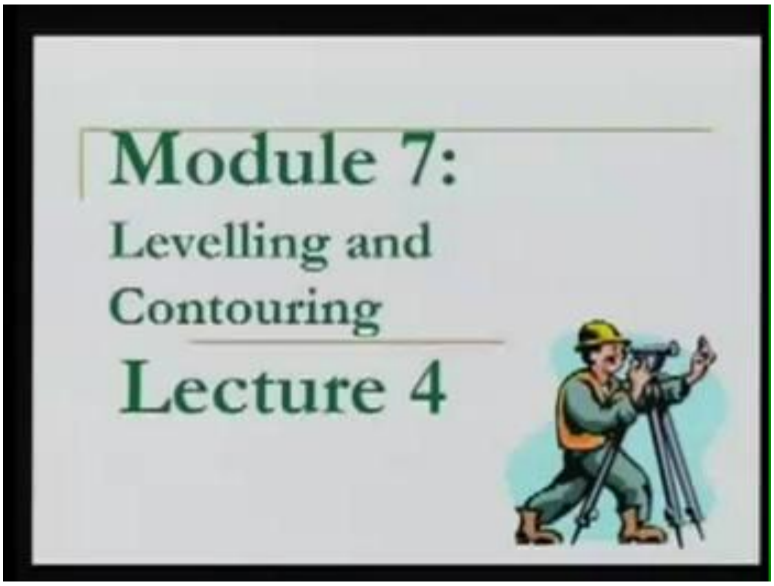
Surveying
Prof. Bharat Lohani
Department of Civil Engineering
Indian Institute of Technology, Kanpur

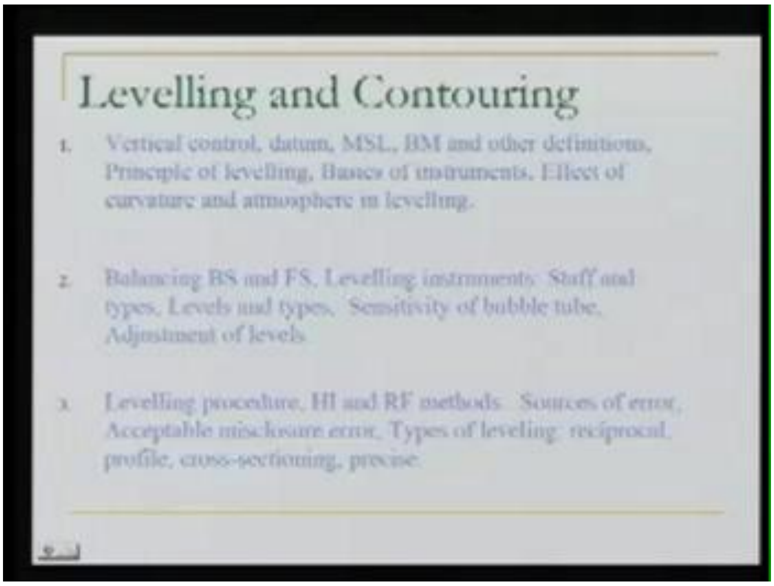
Module - 7
Lecture - 4
Levelling and Contouring

(Refer Slide Time: 00:23)



Welcome to this video lecture on basic surveying; this is module 7. And, in module 7, we are talking about levelling and contouring. Today, we will be in lecture number 4. Now, in lecture number 4, what will we do? We will be talking about the contouring.

(Refer Slide Time: 00:37)

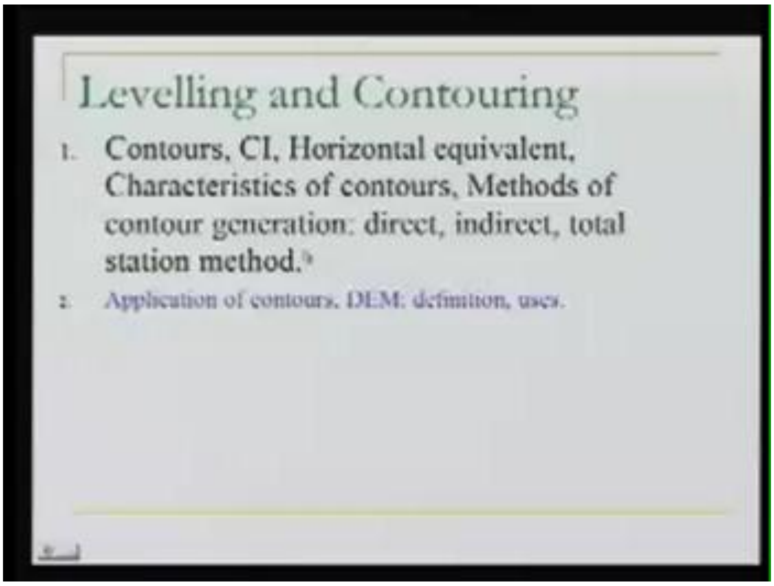


However, before that the basic background of levelling is already known to us. In our last three lectures, as seen here in the slide, what we have done? We have gone through the various methods of levelling. We saw also the instruments - how to use them. We started with the basic concepts of the levelling. We talked about the level surface. We talked about the horizontal surface; the limitations of the horizontal surface to be used as the level surface. We talked about the equipotential thing or the equipotential surface. Then, we also saw some special methods of levelling; for example, the cross sectioning the profiling.

Now, today, having known all these things, as well as in addition to all these, we also discussed the precautions, which we must take while we are doing the levelling in the field. For example, we should try to balance the back sight and foresight, because in our instrument - the levelling instrument - as well as because of the nature, there may be some errors, which may creep in, in our observations.

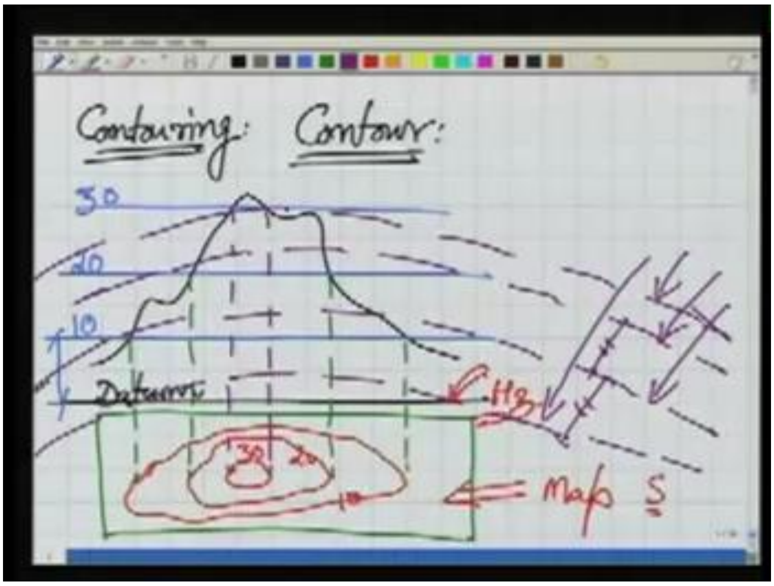
So, what we want to do? We want to eliminate those; either we can eliminate these by, you know, proper adjustment of the instrument. We physically work with the instrument or we apply corrections to the natural error, if you know the physics behind those errors; you know, the physical law which is governing these errors, in case we do not want to do that, there is one more way by balancing back sight and foresight, which we say a strategy of observation. So, having done all these things, what we will do today? We will discuss again one more kind of levelling, which we say contouring.

(Refer Slide Time: 02:37)



Now, in the case of the contouring, we will be looking at the definition of the contours - some more definitions - like contour interval, horizontal equivalent; then the characteristics of the contours, and some methods, which we can use in field to generate the contours.

(Refer Slide Time: 03:03)



Well let us start with the basic term the contour. What is the meaning of contour? Many of you may be already knowing about this term. The contours are those measuring lines on the surface of earth, which join the points of equal elevation. Well, we can see it graphically here. If we have, let us say, a hill here. Now, in this case, for this hill, if this is datum - datum means from where we are measuring the elevations. And now, what I do, I intersect this hill by surfaces which are parallel to datum. As you can see, I can do it like this.

Let us say the elevations of this surface are 10 meter, 20, and 30 meter. Well what we have done? This is our hill, and I am intersecting all these by horizontal surfaces, where the idea is to generate those lines on the surface of the earth, which join the points of same elevation. So, this horizontal plane will have the points of same elevation everywhere, because this horizontal plane is parallel to my horizontal datum.

So, where ever this horizontal plane will intersect my hill, it will form a control. Now, if you see in the slide and we plot the same over here, what I am doing? I am looking at the plan. So, if you look at the plan, I can project these lines here, this particular plane intersects it, the hills here. So, we have our first contour somewhere here. And this we say is of 30 value. Then, the second one, the 20 meter contour cuts it here. So, we have our 20 meter contour, which may look like this. Then finally, we have also the 10 meter.

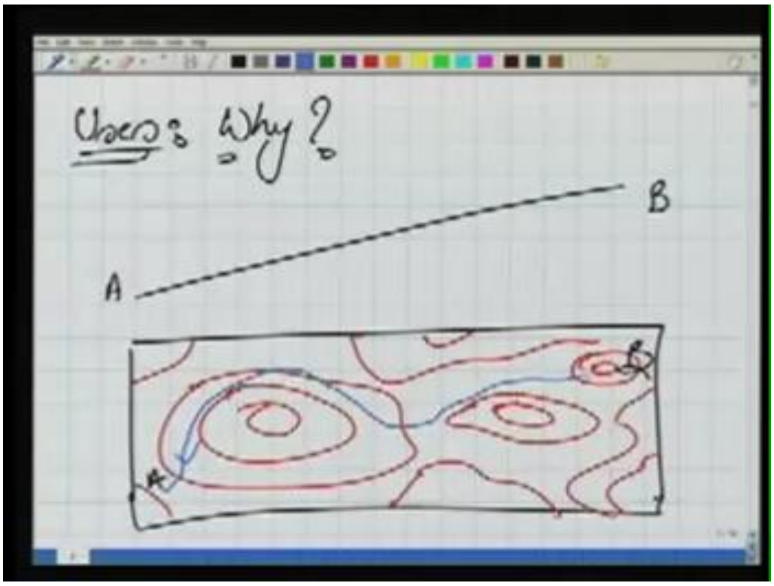
We are just graphically, we are, trying to understand the procedure, that how we can understand - what is the meaning of contours? So contour may look like this; this is 30, 20 and 10. So, this map, is a map, it will have a scale. So, at this scale, this map which has these lines, which we say contours, is called the contour map. So, we are able to understand the concept of the contour by this.

There is one more important thing. I said that the datum here in this case, is a horizontal plane, but is it really horizontal plane? As we have discussed, that we take the observations or rather our datum should not be horizontal plane, rather it should be an equipotential surface. Equipotential means where the gravity potential is same throughout. So, instead of these surfaces, if I am taking a joint, our intersecting planes should be also equipotential. So, these are the equipotential surfaces.

So, we have a equipotential surface here; the another one here; then the third one; and finally, this is our reference, from where we are measuring the elevations; this height;

this height. So, basically or in ideal case, we should have equipotential surfaces, wherever they intersect the hill or the surface, those intersection - intersecting points - are the contours, but for a small area, we know that we can assume it to be the horizontal plane also.

(Refer Slide Time: 07:34)



Next, we will see that - what are the uses of the contours? Why we go for the contours? Why do we need them? Well, I will give you one example. Let us say there is a point A - a village and there is another village B; in between A and B we want to construct a road. So far, there in the ground it is all, you know, undulating terrain; some field, some vegetation or may be some trees and other things, but we want to construct a road between A and B.

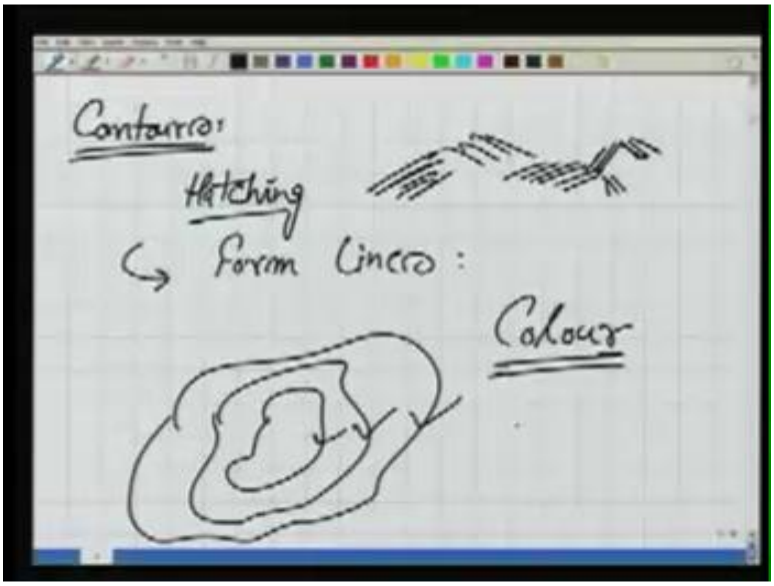
Now, before we construct the road, we would like to know that what the road formation level will be? How much of the area will be cut? And how much of the area will be filled? We want to do those computations, in order to save the cost of cutting and filling. So, we want to arrive at that optimal formation level. Where my road should be? Should it be like this? Like this? Should it be here or here? We would not know this thing. Now doing this thing, there in the ground, is very difficult exercise. These two points A and B could be very far; may be, you know, 3 kilometers, 4 kilometers far apart; we cannot do this kind of job there in the field now. So, this planning of the road or designing of the road. So, what will we like to do? We would like to bring the ground - the terrain - into our laboratory, into our office. Now, we know, so far, that how to bring XY - the planimetry - by making the maps; but here, in this case, we are interested in these formation level, the height of the road - where it should be?

So, we also need to bring the z dimension, the topography, the undulations of the terrain in our office. Now how can we do that? We can bring it only by forming the contours. Somehow, we will occupy this particular area and we will survey this entire terrain, and we will make a map. So that, in the map, we have contours between A and B. Now these contours will have, of course, a value. Now, these are the contours; something like this; and our A and B are here. Now, we are going to take a decision about the road - how the road should be? So, that it is optimal in terms of the construction - cost of construction, the cutting, the filling and all these things. So, we can design this road now, here on the map; because on the map, we know the three-dimensional structure of the terrain. So, this is the where we need the contour map.

Similarly, for example, if you are going to build a building, before you start building - making the building, construct the building - the terrain, there should be, you know, levelled or we should know - what are the undulations in the terrain? How much levelling will be required there? Are there any depressions, which we need to fill up? Many times, we would like to adapt our structure to the landscape. So, we would like to know what the landscape is like. We cannot to these planning there in the field directly. We would like to do these here, in the office. So, what again we would like to do? We would like to make a contour map of that area, and bring it in our office, and plan on top of that.

Similarly, there are many more applications; many, many applications, where the three-dimensional information or 3-D information of the ground or the terrain is required. In all these cases, we would like to go to the field, do the contouring, bring the contours in the laboratory, and proceed with our work. So, this is the use of the contours. We will see some uses later on also. Now, besides contours, there are some more methods of showing this topography or elevation. Now, how it is done? Sometimes these are of measures; one is by Hatching.

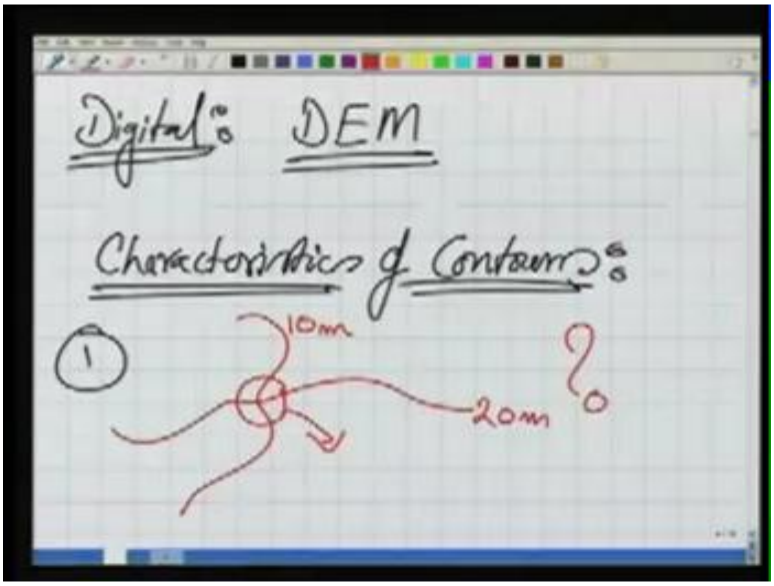
(Refer Slide Time: 11:48)



What we can do? We can create the Hatching. You might have seen some maps where by Hatching, the elevations are shown; this is the rough map; but, it still, you know, it gives an idea of the topography. Generally, this is done if the map is a very, very small scale map, or we can have Form Lines. Form Lines are similar to the contour, the only difference is we do not have any values for this.

In the case of the contours, we know what the elevation of that is. Form Lines, you know, if you are standing in the ground, we can see the ground in front of us, and by you know, we are kind of sketching the contours, without actually measuring it. So, that is called the Form Line. Many times we make use of colours also. You know we show the different sides by different colours. So, by looking at the colour variation in the map, we can have an idea of the height of the topography.

(Refer Slide Time: 13:01)

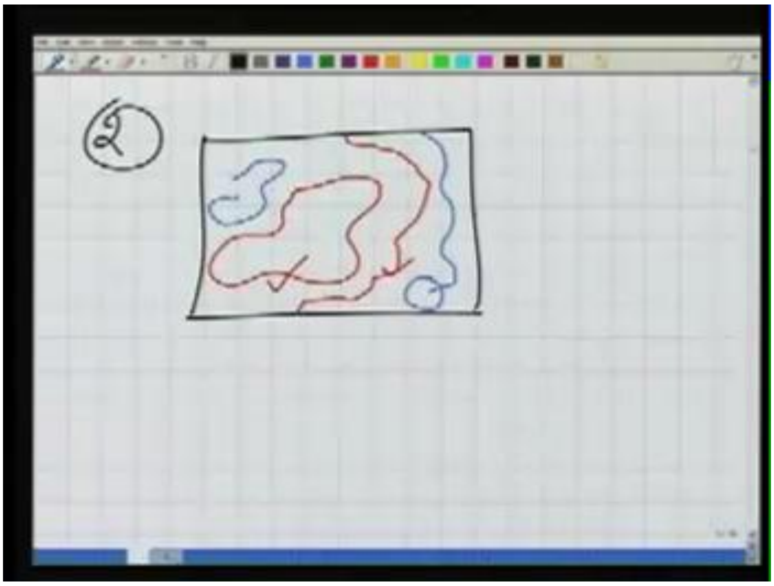


Now, the new methods, which are the digital methods are the very popular one is the DEM. We will see about this DEM later on. It is the digital way of a storing topographic data in our computer. Next, what we would like to do? We would like to see some characteristics of contours. You know their properties. What they should be; what they should not be.

This is very important. Whenever you are reading a map, you have a map; you want to read that map; you must know that what should be the characteristic of the contour. You are going to make a contour in the field; you are going to plot them; again you should know it. What should be the characteristics of the contours? You know, should they follow particular pattern or should they not.

Now, some of these we would like to talk about now one by one. Number one, and very important one is - two contours of different elevations - let us say, this is the contour of 10 meter and this is the contour of 20 meter - can they intersect? That is the question mark. Well is this point of intersection possible? No, because there in the ground one point cannot have two RLs or two heights. So, this kind of intersection is never possible. So, whenever we are making the contours, whenever we are plotting them, we have to ensure that this should be avoided. Now, the second characteristic - whether the contours, how they look like on a map sheet?

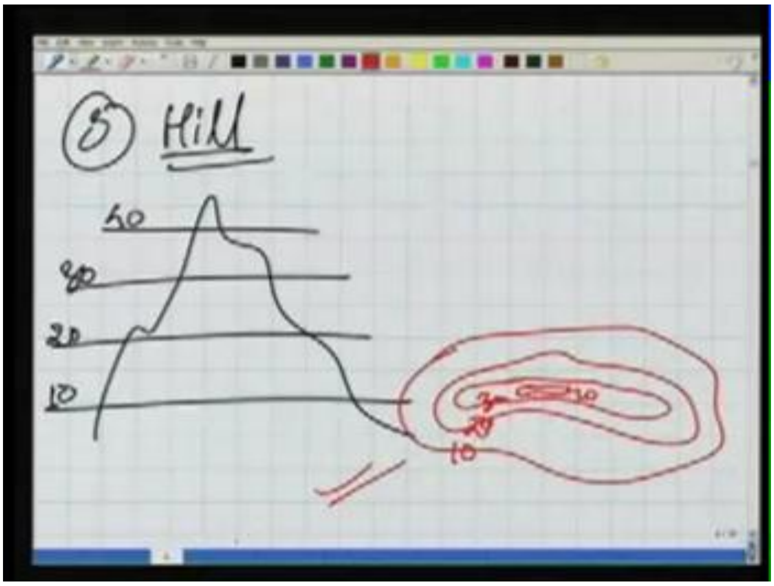
(Refer Slide Time: 14:51)



Let us say, now this the second characteristic, and this is about that the contours should either close in themselves or within the map sheet - we are talking within the map sheet - or they should start from the boundary, and they should close at the boundary. So, these two correct contours are correct; but we cannot have a contour, we will start from boundary, and this, you know, is not going anywhere; it is not possible.

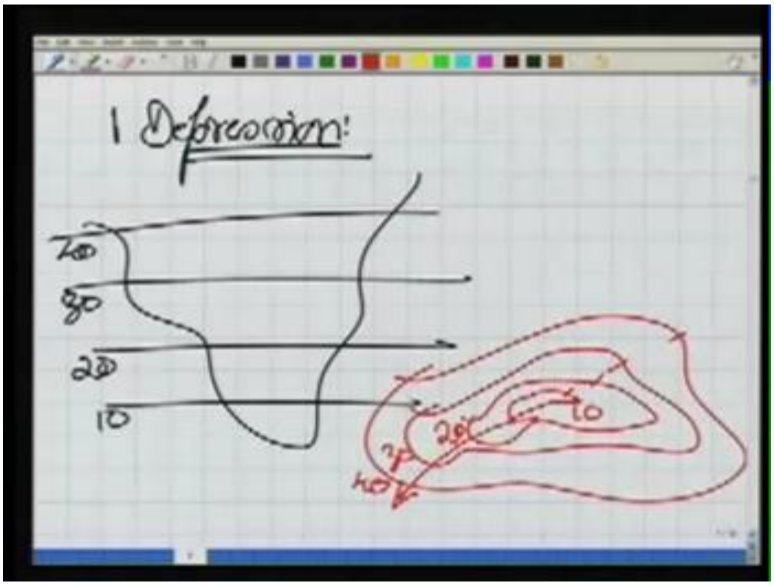
Similarly, we cannot have the contour like this; either it must close or it must start from a boundary, and go to the boundary. Now this is very easy to understand why it is so. Now, when we are intersecting an undulating terrain by the horizontal planes, we will have within the boundary of the maps these characteristics.

(Refer Slide Time: 15:49)



Now, let us see some shapes. How the contours look like for a hill, we know it; we have seen it already, because if we intersect for a hill by different elevations - 20 and 40 meter; then the contour map, will look like, may be like this, where is 10 meter, 20 meter 30 meter, and finally, 40 meter. So, this is for hill.

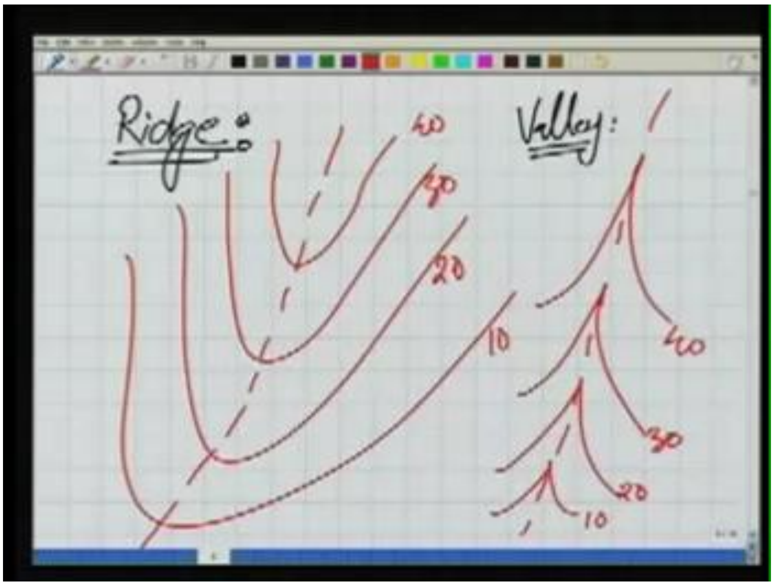
(Refer Slide Time: 16:23)



The second one for valley or our depression. You know what is the meaning of depression? The depression means, any feature, which is of this shape - the cup shape. Now, for this cup shape, if I slice it by horizontal planes, how the contours will form?

So, there is a depression here. I am drawing it in two-dimension; of course, it is a three-dimensional thing, there in the field; and if we intersect it with these horizontal planes - 10 meter, 20, 30, and 40 - the contour map will look like this; we have 40 meter, then 30 20, and finally, 10. So, if these are, you know, closing contours - closing means like this - and the elevations are increasing this way, it is a valley.

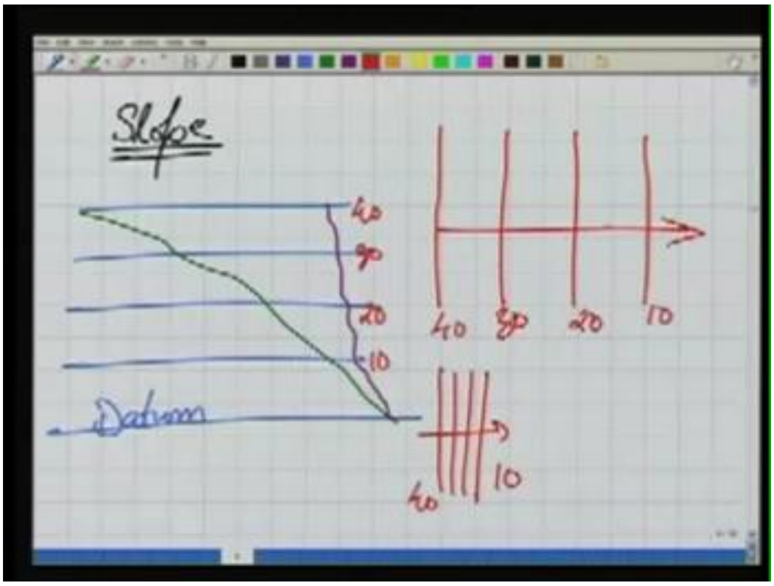
(Refer Slide Time: 17:31)



Similarly, some more shapes. One is Ridge. Now what is a ridge? Now there in the field, if you look at the ridge, the ridge look likes this; if you look very carefully at my hands, the ridge will look like this. Now, if I bisect or intersect, I intersect this ridge by the horizontal planes, what will happen? I will have the contours formed like this. So, for a ridge the contours they look like this; where the elevations are 10 meter, 20 meter, 30 meter, 40 meter, and this line is the Ridge line.

Similarly, for our valley; I will draw the valley here only, so we can compare these two. Now the valley means - valley is a different kind of surface; a surface like this. Now in this surface, if I intersect now, by the horizontal planes, I get the Contours, which are inverted v in shape; 10 meter, 20 meter, 30 meter, and 40 meter, and this is the Valley line.

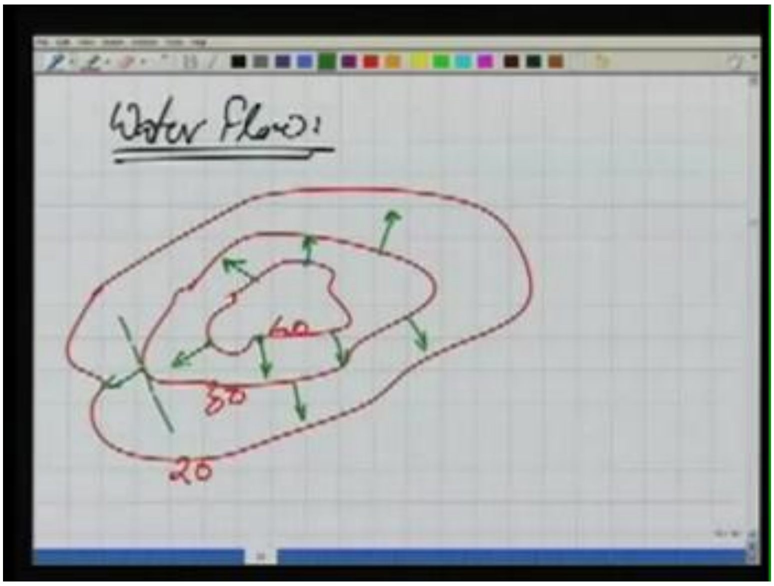
(Refer Slide Time: 19:01)



Now, some more characteristics. One thing about a Slope. What we are doing? Basically, our terrain, we are intersecting with these horizontal planes, which are parallel to the datum. If we have a terrain, let us say it is the very gently sloping; now, for this terrain, the contours will look like, they are nearly equally spaced and far apart. So, I can write the contours as this 10, 20, 30, 40. So, 10, 20, 30, and 40 this is the direction of slope.

Now, in case, if we have a very steep slope; in the case of the steep slope, I will have the same contours - 40, 30, 20, and 10 - but, these will be very, very, you know, equally spaced; again the direction of slope is this. So, looking at this spacing of the chord, contours in a map, we can make it out whether the slope is gentle or a steep or some more things we should look about.

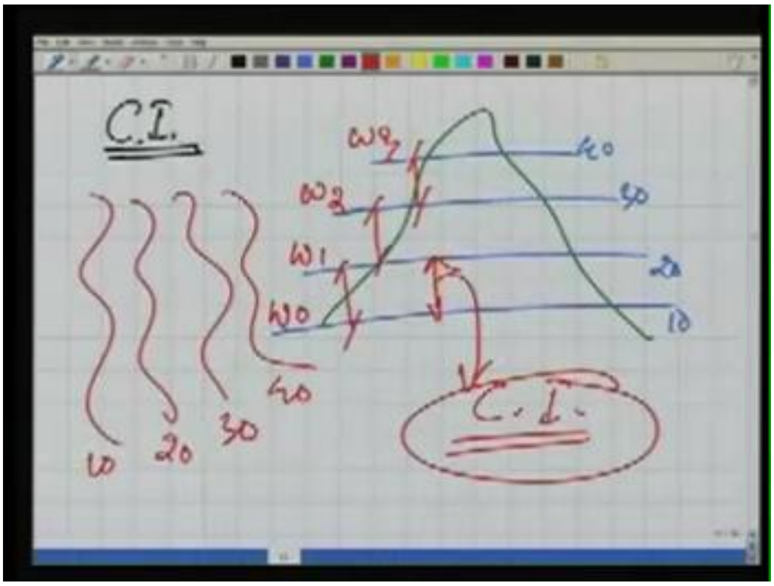
(Refer Slide Time: 20:23)



This is about water flow. How the water will flow in a given contour map. For example, if we have a contour map, like this, this is 40, 30, and 20. So, we can easily make out that this is a contour map for a hill. If the water drop is kept here, where would it go? It would flow in a direction, which is perpendicular to the contour here; it will go in this direction. A water drop, which is kept here, will go in this direction; a water drop, which is kept here, will go in this direction. Obviously because is a hill, and if the water is being poured there, it will flow out. So, similarly here the water is flowing out.

So, at any point in the contour, the water will flow or we can say otherwise - the maximum slope or the steepest slope at any point in the contour, will be perpendicular to the contour direction. Well anywhere, if we have the contour direction here, this is the direction of the contour; this is the direction of the steepest slope. So, this is actually very helpful thing. In many of our applications, we can make use of this information.

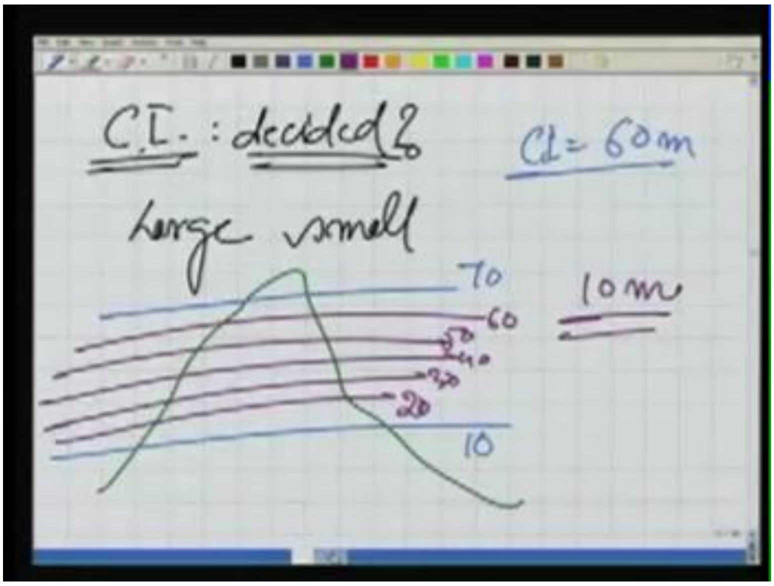
(Refer Slide Time: 21:54)



Now, some more things about the contours: one is contour interval; as you might have seen for any contour, so far, you are writing them as 10, 20, 30, you know 40; I was giving these values. Basically, what is happening here? If my ground is this, and it is being intersected by these horizontal planes, which are of 10, 20, 30, 40; then the difference between these or these horizontal planes, which are intersecting the hill - the height difference -we will say this as contour interval.

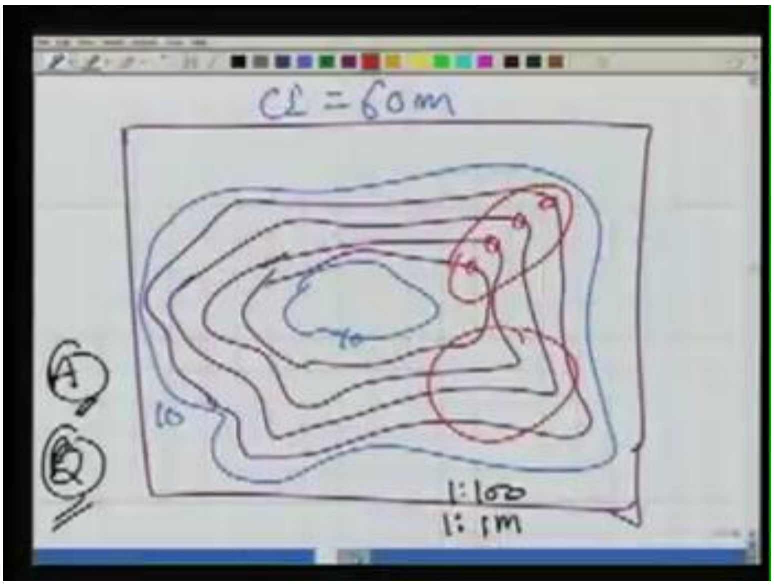
You know, right now I said that this is the difference between horizontal planes, because we are assuming that the horizontal plane is same as the equipotential surface; but in other cases, if these are the equipotential surfaces, we have a potential of W naught here, W 1, W 2, W 3. So, basically, the difference in equipotential surfaces, the difference in potential between these two surface, difference in potential between these two surface, difference in potential between these two surface - all these will be equal, because we would like to have a contour interval which is equal, and we can relate that with the height. So, right now we can just think it in terms of the height difference, which is the contour interval.

(Refer Slide Time: 23:28)



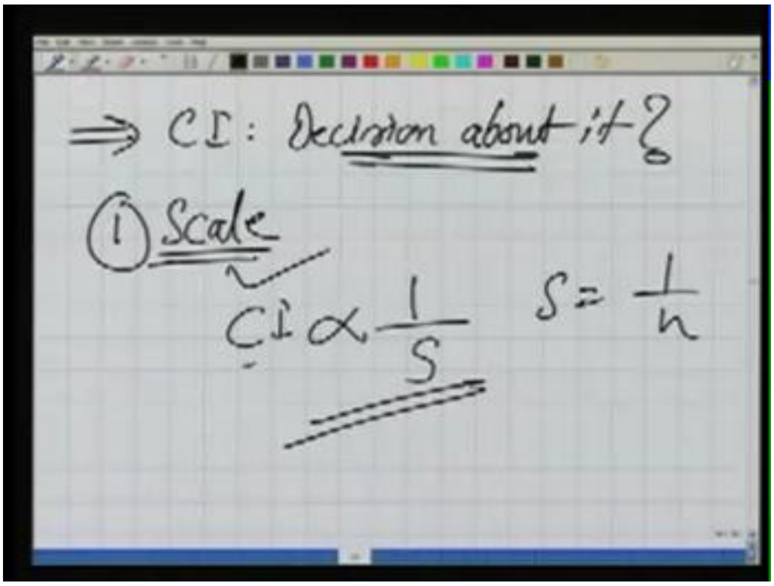
Now the question will come - how the contour interval should be decided? You know, should it be large or should it be small? For same terrain, I can have a contour interval, which is very large; I can have only two contours here; now 10 meter and straight away 50 meter. So, my contour interval in this case is 40 meter, or I can have multiple contours, you know, 20, 30, 40, and so on. Of course, this will be then in that case, 60 here or rather let us say it is 70. So, in one case the contour interval is 60 meter, while in the other case the contour interval is 10 meter. Now we can visualize this effect also.

(Refer Slide Time: 24:40)



In my map, if I had a contour interval of 60 meter - I had only two contours one here and one there, is it not? One was of 10 meter; the other one was 70 meter, but the moment I change my contour interval, I have now many more contours. Well, now there is a question - how should we decide this, whether a contour interval should be large, or small? What are the things on which this will depend upon?

(Refer Slide Time: 25:19)

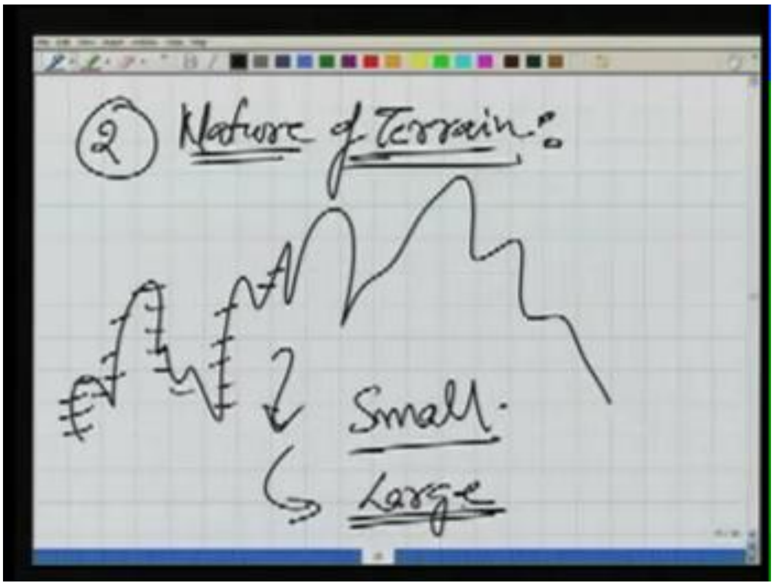


Decision about it - how to take a decision? How to fix this contour interval? Now, what I am going to tell you, only a few things, but the contour interval, when you decide in the field, will depend upon several things there in the field. You will have to take a decision there itself, as per your project, but couple of things: number 1 - is about a scale, well if my this map, would have been a very large scale - large scale means more number of details; large scale means it could be, 1 is to 100, that is one possibility is this - large scale. The second possibility B - this map could have been a very small scale; for example, 1 is to 1 million.

Now, out of these two cases, you know, in larger scale and in smaller scale, how the contour intervals we decide it? Is there any relationship between these two? If the map is large scale, we are able to plot more details. We will be able to show these individual contours separately, because my map is very large.

However, if my map is very smaller scale, you know, we are fitting too much of information - a large area - in one small sheet. Then, in that case, all these will club together; you know, if we are taking a very small contouring interval, all these contours will, you know, club together; they will just become very, you know, confusing; all these lines are on each other - on top of each other. So, we cannot make out the structure of the terrain. So, there is no use of going for large scale method in that case or a very small contour interval for a very small scale map. So, what we can say. Let me repeat it. So, contour interval - it depends upon scale, yes, and contour interval is inversely proportional to the scale; like this. And how do we write the scale? The scale is 1 by n; 1 is to 100; 1 is to 1 million, whatever. So, generally this is a kind of thumb rule, you know, whenever we are taking a decision about the contour interval, if the scale is very large, contour interval could be small. That was about the scale.

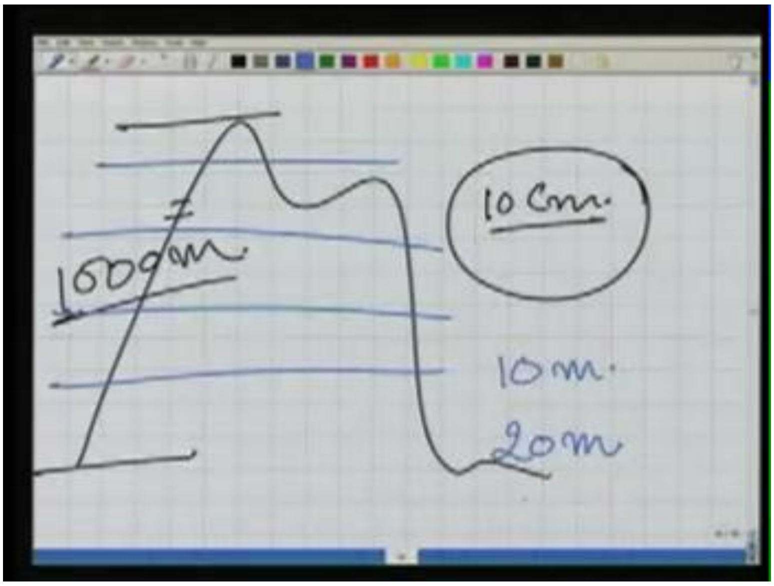
(Refer Slide Time: 28:17)



Now, the second thing. The second thing on which the contour interval will depend upon is about the Nature of Terrain. Of course, many of these things, which I am talking here, they are kind of over lapping arguments. When I distort the scale, I again take care of the nature of the terrain. So, I take care of that. So, they are kind of, you know, overlapping arguments, but still the contour interval depends upon the nature of terrain. How?

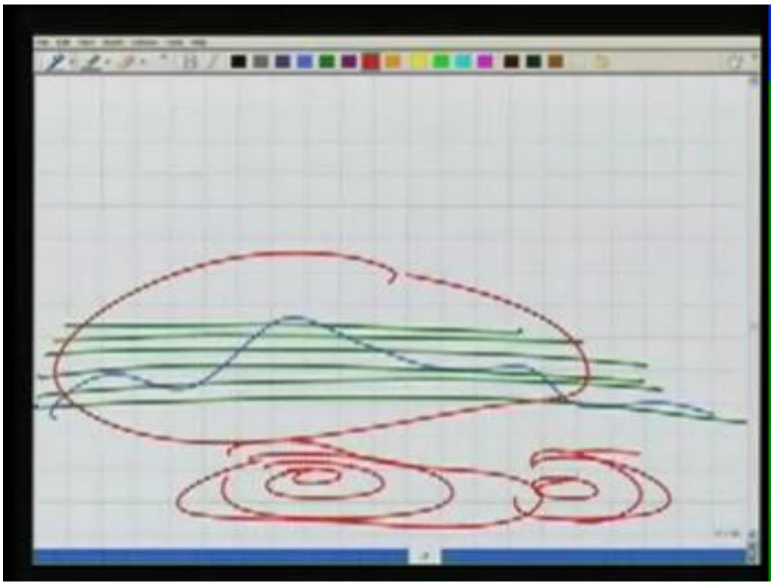
If our terrain is very much undulating, very much undulating, and we want to capture these undulations; we want to capture all these undulations, by our contours. So, contour interval should be small. If you want to capture all of them, our map is large-scale map.

(Refer Slide Time: 29:26)



Or the other way round - our contour interval will be large, when we want to capture these undulations, but not in very minute detail. For example, if you are in a hilly area. You have the big hills in that area. And the undulation is of an order of 1000 meter. Then, in that case, you know the differences in height in 10 centimeter - need not to be of much use for any of the model, because we have very highly undulating terrain where that undulations are also very large. So, we would not like to go for very small, of the order of 10 centimeter or may be meter also information. So, in that case, what we would like to do? We would like to go for the contour intervals, which may be large. So, we may like to go for contour intervals of 10 meter or may be 20 meter.

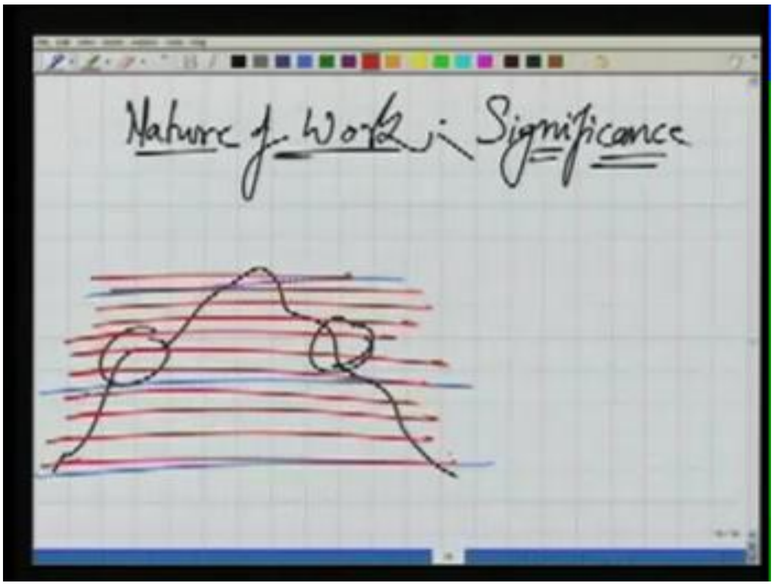
(Refer Slide Time: 30:18)



While in the otherwise case, if we have a terrain which almost flat, but it is important for, you know, drainage network planning; in this nearly flat terrain, we want to do the drainage network planning. If we are not able to capture the topography of this terrain well, what will happen? If there will be a rainfall, the water will remain there; it will not drain out. So, our aim is to capture the proper topography. So, what we would like to do? We would like to keep our contour interval very small. So, we have several contours there. So, that, you know, our area - the topography - is captured very well.

So, it depends upon the undulations. If the undulations are very large, we can go for large contour interval; if the undulations are very, very small, but we have to capture them, our contour interval will have to be smaller.

(Refer Slide Time: 31:19)

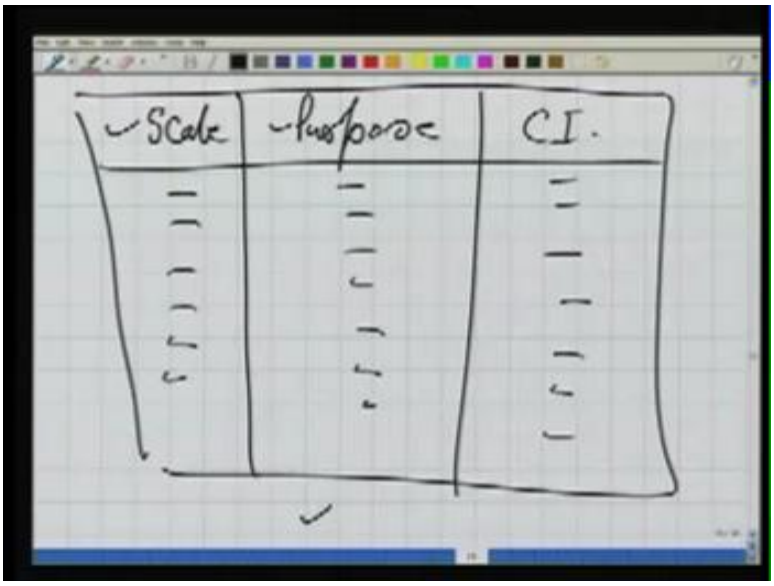


Now, third it also depends upon the nature of work. Or I should say, rather you know, the significance - the significance of work. What is the significance? The contours, as you can guess now, can be used - if we have some ore is there, some ore is dumped here; ores are dumped in very large, huge areas; what we want to do? We want to contour this area in order to find the volume of the ore - how much ore is kept there?

Now, there are many undulations on the surface of it also. These are the undulations on the surface of it. If I take a very large contour interval, I will not be able to capture the undulations very well, I will have an estimate of the volume of this ore, but it will not be very good estimate; while, if I go for very small contour interval, I should be able to capture each and every undulation on the surface of the ore which is kept there. So, in this , the volume which I am computing, of this ore using small contour interval, will be better volume; will be more accurate.

Now, the nature of the work or the significance. If this ore is very precious, very costly, we would like to go for small contour interval. If this ore is not precious, well our contour interval could be large. So, this is how again, you know, contour interval depends upon many factors. It depends or other basically, when you are working in the field, you have to take a decision - what should be the contour interval for my case?

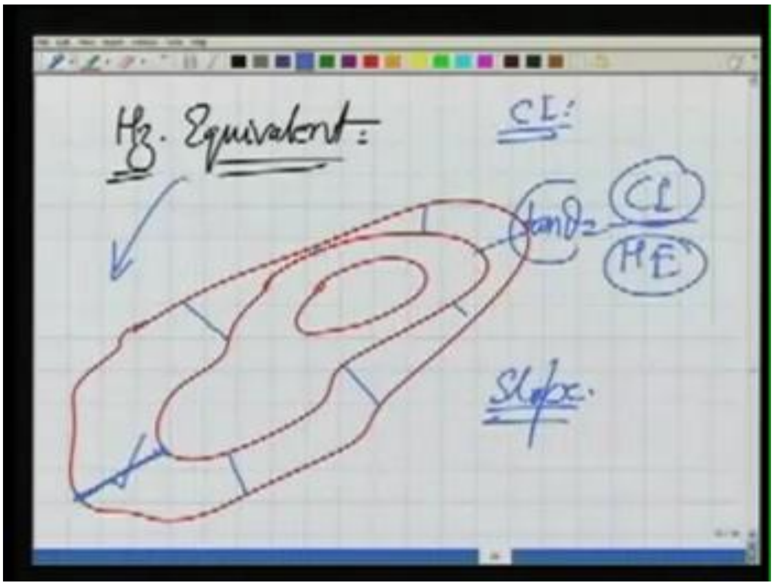
(Refer Slide Time: 33:22)



Now, when you are working in the field, you will have to take a decision about this contour interval. Generally, to help you, there are some tables also, and these tables - they will give you the scale; what is the purpose? A scale of the map, what is the purpose of the map, and then the contour interval is given here.

So, these tables, are available in standard text books, as well as depending to which agency, you are working, you have to work on the standards of that particular agency. So, this table can help us. You know, if you have if I am working for town planning, I am going to make a map of 1 is to 500 - what should be the contour interval? I am going to use the contours for drainage network planning - what should be the contour interval? So, these tables will help in that sense.

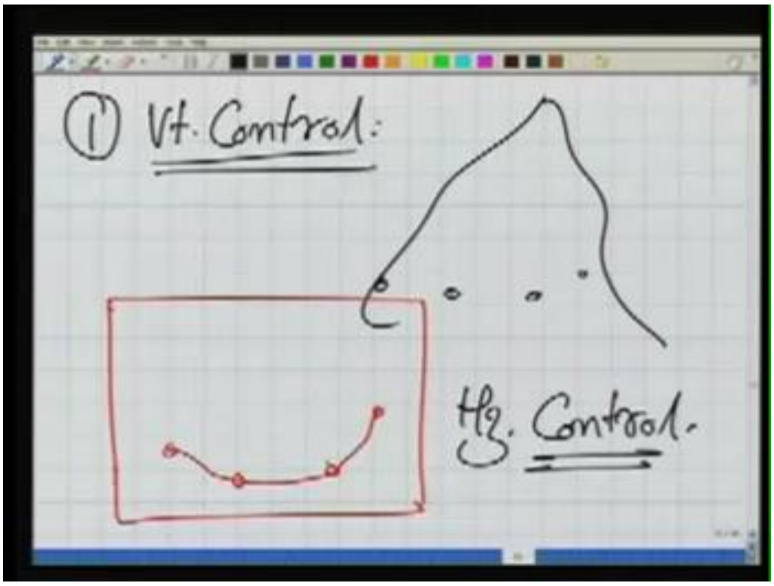
(Refer Slide Time: 34:09)



Next we are going to discuss a term, which is called Horizontal Equivalent. Now what is the meaning of this? This is, if we have contours, now here the distance between any two contours, in horizontal; we know about contour interval, if the separation of two contours in vertical. Now, the separation of two contours in horizontal, we say Horizontal Equivalent; obviously, it will change some place to place depending on the slope of the ground. So, what we can do? If we know the horizontal equivalent, if I know the contour interval, I can find this slope. So, that slope at this point will be the contour interval divided by horizontal equivalent, the horizontal distance between two contours, is the slope here. So, we will need this information also, sometimes for our computations. Well now, we have seen the various things about the contours.

The next questions is - how can we plot the contour on the ground? Well, conceptually we thought, that there is a hill, we are intersecting that with the horizontal surfaces or the equipotential surfaces, and wherever the intersection or the point of intersections are, these are the contours, we join them and this is the contour. But can we really do so in the field? That is not possible. Then, what is the method? How should we realize it? How should we locate those points, which are on the ground, but have all same elevations from a datum? So, when we are making the contours, our effort is to locate those points. So, in making the contours there are two things.

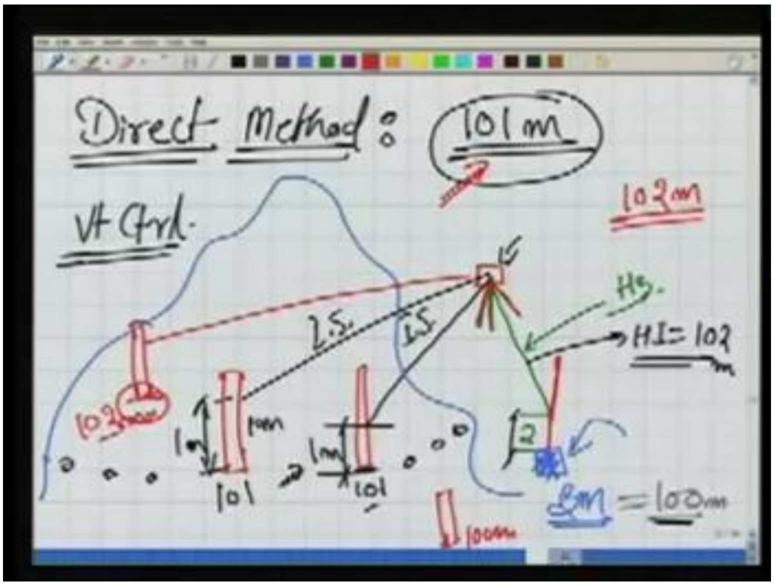
(Refer Slide Time: 36:15)



Number one - we say Vertical Control; the meaning is, Vertical Control, means we are trying to locate those points, which have all the same elevation. Now, if I found, in this hill, all these points have same elevation. I have found it by some method let us say. Still my contouring is not complete, because right now, I know there in the ground, that these points have same elevation. What I need to do? Because ultimately a contour is, we want to plot it on a map. We want to show these points here on the map, and join them by a line.

So, the next thing that I will have to do, I will have to go for horizontal control. So, in any contouring job we will have these two basic things to be done. We locate the point's vertical control, yes these are the points at the same elevation; then we plot these points on a sheet, and join them. So, this the horizontal control.

(Refer Slide Time: 37:39)



Now, how we actually do it? The very first method, which we say is, we say this method as the Direct Method. Now, how can we work in this Direct Method? Let us assume there is a hill. Now, you can visualize any hill, or any little mould, any little, you know, hillock in your area; just visualize that when we are talking about this. And on that hillock, we are trying to locate points with equal elevation - same elevation. Let us say we have also a benchmark here.

Naturally, when we are making the contours, what we would like to do? We would like to relate these contours to our reference, which is the mean sea level. So, what we did initially, starting from some known benchmark - survey of India benchmark - we did the fly levelling, and we established the RL of this point. So, we know the RL of this point. So, meaning is, this my benchmark.

Next I take my level instrument. This is the Dumpy Level, and I keep a staff here, on the benchmark, and I take a back sight. So, a back sight is taken on the staff. Let us say the bench mark as 100 meter as RL. Now, if it is 100 meter and our purpose is - we want to plot a contour of 101 meter. So, benchmark is 100 meter, we want to locate the points on that hill - on that hillock - which are 1 meter above our benchmark or those all those points on that hill which have an RL of 101 meter. So, how we locate it? This is what we are going to see now.

Well I have taken a back sight here. In order to have more clarity, I remove this from here and our level, let us say, is rather kept here. This the level and the benchmark. As I take a back sight on these staff, which is kept at the benchmark, and the back sight is, let us say 2 meter. So, the back sight is 2 meter. Right now, please ensure that this line is a horizontal line, because over here, let me do it also by red; this red and green - this tripod here - that means, it is a level. In the case of a Dumpy Level we know it. Once we have made it, wherever we rotate , it will always make a horizontal line of sight; we know that.

So, I am taking a back sight on a staff which is kept at the benchmark. The reading is 2 meter. Next, I take this is staff and start moving here - on the hill. So, with this staff, I keep moving, while someone is bisecting me. If I am standing on a point, which has an RL of 101 meter, what should be the reading on the staff? That is the question. Well right now, if you look here the reading is 2 meter, while the benchmark is 100 meter. So, what should be the height of instrument? Height of instrument will be 102 meter.

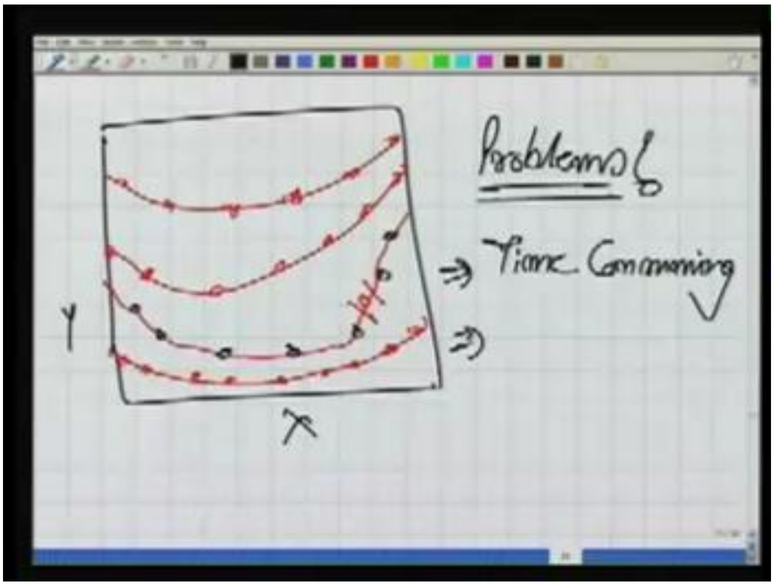
We are looking for those points, which have an RL of 101 meter. To occupy that point, what should be the reading? And now I am taking the foresight or may be the intermediate sights. So, for this intermediate, still because the height of the instrument is 102 meter, in order this point is a 101 meter this reading should be 1 meter, is it not?

So, what we are doing? I am moving with the staff now on the hill, and I keep moving - so, it is a kind of trial and error - till I am bisected - the staff is bisected - at 1 meter graduation or the observation right now for this level is 1 meter. If it is so, this particular point will be 101 meter. Next, once we know, one point has been identified. Well I am standing on the contour now - on the contour of 101 meter.

So, where the next point should be? So, it is now very easy to determine, because the contours are connected; they are not disconnected. So, I know that next point has to be somewhere nearby. So, after locating the first point; the location of the second point becomes easier. I can just move - also by some idea of the terrain - to the second point. So that again, the intermediate sight here is 1. This is also 1 meter; if it is 1 meter, again this point will be 101 meter. So, what we have done by this? We can establish, similarly, several points, and all these points will have the same RL of 101 meter. So, what we have done? We have completed our Vertical Control.

How about the Horizontal Control? We have still not plotted these points on sheet. So, what we would like to do? Using any method of planimetrics survey - you know by triangulation, by traversing, by chain survey, by compass survey - by any method, we can also locate the horizontal position of these points.

(Refer Slide Time: 44:18)



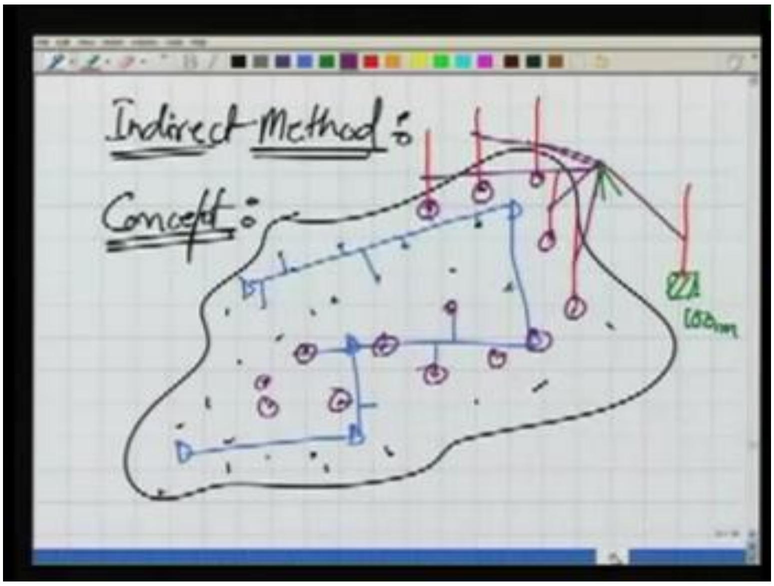
So, what we will have? At the end of this we will have these points which are plotted as there X and Y; X and Y on a sheet, and we know all of them have the same RL ,which is 101 meter. So, my contour may look like this, and I will write it here 101. So, this is my contour of 101 meter.

Similarly, on this surface, if I am looking for now a contour of 102 meter. If I am looking for 102 meter, you can easily identify where should I keep my staff, and what should be the reading here in the staff. What should the reading be, so that the point here is 102 meter? Or for example, 103 meter; 100 meter - still there is no contour of 100 meter; you keep this staff now, in these locations where it is 100 meter. So, we are generating all these points, plotting them by horizontal methods also; the Horizontal Method of Control and this is how our contours will be generated. So, this is direct method of contouring.

Well are there any problems? Because, right now, we are doing it here on the, you know, our screen, and doing it on a screen with a pen is very easy; but actually doing this thing in the field is difficult; this trial and error.

You know, I want to bisect 1 meter, the cross-wire of my level should bisect 1 meter. So, there is lot of trial and error involved. You cannot move your instrument; instrument is fixed, at the height of the instrument is making their horizontal plane. The only thing that you have to move is of course, your staff and the staff should also touch the ground. We know there is a point, above where it is, for which exactly 1 meter is being bisected. So, this is lot of trial and error which is involved there. So, this method is really time consuming; it is very, very time consuming. Though yes this method could be accurate; accurate because you are standing on the contour; you are trying to locate that point where the ground has exactly that elevation. So, having seen this method, now we will go for another method.

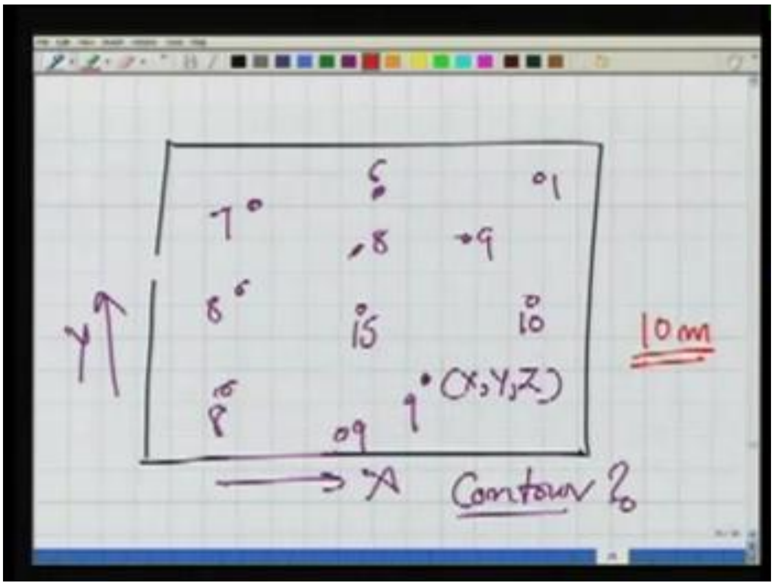
(Refer Slide Time: 47:04)



Now this method is we say Indirect Method. Well what is the basic concept of this Indirect Method? We would like to see that concept. Well keep in mind, that we are making use of these methods in order to plot contours there in the field. Now, we have seen the problems with the Direct Method. We need to occupy the actual contour there, which is not possible many times.

So, in this case, in Indirect Method, what we do? Let us say, for some area, you want to do the contouring, now somehow - somehow means, we measure several points there - these are various points which are in this area randomly distributed; just randomly distributed points. Can I plot these points in planimetric? Yes. How can we do that? We can have, for example, let us say if I want to do it by a traverse. I can have a traverse like this. So, using this traverse and as well as the offsets, I can plot all of these points in horizontal.

(Refer Slide Time: 48:41)

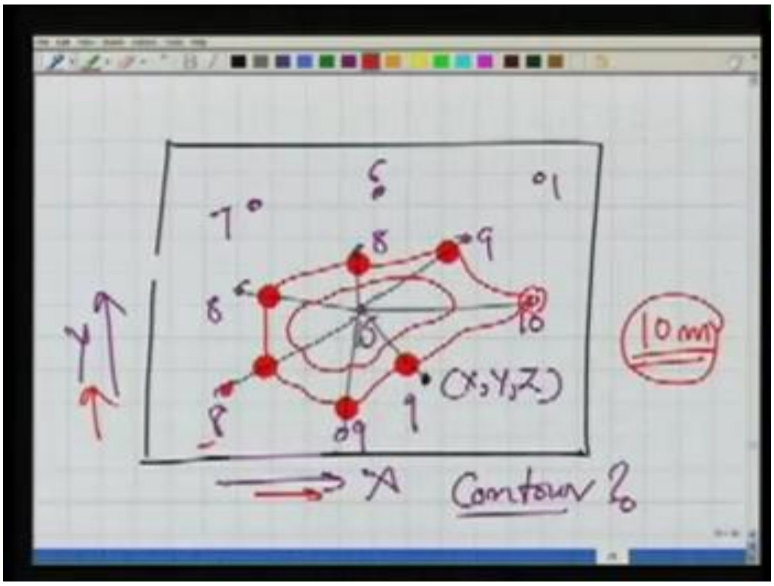


So, what will I have? I will have for this area a map, and on this map all these points are plotted. Right now, the points are only in X and Y; means the planimetry.

Next, somehow, for example, let us say by establishing a benchmark here, it is 100 meter for example, also by keeping a level, by taking a back sight on the benchmark - on the staff which is kept on the benchmark - then what I can do? I can move my staff to all these points - wherever these points are - .and I can start taking now intermediate sights All the intermediate sights are being taken. So, using that, what we can do? We can determine the RLs of these points also. So, by doing that we will know RLs of all the points here.

So, here in this map, we had already plotted X and Y in planimetry, where the same time now, we also know, for any point we know this X, Y, and Z. Now, with this information, is it possible that I can locate my contour? Well, let us say, just into ease in understanding it, I am trying to reduce the data density here; just to make a better figure. Well let us say we have the points, which we have plotted like this. I am writing the RS Ls of these points - it is 15 meter, 8 meter, 7 meter, 6, 8, 9, 1, let us say 10, here it is 9, and 9, and 8. Let us say you are interested in plotting a contour of 10 meter. What we have done so far? Please understand this. So far, we went to the field, and there in the field, we located some points - you know arbitrary, random points - we will see in a moment how we locate these points; but so far, we can consider them or right now, we can consider them to be randomly distributed. For each point we measured its X and Y or the planimetric position, as well as we also observed its RL. So, with this data, the data is with me.

(Refer Slide Time: 51:45)



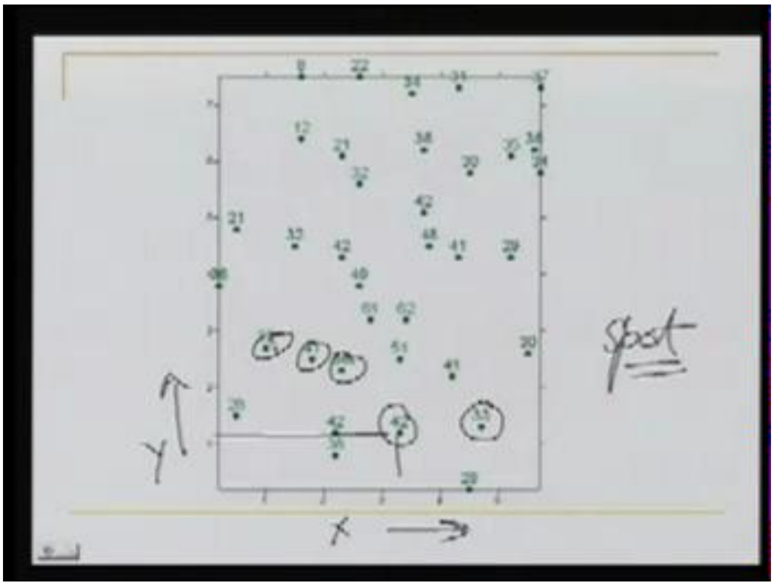
The moment I write it X and Y, and fix a point here, I am fixing it because I know its X and Y. This 8 indicates the RL of the point. We are interested in a contour of 10 meter. Now where this contour should be?

Well, generally, the ground will have a particular kind of slope, you know. Can we establish that slope? Can we establish that topography of the ground using the data, which we have captured. If you look at that, what I can do, a very simple procedure. I can simply join, let us say these points, all of them. I join these points - it is a very simple way. Now this point is 15 and I join all of them. Now where the 10 meter contour should be? 10 meter contour should be - because this is already a 10 meter point - it should pass through this point. Where this 10 meter contour should be? Over here, because this is 9 meter; this is 15 meter. So, 10 meter contour should be somewhere here. 8 meter, 15 meter, 10 meter contour should be somewhere here. Again, 8 meter, 15 meter, 10 meter should be somewhere here.

If we are considering the slope between this point and this point is uniform; again, you know, the point could be here; the 10 meter point could be here; the 10 meter point could be here. So, what we can do now, once we have located all of these, I can simply join them by free hand curve. So, we are able to generate a contour of 10 meter. If we are interested to generate a contour of, let us say, 12 meter - the same thing can be done. I can locate the points, which are 12 meter, everywhere. So, this will be a contour of 12 meter.

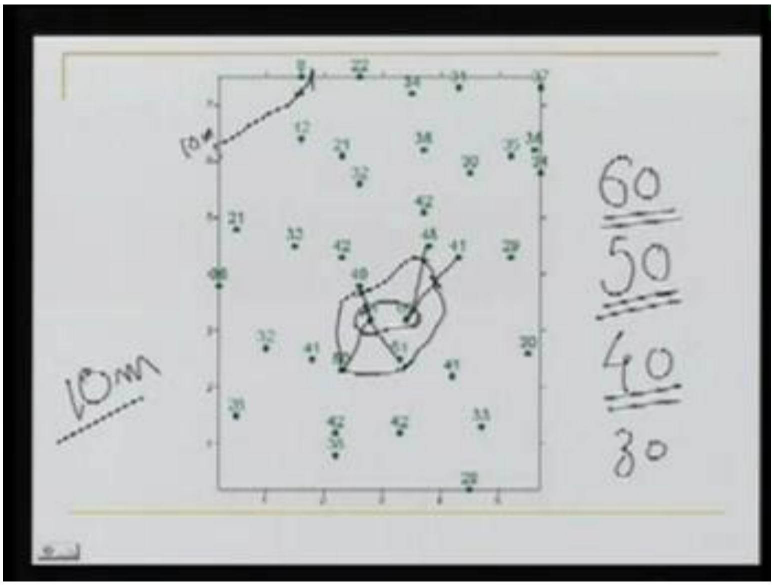
So, what we are doing? Using our randomly collected data there in the field, you know, there was some randomly distributed points; we determined their X Y Z, and now on my map sheet I am drawing the contours by interpolation. This is what we are doing. What we will do now? We will see one example of this. Now, in this example, as you can see in the slide we have collected again some points.

(Refer Slide Time: 54:12)



All these points which are shown here, we know their location in X and Y. So, this is X and this is Y. It is a map - a map of spot elevations. There the spot elevations for each point I know its RL.

(Refer Slide Time: 54:39)



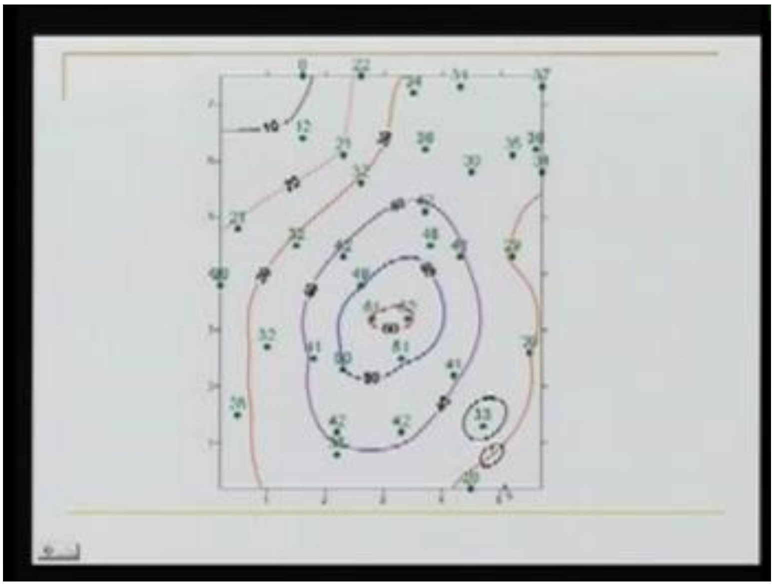
Now, for all these points, we want to generate a contour. Let us say our aim is to generate a contour of 60 meter. Where this contour should be? If you look at this data, we have two points 61 and 62. Then, everywhere, outside we have the points, which are lower in elevation.

So, what it appears? It appears like we have a hill, where we have 61, 62 – two points. Then over here, we have the points of 49, 50. So, this is a place like this. A hill - a hill top. Well, what we can do? I can interpolate between these points in order to determine where my 60 meters should be. So, the 60 meter should be here, here, here, here. So, I can make a contour of 60 meter here like this. So, that is the contour of 60 meter.

Next, if we are interested in a contour of 50 meter. Well where it could be? If this point is 61 this is 49, 50 will be here. Again this is 48, this is 62, 50 will be here, then in between these two, because this is 41, 62. Over here, the point is 51 this is 41. So, our contour should pass here. Then this point is 50 itself. So, contour should look like and finally, it joins here. So, that will become the contour of 50. Similarly, we can go for 40; we can go for 30; and so on.

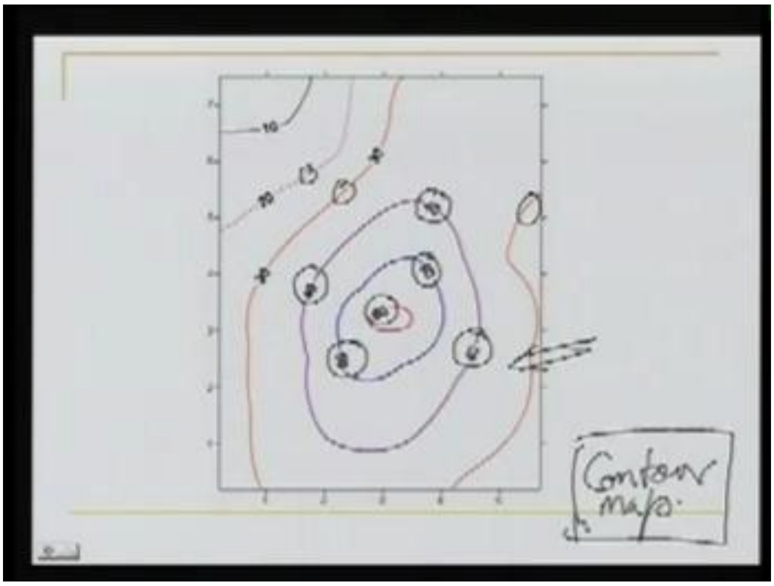
Now over here the contour of 10 meter. If we see the contour of 10 meter between 8 and 22, if we concentrate to be the uniform slope, the 10 meter contour should be here, 8 and 12, the 10 meter contour should be here. So, we will have a 10 meter contour which will go like this. So, 10 meter.

(Refer Slide Time: 56:52)



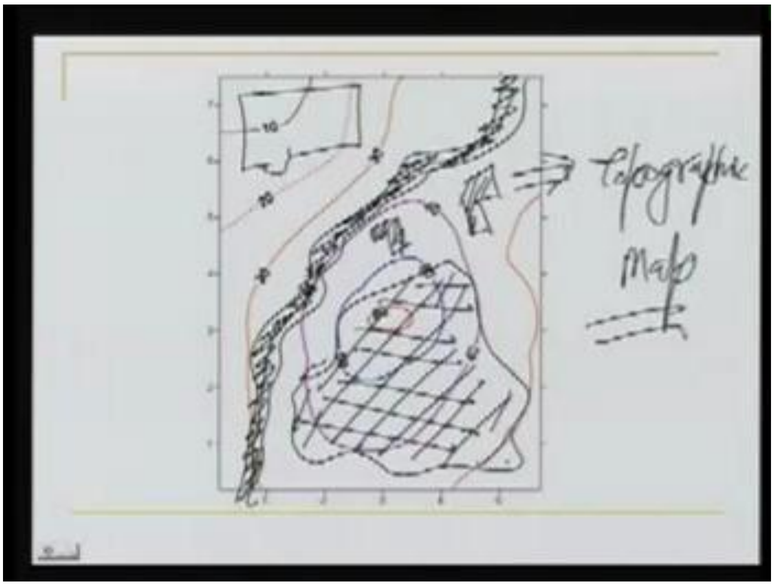
So, what we can do? We can plot all the contours for this area like this. Right now, in this case, the spot elevations and the contours are plotted together.

(Refer Slide Time: 57:03)



However, in actual practice, the contour map will look like this. Now some more things, which needs to be understood here. I have used the colours only to differentiate different contours; otherwise, all the contours are generally given in one colour, which is nearly this colour. You should see the actual of actual Survey of India map, that what is the colour, which is given for the contour. In addition to that, in each contour, the value of the contour is also written. So, the contour is broken, only to write the value of the contour - as you can see here. So, this is our contour map. What we can do? We can superimpose this contour map on the planimetric map.

(Refer Slide Time: 57:59)



What is the meaning of that? The meaning is, if this the contour map, our planimetric could also be there. You know there was a building, there was a road, then there was a garden. So, you can think of this garden; this garden is a sloping garden; it starts at the top of the hill and goes down up to here.

Similarly, this road it follows nearly the same elevation. It starts somewhere from, you know, in between 30 and 40, and it sticks to 40 meter contour, and then again, in between 30 and 40, and finally, answered 30 meter contour. So, this is the road. So, our planimetry details can be also plotted there. So, all the planimetric details plus the contour, they put together, we say generally as Topographic Map.

So, we saw today that what is the contour is. You know how we can conceptualize it. Then we discussed the uses of the contour; some definitions - Contour Interval, Horizontal Equivalent. We also saw the method - how we can make really the contours in the field, how we can plot them. So, the method, which we have seen so far is the Direct Method. We also saw the concept of Indirect Method. In our next lecture, this Indirect Method will be continued.