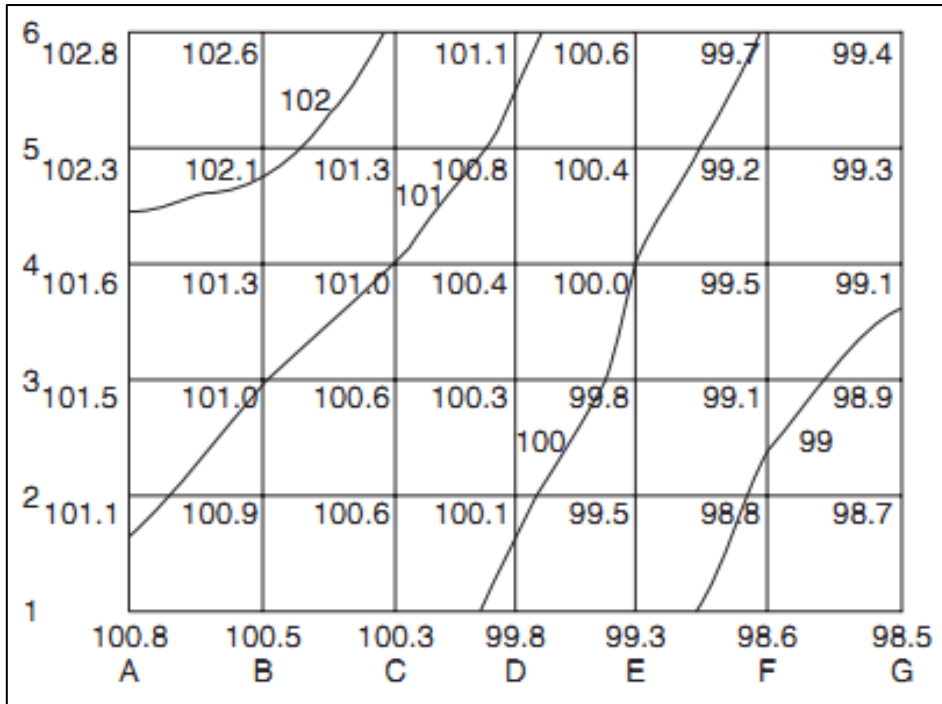
After locating the points on the plan, reduced levels are marked and contour lines are interpolated between the selected points.

For selecting points any of the following methods can be used:

1. Method of squares
2. Method of cross-section
3. Radial line method

### Method of Squares

In this method area is divided into a number of squares and all grid points are marked (Ref. Fig. 1).

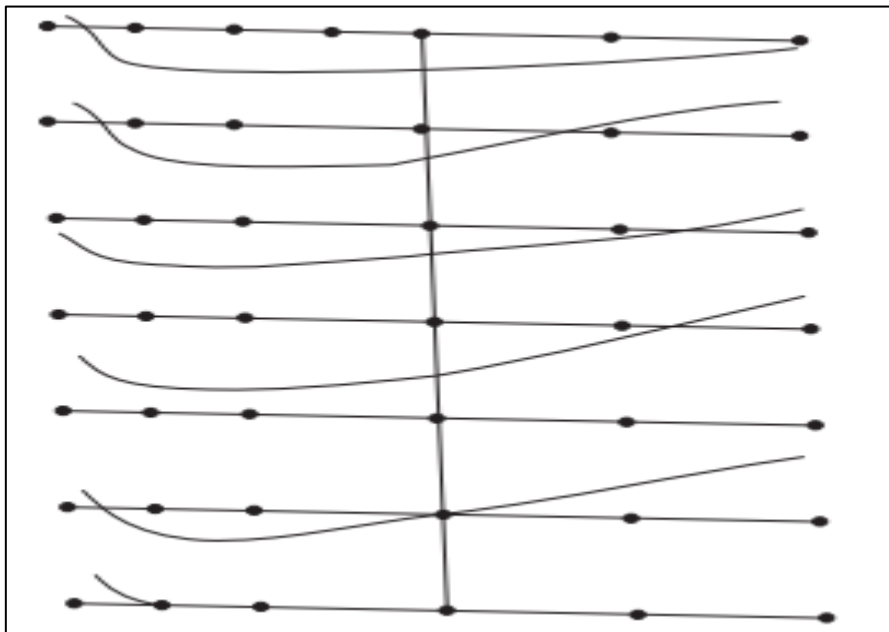


**Fig. 1**

Commonly used size of square varies from 5 m × 5 m to 20 m × 20 m. Levels of all grid points are established by levelling. Then grid square is plotted on the drawing sheet. Reduced levels of grid points marked and contour lines are drawn by interpolation [Ref. Fig. 1].

**Method of Cross-Section**

In this method cross-sectional points are taken at regular interval. By levelling the reduced level of all those points are established. The points are marked on the drawing sheets, their reduced levels (RL) are marked and contour lines interpolated.



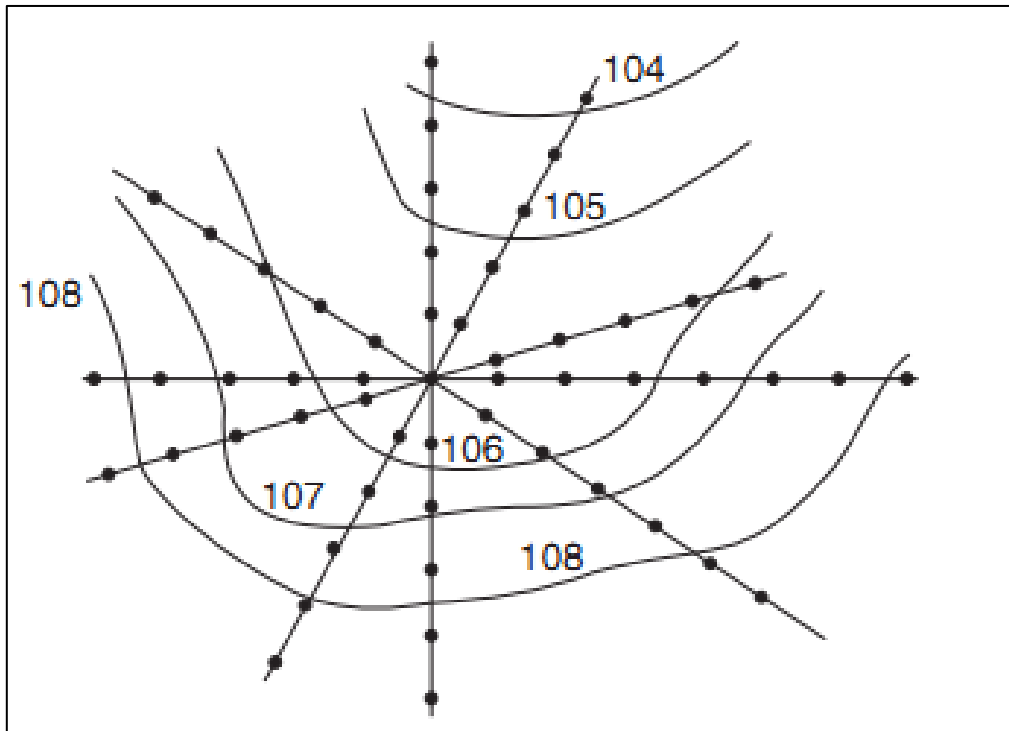
**Fig. 2**

Figure 2 shows a typical planning of this work. The spacing of cross-section depends upon the nature of the ground, scale of the map and the contour interval required. It varies from 20 m to 100 m. Closer intervals are required if ground level varies abruptly.

The cross-sectional line need not be always be at right angles to the main line. This method is ideally suited for road and railway projects.

### Radial Line Method

[Fig. 3]. In this method several radial lines are taken from a point in the area. The direction of each line is noted. On these lines at selected distances points are marked and levels determined. This method is ideally suited for hilly areas. In this survey theodolite with tacheometry facility is commonly used.



**Fig. 3**

For **interpolating contour points** between the two points any one of the following methods may be used:

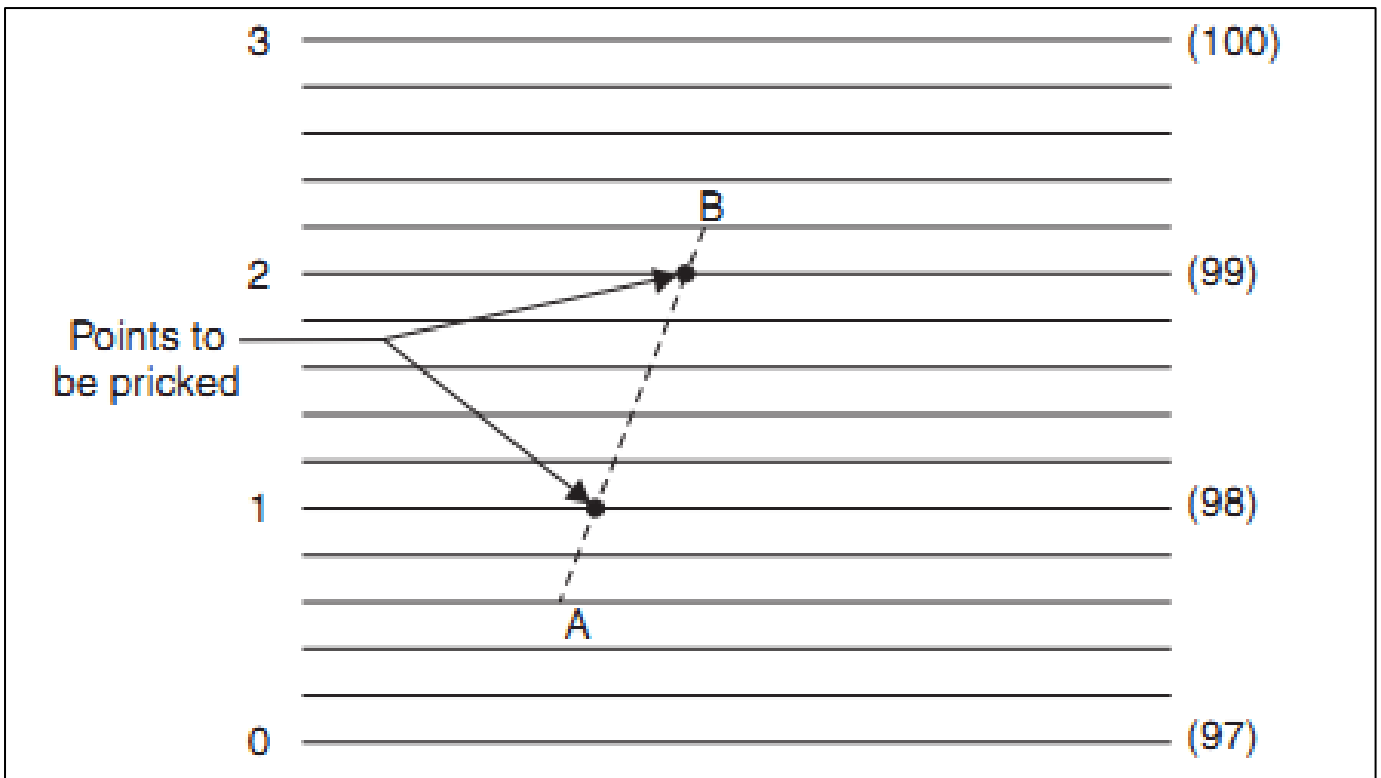
- (a) Estimation
- (b) Arithmetic calculation
- (c) Mechanical or graphical method.

**Mechanical or graphical method of interpolation** consist in linearly interpolating contour points using tracing sheet:

On a tracing sheet several parallel lines are drawn at regular interval. Every 10th or 5th line is made darker for easy counting. If RL of A is 97.4 and that of B is 99.2 m. Assume the bottom most dark line represents 97 m RL and every parallel line is at 0.2 m intervals. Then hold the second parallel line on A.

Rotate the tracing sheet so that 100.2 the parallel line passes through point B. Then the intersection of dark lines on AB represents the points on 98 m and 99 m contours [Ref. Fig. 4].

Similarly the contour points along any line connecting two neighbouring points may be obtained and the points pricked. This method maintains the accuracy of arithmetic calculations at the same time it is fast.



**Fig. 4**

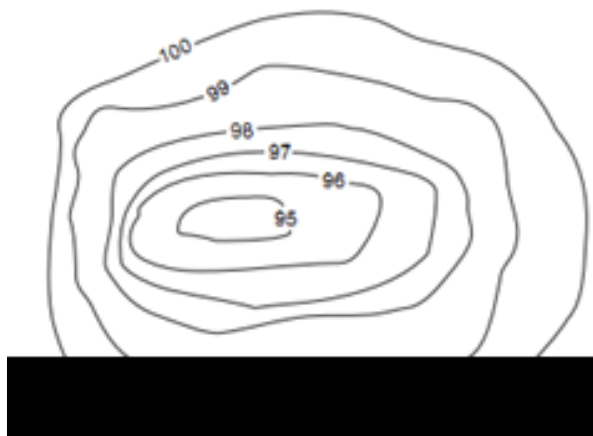
**Drawing Contours**

After locating contour points smooth contour lines are drawn connecting corresponding points on a contour line. French curves may be used for drawing smooth lines. A surveyor should not lose the sight of the characteristic feature on the ground. Every fifth contour line is made thicker for easy readability. On every contour line its elevation is written. If the map size is large, it is written at the ends also.

**Contour Maps and Its Uses**

A contour maps consists of contour lines which are imaginary lines connecting points of equal elevation. Such lines are drawn on the plan of an area after establishing reduced levels of several points in the area.

The contour lines in an area are drawn keeping difference in elevation of between two consecutive lines constant. For example, the contour map in fig. 5 shows contours in an area with contour interval of 1 m. On contour lines the level of lines is also written.

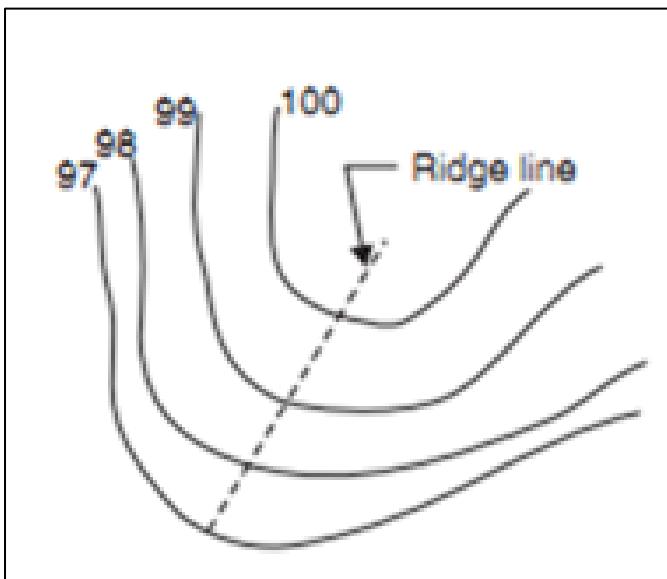


**Fig. 5: Contours**

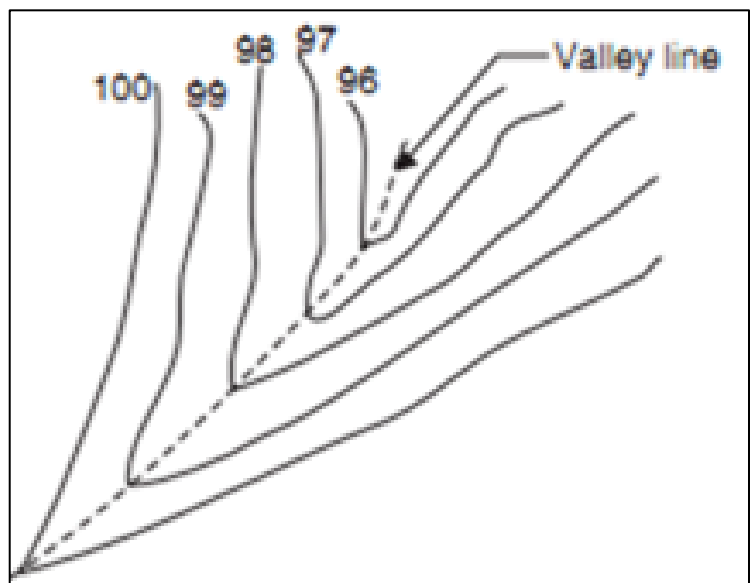
## Characteristics of Contour Maps

The contours maps have the following characteristics:

1. Contour lines must close, not necessarily in the limits of the plan.
2. Widely spaced contour indicates flat surface.
3. Closely spaced contour indicates steep ground.
4. Equally spaced contour indicates uniform slope.
5. Irregular contours indicate uneven surface.
6. Approximately concentric closed contours with decreasing values towards centre (Fig. 5) indicate a pond.
7. Approximately concentric closed contours with increasing values towards centre indicate hills.
8. Contour lines with U-shape with convexity towards lower ground indicate ridge (Fig. 6).



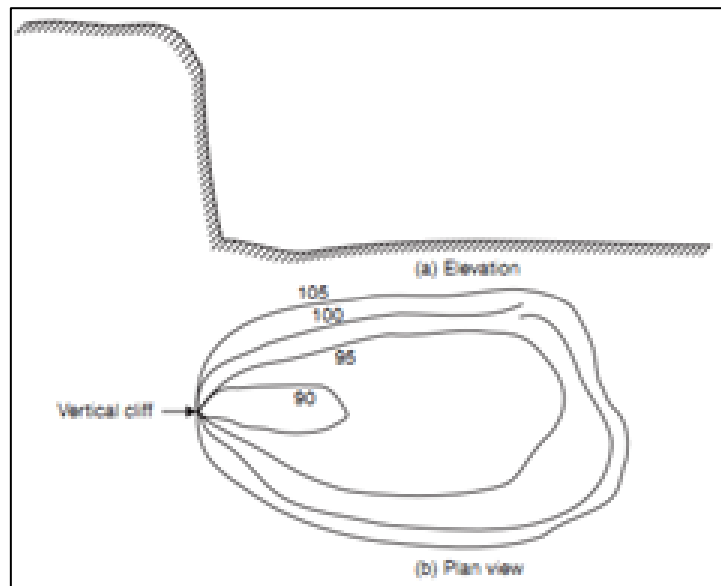
**Fig. 6**



**Fig. 7**

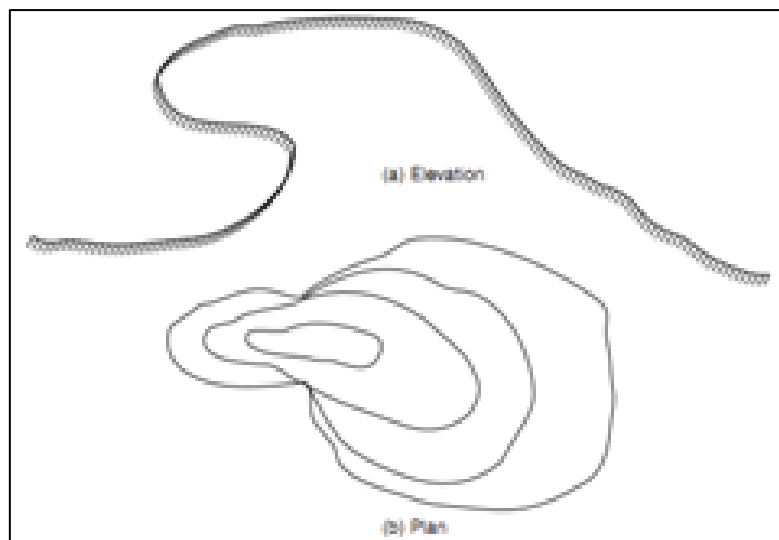
9. Contour lines with V-shaped with convexity towards higher ground indicate valley (Fig.7).
10. Contour lines generally do not meet or intersect each other.

11. If contour lines are meeting in some portion, it shows existence of a vertical cliff (Fig. 8).



**Fig. 8**

12. If contour lines cross each other, it shows existence of overhanging cliffs or a cave (Fig. 9).



**Fig. 9**

## Characteristics of Contour Lines in Surveying

Following are the characteristics of contour lines in surveying for reading contour maps:

- No two lines meet or intersect each other in any case.
- All lines close themselves within the map boundaries or outside it.
- If the contour lines are very close to each other, this indicates steep slope.
- If the contour lines are at very large distance to each other, this indicates a gentle slope.
- If the closed lines have higher elevation in the center then it represents the hill or mountain.
- If the closed line have increasing elevation as we move away, then it represents a pond or a depression in the ground profile.
- In a single contour line, at any point the elevation is same.

## Types of Isoleth Lines

Isoleth lines are generally the lines joining the equal values. It can be differentiated into many types based upon the function it denotes, they are listed as below:

1. Contour lines (Spot Height)
2. Isohyet (Rainfall)
3. Isobar (Atmospheric Pressure)
4. Isobath (Depth of sea)
5. Isohaline (Salinity of the ocean)
6. Isotherm (Air temperature)
7. Isohel (Sunshine duration)
8. Isohume (Humidity)
9. Isoneph (Cloudiness)
10. Isopietic (Ice growth)
11. Isotach (Wind Speed)
12. Isogeotherm (Temperature beneath the ground Surface), etc

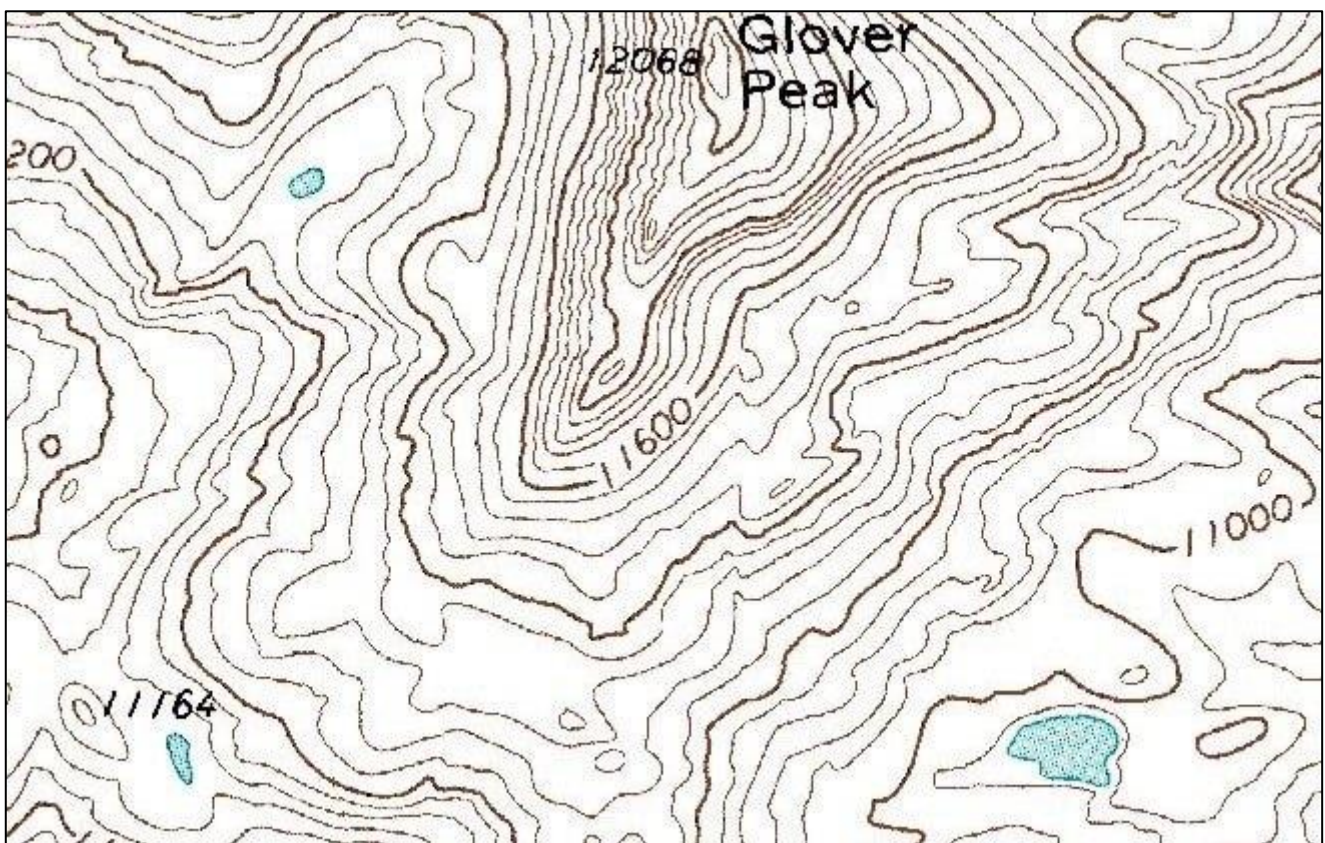
## What is Contour Interval?

A contour interval in [surveying](#) is the vertical distance or the difference in the elevation between the two contour lines in a topographical map.

Usually there are different contour intervals for the different maps. Considering the size of the area to be mapped, contour intervals are assumed.

In every map, on the right-hand bottom side, the contour interval is specified. When the contour interval is not specified in the map, it can be calculated as explained in the following sections.

The commonly used contour interval is 20 feet for a 1:24,000 map scale.



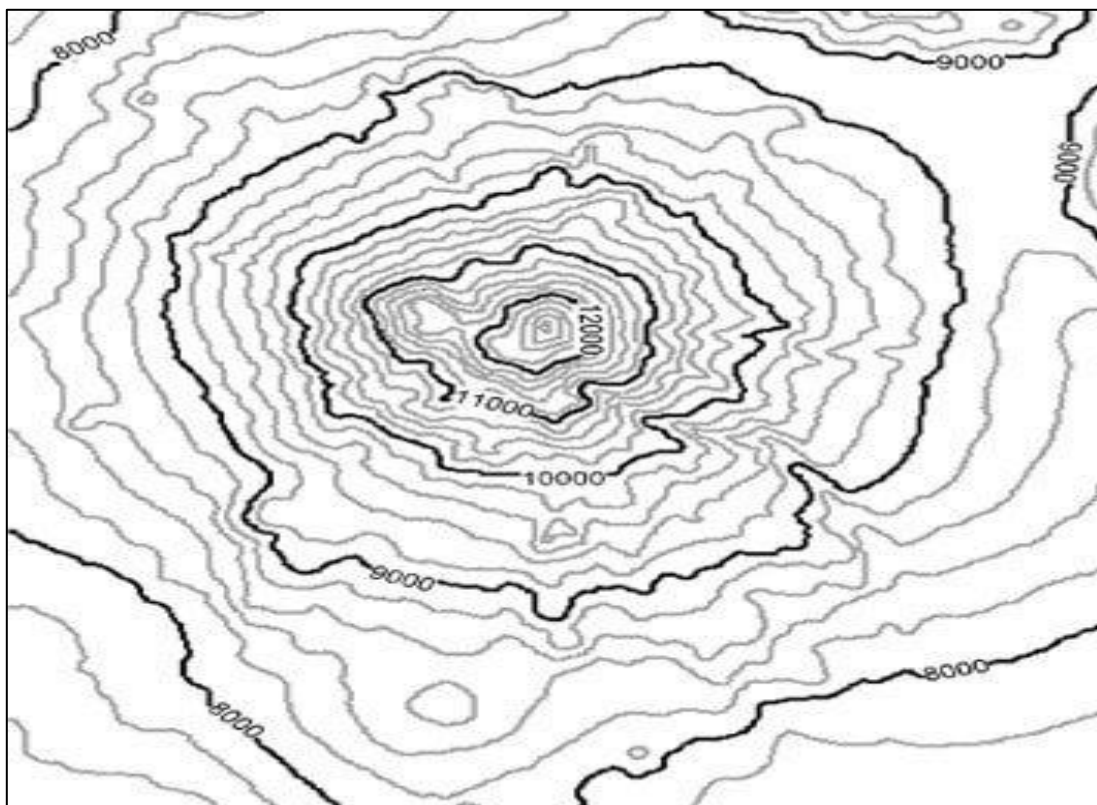
## Factors Affecting the Selection of Contour Interval

The selection of the contour interval is decided by the survey leader before the start of the mapping process depending upon the ground factors.

Sl. No	Factors	Select High CI like 1m, 2m, 5m or more	Select Low CI like 0.5m, 0.25m, 0.1m or less
1	Scale of the map	For small scale maps covering a wide area of varying terrain	For large maps showing details of a small area
2	Extent of survey	For rough topographical map meant for initial assessment only	If a detailed map is to be prepared for execution work
3	Nature of ground	If the ground has large variation in levels, for instance, hills and ponds	If the terrain is comparatively level
4	Time and resources available	If less time and resources are available	If time and resources abundant

## How to Calculate Contour Interval from Maps?

A contour map consists of contour lines of a given geographical region. To keep the contour map simple and easy to read, not every contour line is marked with its elevation reading. These marked or labeled lines are known or termed as Index Contour Lines.





In the above figure, the dark lines with reading are index contour lines.

The calculation of the contour intervals is as below:

**Step 1:**

Firstly locate 2 index contour lines that are labeled with a specific elevation.

**Step 2:**

Now calculate the difference between the two-selected index contour line selected from a map.

To take the difference, subtract the higher elevated line with the lower elevated line reading.

**Step 3:**

Now count the number of non-index lines contour lines between the 2 index contour lines selected for the contour interval calculating in the 1<sup>st</sup> step.

**Step 4:**

The number of lines obtained in the above step is taken and added with 1.

**For Ex:** If the number of lines between 2 index lines are 5. Then add 1 to 5 that becomes 6.

**Step 5:**

the final step is the quotient of the difference between 2 index lines (step 2) and the number of lines in between two index lines plus 1 (step 5).

**Step 6:**

The final answer we get after dividing is the contour interval of the specific topographical map

**Example Calculation of Contour Intervals:**



Considering the above map, the steps involved in contour interval calculation are,

Let's assume, 7000 and 7100 and calculate the interval between it.

Now difference between 7100 and 7000 is  $7100 - 7000 = 100$

The number of contour lines in-between 7000 and 7100 are 4.

Adding 1 to 4,  $4 + 1 = 5$

Now dividing 100 by 5,

$100/5 = 20$  units

**The Contour Interval of the above map is 20 Units.**

## Uses of Contour Intervals in Surveying

1. When a large area is to be mapped in small piece of paper contour intervals are used. A higher contour interval is used for a large area and small contour interval for small area.
2. In a large map, index contour lines are less to keep it simple to read the map easily. In this case, to find out the intermediate points elevation, contour intervals are used.
3. Earthwork estimations for any type of structure like bridges, dams or roads can be found out with the help of contour intervals in a map.

As contour intervals are for the calculation of vertical elevation of an area, same way to calculate the horizontal distance it is termed as Horizontal Equivalent.

The **horizontal** distance between two points on two consecutive contour lines for a given slope is known as **horizontal equivalent**.

**The difference between Contour intervals and Horizontal Equivalent are tabulated below:**

S. No	Contour Interval	Horizontal Equivalent
1	It is based on vertical levels	Represents horizontal distance
2	No measurement or scaling is required since the contour levels are indicated on the contour lines	The distance must be measured on the map and converted to actual distance by multiplying with the scale of the map
3	In a given map the contour interval is a constant	The horizontal equivalent varies with slope. Closer distance indicates steep slope and wider distance gentle slope

## Uses of Contour Maps

Contour maps are extremely useful for various engineering works:

1. A civil engineer studies the contours and finds out the nature of the ground to identify. Suitable site for the project works to be taken up.
2. By drawing the section in the plan, it is possible to find out profile of the ground along that line. It helps in finding out depth of cutting and filling, if formation level of road/railway is decided.
3. Indivisibility of any two points can be found by drawing profile of the ground along that line.
4. The routes of the railway, road, canal or sewer lines can be decided so as to minimize and balance earthworks.
5. Catchment area and hence quantity of water flow at any point of *nalla* or river can be found. This study is very important in locating bunds, dams and also to find out flood levels.
6. From the contours, it is possible to determine the capacity of a reservoir.

