Surveying
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Module - 7
Lecture - 5
Levelling and Contouring

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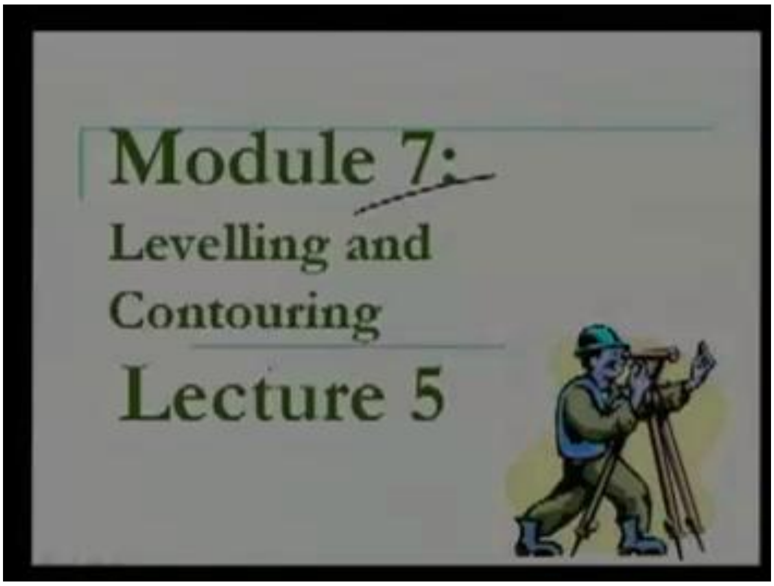

Welcome to this video lecture series on basic surveying. This is module 7 where we are talking about levelling and contouring. And today, we are in the last lecture of this module lecture number 5. What we have done so far? We have discussed about the levelling.

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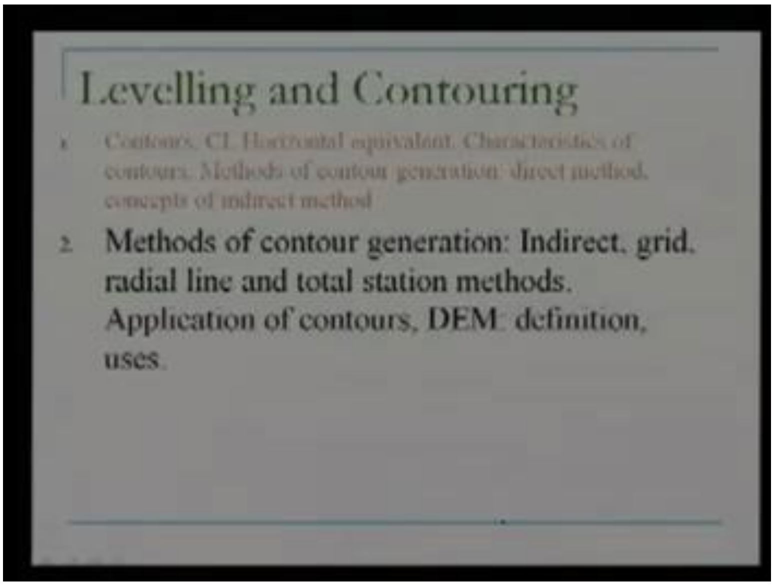

And more importantly in our last video lecture, we talked about contours some definitions. For example, contour interval, horizontal equivalent then we looked into the characteristics of the contours. The meaning is whenever we are reading the contour map how to interpret it? The different landscape features, how to make them out from the contours? Then we looked into the method of contour generation. Conceptually we are saying that the ground or the topographies intersected by horizontal plane or an equipotential surface. And wherever the line of intersection is there or the points of intersection we joined them that is a contour, but how actually it is to be done in the field? We saw in our last lecture a method, which is a direct method. In addition to that we also saw the indirect method. In the case of the direct method, we are standing on the ground on a point where a particular contour passes through.

So, basically that was an trial and error method we try to stand on the contour we try to follow the contour and we keep recording it. The direct method we also saw the disadvantages of that it is very difficult time consuming based on trial and error. So, can we do something different? So, the next method or the next category of the methods is indirect method. So, what we will do? We have already seen the concept of indirect method where we measure several points the X Y Z of several points in the terrain. And then by interpolation we locate where the contours are what we will do today will see in some specific methods in that line. The very first indirect method that we are going to talk about is grid method. In the case of the grid method, what we do there in the ground? We try to establish a grid well. It depends upon how accurate we want our contours to be and the size of the grid will depend upon that the grid means.

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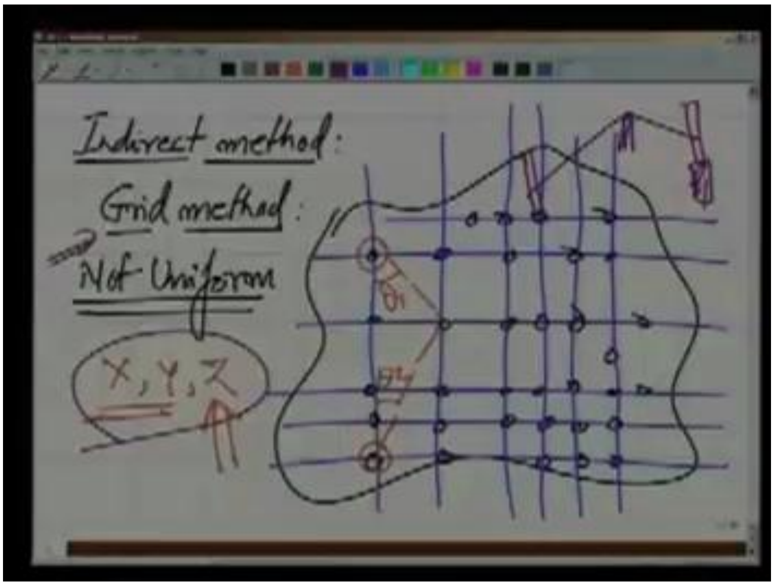

There on the ground, we establish a grid like this and we measure the RLs of all these points. Now, grid means all these points are along certain directions. So, that it is easy to establish them urgently or the planimetric control is easy. However, the same time you may be observing that the grid spacing is not uniform it can be uniform or it cannot be uniform also. Well, the method is whatever the method we choose of planimetric survey. First of all we have to establish that grid may be by simple chains or by some sophistication you know using the theodolites. What we can do? We can use 2 theodolites one kept here, one kept here and in our grid design which we have already designed I can have the angle of intersections for all the points. For example, here this theta and this theta, so using theta 1 and theta 2 for all the points I can locate those points there in the ground.

So, while 2 theodolites are working someone is moving with the ranging rod till his bisected by both of them there is a point. So, we locate at that point is a RL. So, what we are observing here? We are basically observing X Y Z X Y is really not required here if the grid is uniform. Even if the grid is non-uniform if we know about the idea of the grid measuring X Y is not required, because we know it already. However, we keep measuring Z using the same principle what we have done starting from the benchmark keeping a staff there. And keeping the level it may be the dumpy level it is levelled. So, wherever we are rotating it, it will make a horizontal line of sight. So, we keep putting our staff in all these points and measure the RL's what we are achieving? By doing this we are achieving the X Y Z of all these points.

Now, the grid could be uniform if our ground is you know the undulations in the ground are nearly uniform the slope is uniform. It is not differential undulation you know some parts of the ground is flat while the others are highly undulating. If the ground is like that some parts of the ground are uniformly sloping while the others are highly undulating you know. So, in those cases we would like to go for non-uniform grid because the idea of contouring is to represent the ground as good as possible. If you choose the uniform grid then either we are working more if our grid size is very small or we are putting less accuracy in the work if our grid size is large. So, instead of that we can go for non-uniform grid a grid which at depths to the terrain. So, this is the very first approach the grid method. Now, the second one we can say is radial line.

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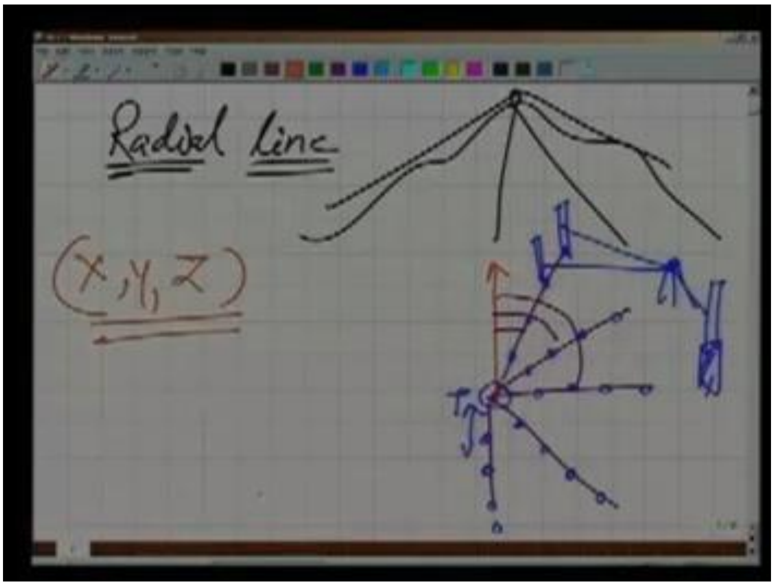

Radial line method is again it depends upon the terrain where you are working which method should you use. It will depend upon you know what kind of terrain you are working in. If the terrain is something like you know a hillock you want to stand at the top of the hillock. So, from there you can take the observations in all the directions. So, what we would like to do? Let us say we are drawing this in plan this is the direction of north or our azimuth. I can set my turbo light at this point, which at the top of the hill T and here on I can take different lines of sights they are the radial lines. So, what I am just doing? I am just putting these at different angles from my azimuth. And then we move along these by equal horizontal distance that could be possible by using the tape or chain. This distance could be equal could be unequal also the only thing is we need to measure these distances.

If the distance is equal we are ensuring equal distance we need not to measure it our horizontal control is fixed. Because we are looking in certain angle we know what that angle is we are moving equal horizontal distances. So, by doing that our horizontal control is fixed. So, we need not to plot those points horizontally. We need not to measure them the only measurement that we need to carry out is the elevations. So, the elevations can again be done by using the level which is starts from the benchmark where we are taking a backside and then several intermediate sides. Again in this method we are basically observing the Z, but X Y are also being observed indirectly. So, using this also what we can do? We have or rather we end up with several points.

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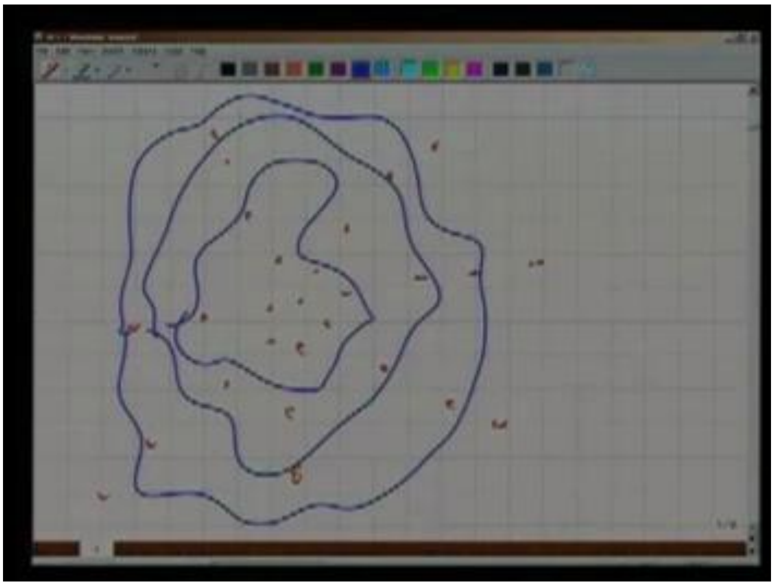

And all these points are in radial directions for all these points we know their spot elevation. So, the next job will be using these points drawing the contours. So, it is a method of using any method of interpolation as we have seen before also we can draw the contours here. So, this is our radial line method again when do we need it? You we will need it if our terrain is like a hill where we can stand on the top.

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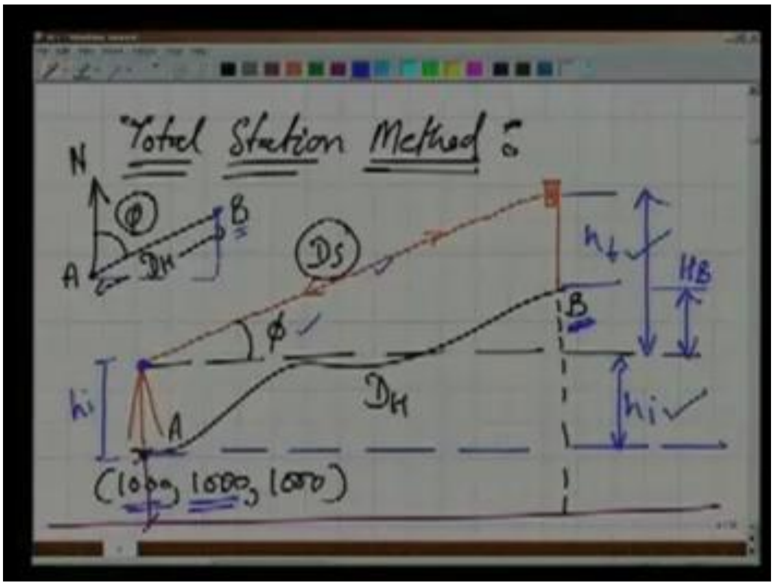

Now, the third method and I would like to call this as total station method whatever we have discussed. So, far we are using the same principle here also in total station, but as per the abilities of the total station we are calling this method as total station. What we do in this method before doing that? We would like to see a little bit of principle of working of the total station particularly in the case of contouring. Well there may be a terrain like this and our total station. Let us say it is kept here while our target is kept over here we know the height of instrument h i we also know the height of target. Let us assume that for this point is an initial point we assume its coordinates to be any value 1000 1000 and 1000 any value. These coordinates could be also drawn from some adjusting reference system. Let us assume right now these to be 1000 1000 and 1000 well the datum the datum in this case is let us stay here.

So, this height is 1000 now, how the total system work? The total system works by sending an electromagnetic wave, which comes back and we are able to measure the distance between these 2 points. This is distance sloping at the same time the total station also measures from the horizontal direction. The angle which I am writing as phi the vertical angle from the horizontal direction the vertical angle it will also measure that in addition to this the total station will also measure. Let us say if this point is A here it is B at A this point A if I draw a distant plan this is the direction of north. North means we are saying azimuth any fixed direction which we have taken as our y axis and the point B is here. So, that the total station also observes in it is horizontal circle the angle theta now using this theta. Because we already know the horizontal distance by knowing DS we know the horizontal distance the edge, because we know the angle in vertical. So, by knowing this DH I can compute the coordinates; coordinates means the latitude and departure of my point B.

So, with respect to this point I know the coordinates of B. So, the X and Y are fixed well in addition to this, because we know this angle we know this distance. We can also determine this particular elevation difference. If we know this we also know the height of this instrument we know this is h i the height of the instrument. So, knowing the height of this instrument knowing the height of the target we can now determine the height of point B from instrument. So, using this we can determine the RL HB for point B. So, for point B now we are able to measure the X Y as well as the Z by taking the basic measurement. This was the sloping distance the angle in horizontal angle in vertical this how the total station works. So, what we do? We make use of this same principle for contouring.

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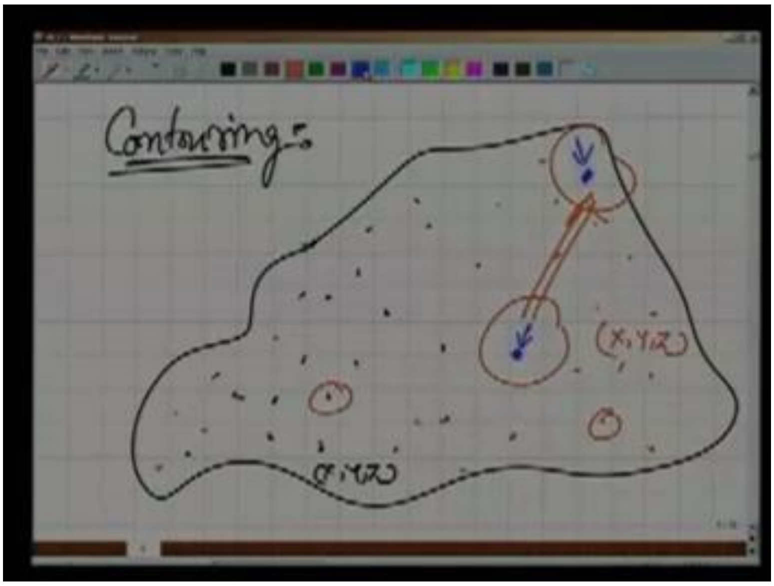

And the method is indirect method. Well, the idea is in our terrain we occupy somewhere for example, let us say my total station is kept 0 1. And this is the point for which I know the coordinates then for all these points I determine their coordinates for all these points. I can shift if it is required the total station to a different point and also now observe for these other points while I shift the total station it is possible to relate these 2 points. So, that the points here in black and blue both are in the same reference system. So, basically we have now the coordinates of all these points wherever we select it all the points. Next our job will be, because we know the X Y Z our job will be to interpolate it generally the job of interpolation.

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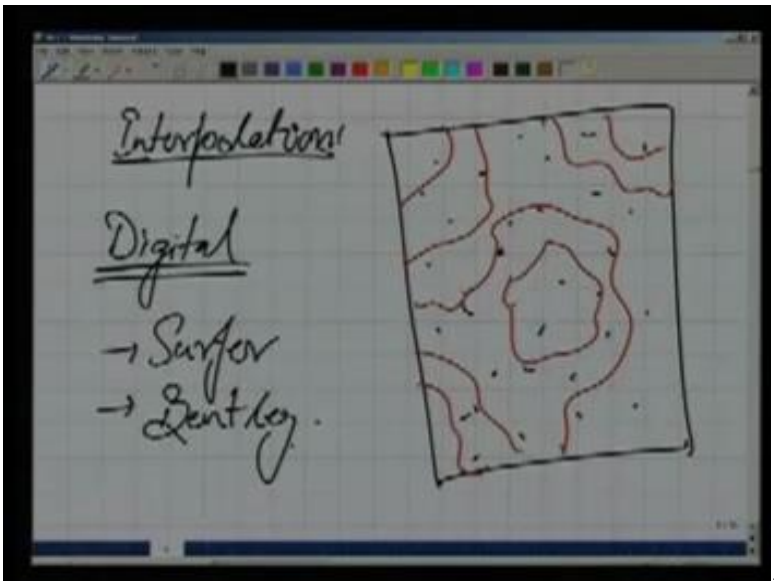

Can be done as we have seen I can plot these points on a sheet I know the X and Y. So, I can plot them on a sheet as well as I know the RL of RL of each of these points. So, using the RL of these points and their location manually we can draw the contours. If the data volume is very high drawing the contours manually becomes very difficult. So, in that case the method is digital means we are making use of the computer. And we have some algorithms whatever we are doing manually in order to interpolate the contours. These algorithms does the same thing in the computer there are many software's for that purpose like surfer is a very common one. Then in Bentley we had the software's in any remote sensing software GIS software, surveying software.

And any software you name you will find there is a routine for contouring which takes the X Y Z coordinates and using this X Y Z coordinates it can give you the contour map. Now, have we seen how we plot the contours will like to see now some applications of the contours where we can use them? Of course, when you are studying the other subjects for example, the water resources engineering or may be others. You will again see the applications of the contours in that area, but we would like to see a little bit about that here now the very first application of the contour is a contour gradient.

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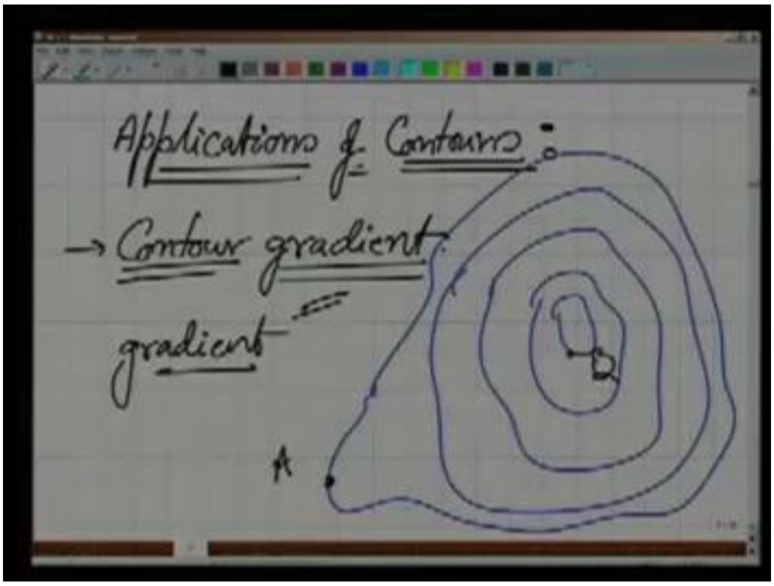

Now, what is the meaning of contour gradient? The meaning is for example, let us say if we have a hill and the job is you has in charge you have to plan a road from point A to point B. And you have to plan this road in such a way that the gradient of the road and is the slope of the road is uniform or is not more than the certain value that is the design consideration. Now, how to get that road, how to plan that road? So, that this road always follow the same gradient number 1 or does not follow a gradient on more than the required one, how to ensure that by making use of the contour map? Now, that kind of line which follows the same gradient everywhere in climbing up the hill we say as contour gradient. Now, we will see this by an example, in this example if you look here.

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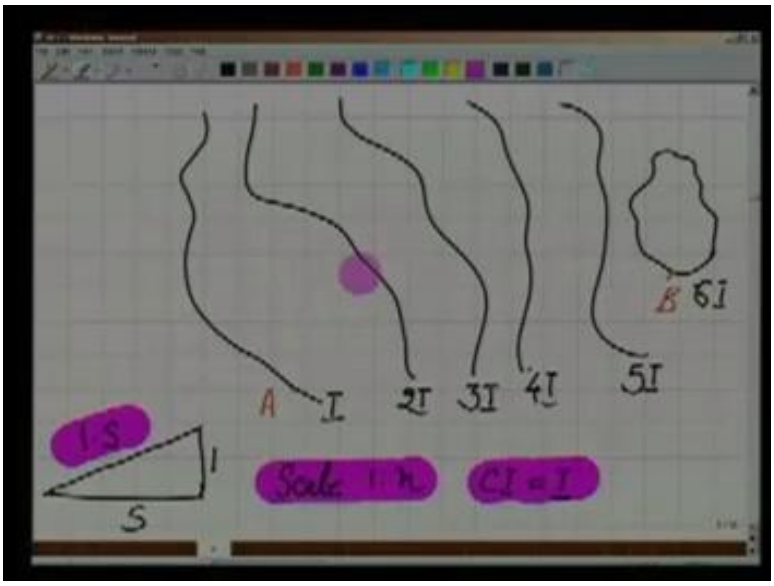

We have contours and I have given them the value of I, 2 I, 3 I, 4 I and 5 and 6 I. Because we are assuming that the contour interval in this case is I. Well, we want that a contour gradient of 1 is to S, S means the horizontal distance and one is the vertical one. So, this is the slope, so we want to maintain this slope of 1 is to S everywhere on this contour map whether it is pipeline railways or road we need that kind of contour gradient. Now, how to do that? Let us say this scale of the map contour map is 1 is to S well we want to start from A and we want to reach B by following a contour gradient. So, idea is very simple here you know what we want to do? We want to jump from one contour to other contour and the jump from one contour to the other contour is always equal to I in vertical. So, how much horizontal distance should we would travel? So, this horizontal distance we will try to find using the slope well let us look at that.

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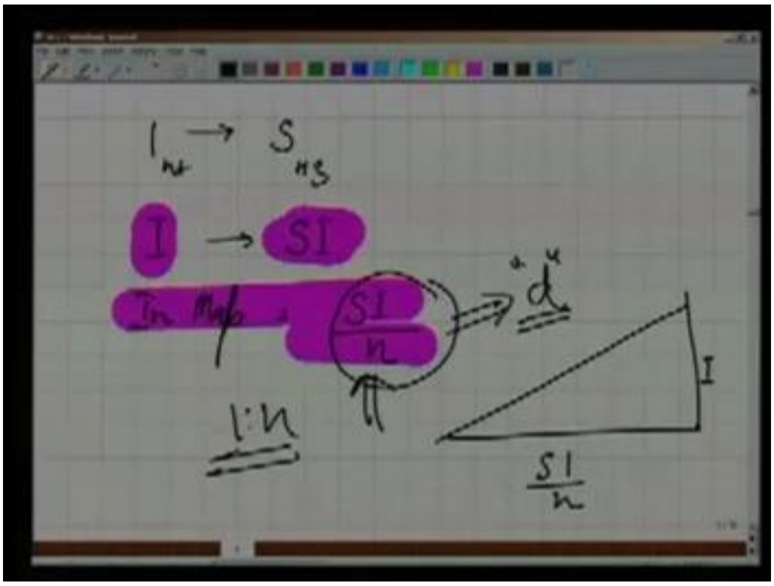

Corresponding to I difference in height if the slope is 1 is to S that is the horizontal distance S into I. So, there in actual ground, we need to move by a horizontal distance of S into I, in order to go up by I and if it is, so we are following that contour gradient. So, in the map what it will be if the map scale is 1 is to n. So, this is the distance which is equivalent distance there on the map. So, what we should do using this distance, if I say this distance to be as d? So, I know now in my map.

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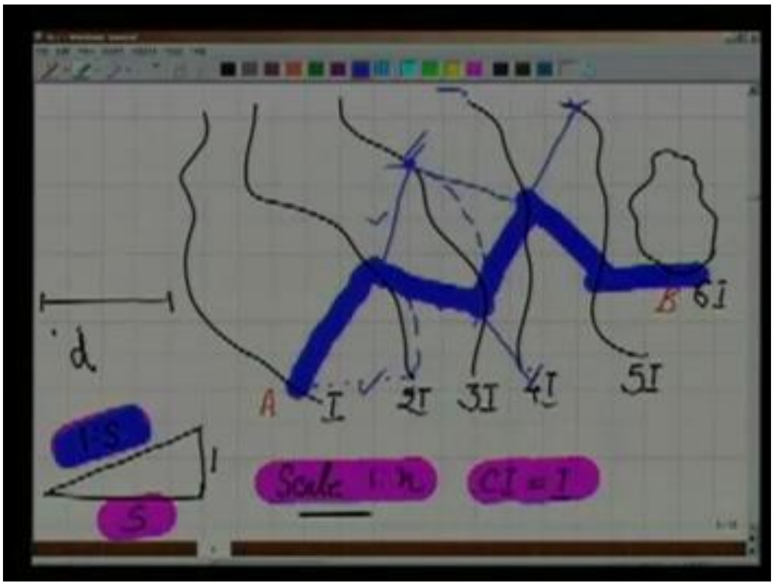

Is starting from a contour over here I should move a distance equal to d in order to reach the second contour. If I move horizontally by d and reach I reached the second contour then I am maintaining a slope of 1 is to S. Now, how to do that? The moment we know about this d I can take let us say the d length is this much at this scale that is the d. So, what we can do starting from here I will draw the arcs. Let us say it cuts here and may be somewhere here let us say that is the arc and it cuts like that. So, both of these this way as well as this way both ways our slope will be same. Well, from the second point again I can draw the arcs and the arc will we may cut 2 points or more.

So, both of these this as well as this have the same slope which is 1 is to S. Then from this point on again I can cut a point here or cut a point here. Similarly, I have a choice could decide a route from here also, because I can cut same distance from here also. Then let us say I choose this point and from here again I cut a distance and I cut a distance over here and then from here I cut this here. So, I reach B, so what is the meaning of this? The meaning is if we have chosen this for example, we went to this point then to this point then to this point. And then to this point all along this route everywhere the slope is 1 is to S which is the desired thing.

So, working on a physical map you know a map is there in front of us and using this arcs we can plan a route for which the slope is uniform everywhere. So, this is the control gradient the next application is about drawing the profiles from the contour map why do we need the profiles we have already discussed. Let us say starting from this point here we want to go here and we want to see how the ground is you know the elevation of the ground is changing between these 2 points. We have seen some examples of use of this in the road construction and in many other places.

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So many times we desire to draw the profile along a particular line the procedure is very simple.

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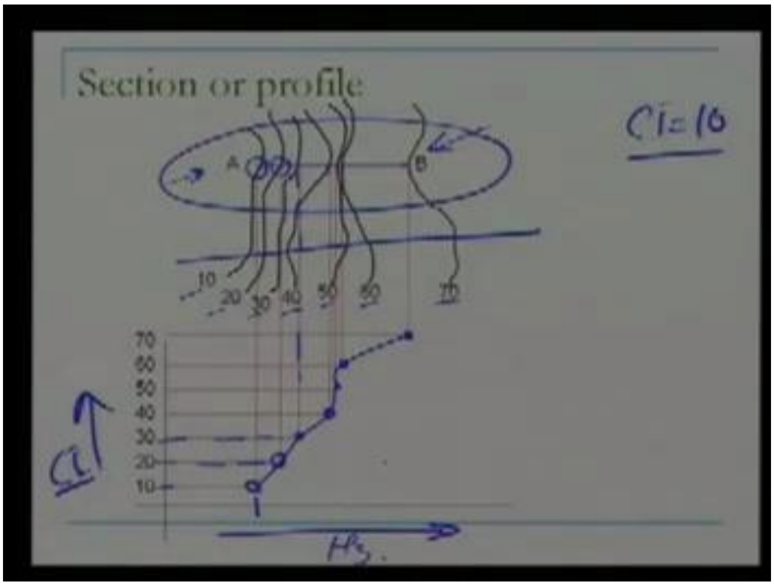

Well, let us say we have a contour map here and these are the contour values with the contour interval of 10 between point A and B. We want to draw a profile known to see how the ground looks like between these 2 points. So, how to do that profile? Well, we draw an access system here this is the distance in horizontal and this is the contour value not for point A. If you look point A what we can do where this point is? This point A horizontally; this point is here while the elevation of this point is 10. So, this point is located here then the second point which is being cut in contour of 20 over here. Where this point is horizontally this point along this line is here as well as in vertically 20.

So, the intersection of these 2 gets the point similarly for the third point where this line intersects over here is the point then for the fourth, fifth and sixth and all these. So, what we are doing? We are able to locate all these points and we will join them by the profile. So, by following this methodology, we can draw profiles using a contour map and this can be drawn along any line by using this. Next we are talking about the water set delineation or the catchment area, what is the meaning of that? The meaning is if you know you your, are on a hill terrain and the rainfall is there this rainfall for a hill. You know the rainfall on this side will flow here and it will flow here.

Then it will flow here no if you are measuring the discharge at a cross section in a river. We want to know that where from this water has come for a hill. We know there is a hill the water will flow like this we know also for a contour map. In a contour the water will flow perpendicular to the contour. So, by making use of this and using a contour map we can delineate the catchment area the meaning is at that cross section of the river where all the water has come from. So, if we can locate that, so that is for this cross section is the catchment area. How to do that? Let us have a contour map first the contour map in this case is.

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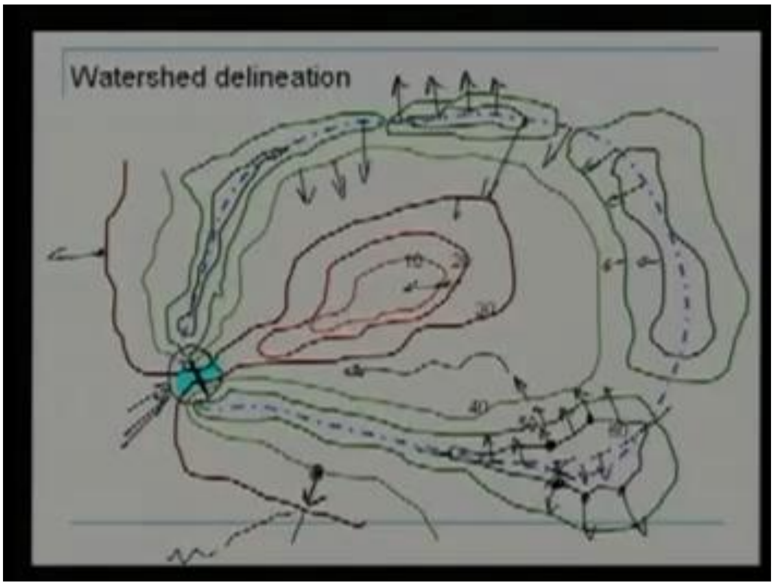

If a first contour of 10 meter 20, 30, 40 now, you can see how the ground is like just start feeling the ground you know there is a little cup kind of ground here. Then it is opening over here the ground opens here 40 and this is the 50 all these are the 50 contour 50 meter. Finally we have the 60 meter contour let us say this is the contour map. Now, in this contour map we know how the water will flow? The water which is falling here will it flow or rather it will flow definitely this way? So, this water is not going to contribute water to if you are talking of this cross section let us say the cross section is here. So, this particular water is not coming out of this cross section rather it is flowing out here. Similarly, the water here is going like this is not contributing to this cross section.

But all the water which is falling here anywhere you know this 10 meter 20 meter or 30 meter all these is finally, flowing out of this cross section. Similarly, if we take a point here in 60 meter contour over here now the water from this 60 meter will flow down then again down. And then again down and finally, again this water will contribute at this cross section. So, same is the case with all the contours; however, at the same time the water on this side here it will not climb up. Because the slope is more here rather it is going up upward slope rather the water will flow this way. So, this will not happen and similarly here also the water will flow out. So, water is flowing out from all these while from these points water is contributing to this cross section here. If we use the same methodology we can you know for this point for example, here the water everywhere along this line on this side, the water will flow out while here the water will flow in.

So, this kind of line we say is the ridge line the ridge means the ridge is there and it is assuring that the water on this side is flowing inside and the water here is flowing out, out of the catchment. So, using this what we can do? We can draw the full catchment. For example, the red line here if it satisfies that where with the out of this red line on this side the water will not contribute to this cross section while the water here everywhere will contribute to the cross section. So, this red line here it indicates the catchment area or the water set for this particular cross section. Now, next using the similar example what would we like to do? We like to find the reservoir volume. The idea is we are going to build the dam somewhere and even if the dam is not built.

We want to know we want to estimate how much of the area will be inundated how can we do that? We can do it if we have the topography with us topography means the contour map. So, if you have the contour map of some area with you and you are deciding that at this point we want to build a dam of certain height. You want to know in advance what all area will be inundated at the same time. If you know that this much area will be inundated what is the volume of the water which will be stored in that reservoir. So, all these computations can be done using the contour map. Now, let us see here by this example.

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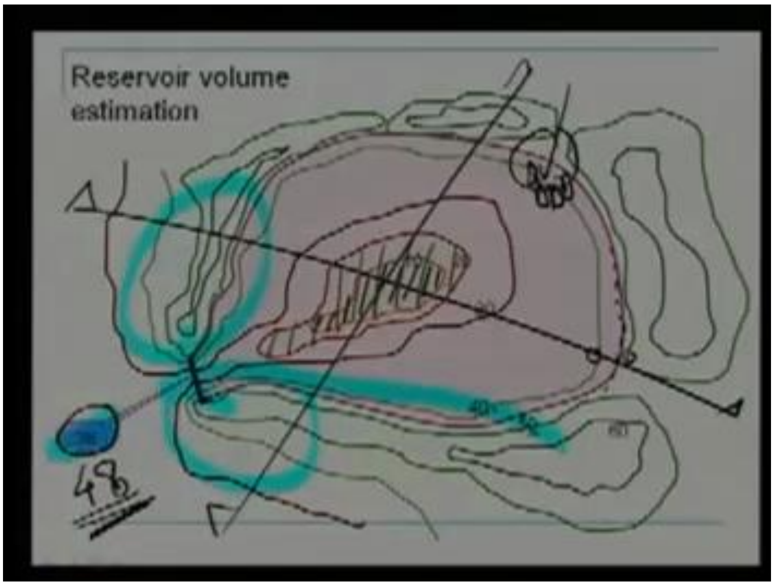

Again our area is similar to the previous case here we had the contour of 10 meter 20 meter 30 meter then 40 meter and 50. And finally, 60 meter now try to visualise this area the way we did the contours here try to visualise. What this area is like this area is somewhat like a little you know valley while it is opening here. Opening means over here if I highlight that over here the valley opens out further over here the slope is very steep similarly on this side also the slope is very steep. So, for the hill here and for the hill here the slope is very steep in this location. Well, a decision is taken to build a dam let us say the dam is being built at 38 meter. The top of the dam is 38 meter and this, the location of the wall.

Now, if that dam is being built by making use of this contour map it can be easily estimated that what all areas will be inundated. You know what we need to do? We need to draw a contour of 38 meter how to draw that contour of 38 meter. Well, we can make use of the adjusting contour. Here is the contour of 40 meter and this is the contour of 50 meter. Let us say this is not 38 rather it is 48 as per the drawing will do it for 48 meter now, this is 40 and this is 50 meter. So, 48 meter contour should be somewhere here now if we keep drawing this contour everywhere it will form a closed figure which will end at the edges of the dam. So, from the top of the dam we follow that contour of 48 meter everywhere. So, if there is rainfall in this catchment that entire area will be full of water then only the water will start filling out of the dam wall.

Now, how much that area will be? We can say if we follow the same methodology, we will draw the contour of 48. So, this particular area as shown here in this line is the area which is covered by a contour of 48 meter. So, this is the total inundation area. We know in advance if we are going to build a dam of this height this area is going to be inundated. So, the people living in this particular area the villages there they needs to be displaced relocated not only that, because we know how this area is. We can draw the cross sections now you can visualise this cross section we know how to draw the cross sections we can draw several cross sections here. So, if you can visualise that cross section.

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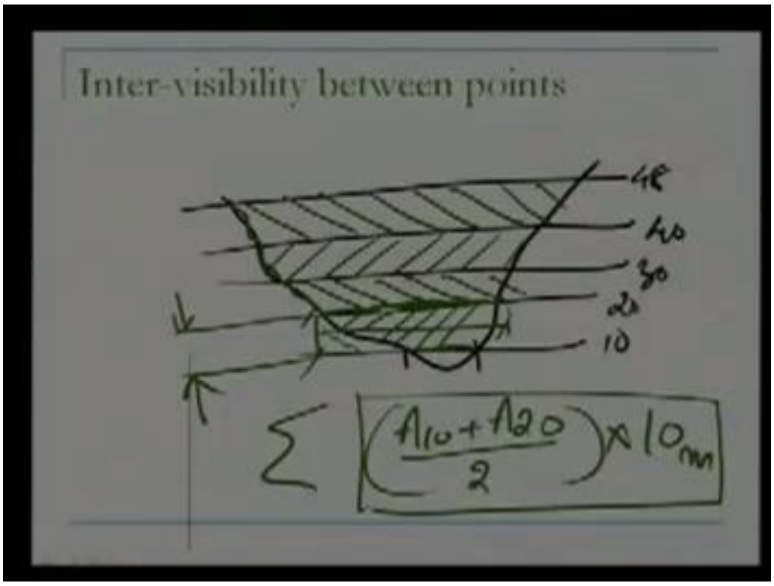

The cross section will look like over here we know we have a contour of 10 meter, 20 meter, 30 meter, 40 meter and 48. Now, what you want to do? We want to compute the volume for 40 meter. So, for 10 meter how much is the area? For 10 meter this is the area of the contour for 10 meter. Now, for 20 meter this, the area of contour for 20 meter if you look over here we know the area of 10 meter we know the area of 20 meter. So, if I can take simply area of 10 plus area of 20 assuming these slopes to be uniform divided by 2 I know the average area here. Now, for this prism here we know the height difference this multiplied by 10 meter it gives me the volume of water which is stored in between these 2 contours. So, that is the volume of water similarly what we can do of course, we are following a very simple methodology here in order to be accurate this must take care of this particular slope. Here what kind of slope it is? Is it you know uniform sloping or it is steep it is what kind of slope it is?

We must take care of that in order to compute the volume more accurately, but we are able to see the concept that how we can compute the volumes of water which are stored there. One case this then the second slice then the third slice next slice this is the last one the top most. So, we are computing this volumes in slices. So, addition of all these finally, will give us the total volume. So, we are able to just by looking at the contour map recent computations you are able to determine the volume of water which will be stored in that reservoir of height 48 meter.

Next in application we are seeing the inter visibility between points, what is the meaning of that? Looking at the contour map we want to ensure if I standing at a point A can we really see the point B or not. Because this is something, which will need many times in the ground you know for example, the military applications where you want to locate yourself at a point. So, that you are seen from very few points all over or you want to locate yourself in such a point. So, that you are in a commanding area and you can see as much as area which is possible. So, this is the inter visibility and we can solve this problem by the contour map. Because contours means the topography of the ground is there how to do it? We will do it by one example now in this example.

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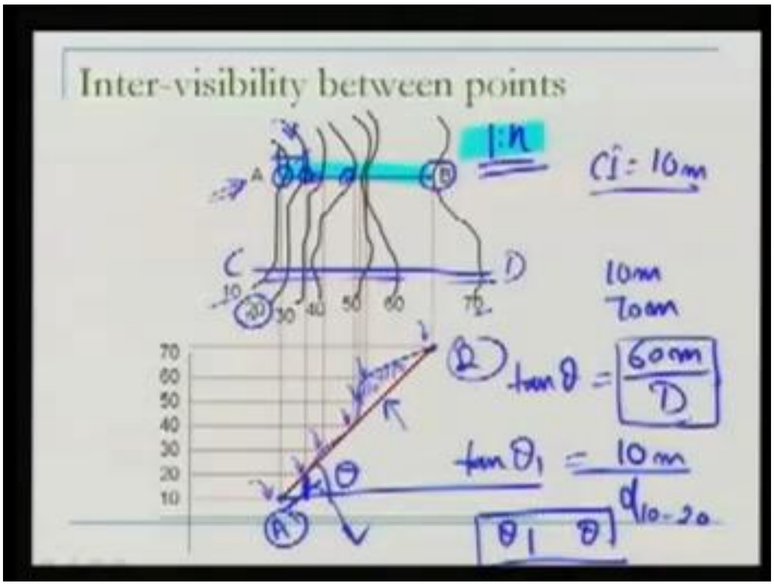

Let us say this is the contour map where these are the contour values with the contour interval of 10 units. Let us say 10 meter here what do you want to do? We want to see whether from station A which is on the contour of 10 meter we can see a point a station B which is at a contour of 70 meter. Now, how to solve this problem? We can solve this problem computationally as well as graphically. We will see the graphical solution here and the computation one is the same one you know we can very easily do the computations also if we understand the graphical one. In the case of a graphical one first of all we will draw a profile here. So, the profile as we have seen how to draw the profiles, we can draw a profile here a point A is located here. And the point B is located here before I get into the profile what will be line of sight? Line of sight means a line joining these 2 points by a straight line.

So, the line of sight between these 2 points will be like this now, if I draw the profile for point A. The corresponding point is here for point B for the next point on contour of 20. The point is here for point on 30 the next point is again 30 next one and next one and finally, for 70. So, the profile will look like this. So, this is the profile as you can see now what is the meaning of this? The line of sight is gracing the ground somewhere here the meaning of gracing the ground is the line of sight is nearly parallel to the ground and is touching the ground. However, in this area the line of sight is inside the ground. So, the point A and point B will not be inter-visible, because our line of sight is inside the ground the ground is here. So, what we can conclude? We can conclude they are not inter-visible. Similarly, the same job can be done over here also the situation will change as per the stiffness of the contours. You know of the terrain how steep or how the slope of the terrain between A and B changes. So, accordingly we can determine whether this point C and D are inter-visible or not now, how to do this computationally you want to compute? In order to compute the moment you know of point A and point B you know their RLs the RLs are 10 meter and 70 meter.

So, the difference between these 2 is 60 meter and the horizontal distance between these 2 using this map and this scale 1 is to n what we can do? We can measure the distance A B we can measure this horizontal distance convert it to this scale and we can write this distance A B whatever it is let us say D. So, this gives us the slope of the line of sight and this we can also write as tan of theta. So, what theta angle is this? Now, what we can do? We can go to each contour. Well, whether this contour over here at 20 meter is obstructing or not if it is obstructing, what we will do? Again we will find whether the height of next contour forms, because what we can do here. We can measure the distance between these 2, the horizontal distance whatever the horizontal distance is small d let us say between contour of 20 and 10. That is the horizontal distance and we know that the vertical distance between these 2 is 10 10 meter.

Now, let us say this angle is 10 theta 1 now by the relationship of theta 1 and theta we can easily see or other we can easily conclude whether the line of sight is above the ground or below the ground at this point, which is on contour 20. Similarly, for other points also this thing can be computed by the relationship between theta 1 and theta. We have seen so far about the contours how we generate them, what are the applications of them? Contour access is a way of representing the topography of ground on a map sheet. So, on that map sheet there is a scale on that scale we have these lines drawn there. Now, most of our work we are doing nowadays in digital domain digital means within the computer. But for a computer it is difficult to understand auto store a continuous line like the contour rather the computer has got some other advantages. It cannot understand that continuous line, but still our desire is to store the topography within the computer. So, what is the way out, how we are storing the topography in the computer now in this in the digital form? This is done or this is realised by creating DEM.

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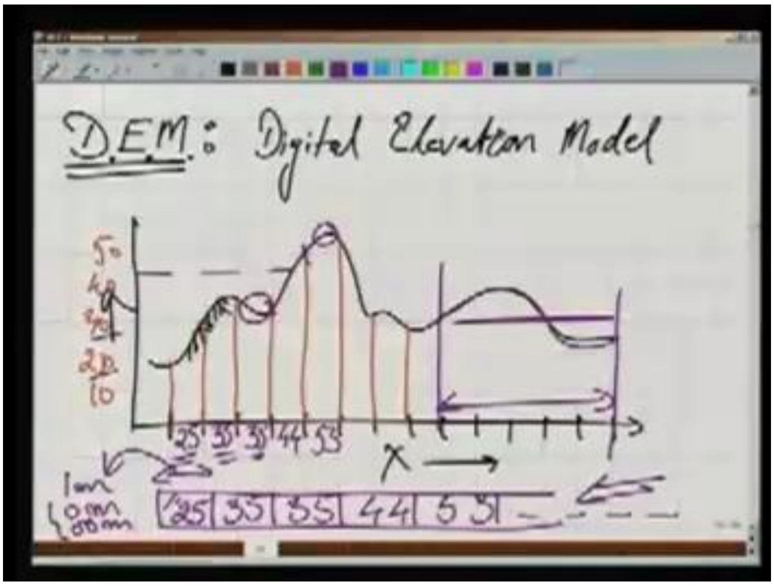

The DEM stands for Digital Elevation Model. So, we are doing the same job as in the case of the contouring, but now we want to store the topography in digital form. Now, what is the method we would like to see it by first one example? Let us say this is our ground I am doing this example only in one dimension. One dimension means this is the height and over here is that is the x axis, what we do? We divide this x axis in certain intervals. Now, for each interval you know can think that this is our ground this is the ground here; this is the ground. Now, for each interval if you look at the ground the ground will have some height. Let us say the height say here 10 meter, 20 meter, 30, 40, 50. And on the basis of this, what I can say? I can give a height of in between 20 and 30 to this particular shell. So, this is 25 over here I give it as 35 over here again 35 over here. The height corresponding to this, which is around 44 and over here a height of 53 and what we end up with?

We are now representing a continuous ground in discrete form as 25 35 35 44 53 and so on. So, what can I do? I can form a one dimensional array here or a grid for each grid cell it is average height is 25. So, the ground here which is continuous we have represented that ground now with a average heights on a particular discretisation. Now, this size it could be 1 meter, 10 meter, 100 meter or any value in order to represent the ground more faithfully. The shell size should be as small as possible, but at the same time if you are taking very small size our data volume will be very large. If you are taking this as size to be very large we may not be able to. For example, if I am taking the shell size to be this big this is my shell size I will not be able to represent all these undulations rather I will be storing only an average value. So, depending the application what you are doing, how you are, why you are using your DEM? We decide the shell size right now we are seeing this DEM only in one dimension.

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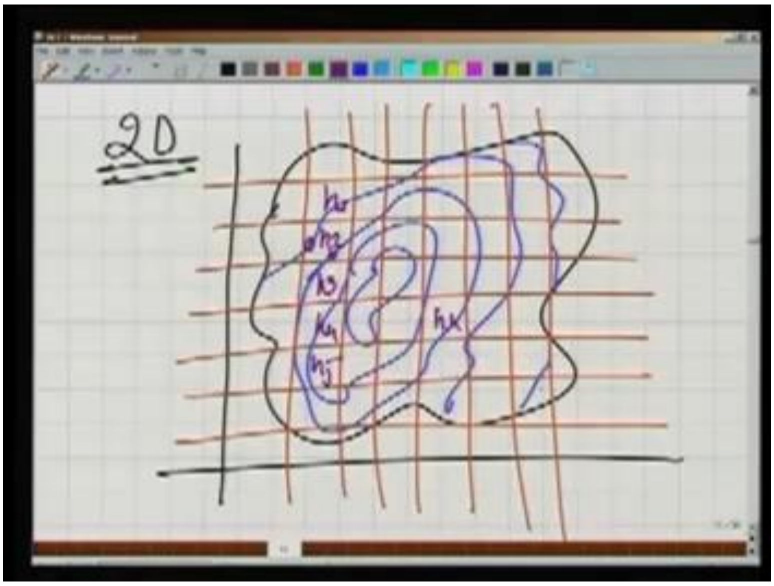

The same thing can be seen in 2 D and actually the DEMs are in 2 dimension what we are doing here? Let us say there is a ground here the field and on this field we have the different elevations. I am showing this by contour maps within the bound of this area in order to create DEM of this area. What we can do? I can divide this area as we did in the previous case in grids. The contours are shown here only to show you that they are undulations in the ground. Now, for each grade, we can write a particular height value depending the contour here I will give a height value here h 1 or h 2. So, this h 2 will be average of this contour and this contour similarly here h 3 h 4 h 5 you know and so on may be h n. So, each grid shell is being given a height value well what we end up with.

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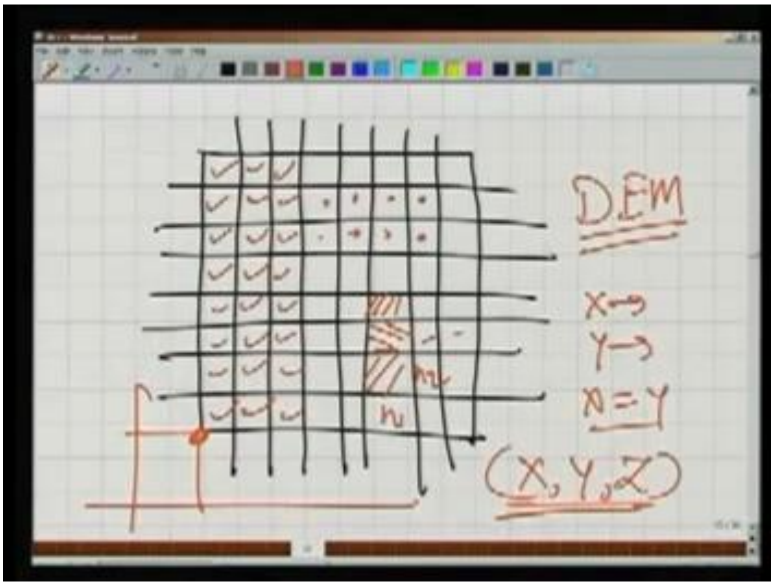

We end up with something like a matrix where of course, this will be uniform we have grid and on this grid for each point we know it is average height. So, you know continuous or rather discrete way of representing the ground for each point we know the height. So, it is like a matrix and this kind of thing we say as DEM Digital Elevation Model. So, for a Digital Elevation Model what you need to know? You need to know the spacing. What is the spacing in x direction? What is the spacing in y direction? Generally this spacing in x and y are same. The square grids if you know that also we want to know the origin of the sorry the coordinates of the origin if you know this you can determine the coordinate of any point here anywhere.

So, the coordinates of all these points are known in x and y as well as for each grid shell we want to determine or we want to know their height h 1 h 2 and so on. So, what we have achieved for each grid shell? We know now these 3. So, that ground there is being represented now in the matrix form on the grid form. Or we shall also raster form where the X Y coordinates of the raster are fixed. Or it can be determined using the coordinates of the one point as well as the sizes of the grid in X and Y and as well as for each raster shell the grids hell we have the height there. So, this is one way of representing the terrain digitally, because this information this huge list of data can be stored within the computer. And computer can read this values one more way of storing this is TIN.

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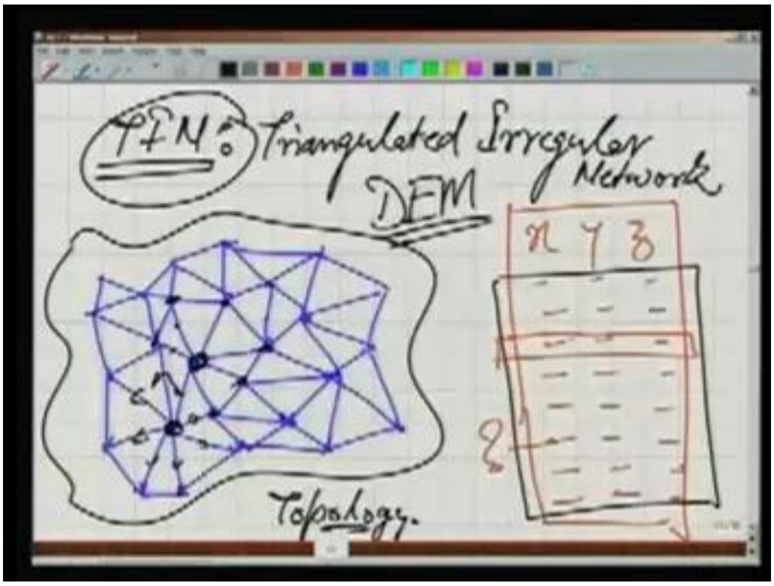

TIN stands for Triangulated Irregular Network. Now, what is the meaning of that? The meaning is if there is a ground on that ground we have observed several points. You know we have observed the X Y Z of several points we can do that using the total station. Now, so for all these points are stored in a file within the computer and this file is X Y and Z. And you know just the coordinates are stored there by storing this huge data file in the computer only listing of the data is stored still it is not a full DEM. It is not a model. Model means we do not know in this data file that for this particular point here what are it is neighbours is this point it is neighbour we do not know that.

So, what we need to define? We need to define a relationship something, which is stored in the computer all those data points how they are related to each other. No, are; what is the neighbourhood relationship between these? So, this is what we need to define and in order to define that what we do? We create a triangulated network here they are methods of creating these networks. So, that the network is optimal. Optimal in the sense that it represents the ground most faithfully most of these triangles should be well conditioned our method will ensure that. So, they are methods in order to create these networks. Networks means how these points are connected to each other once we have formed a network like this we also define a term is called topology. The meaning is how these points are related this point is related to these neighbouring points.

This point is related to these neighbouring points. So, how they are related to each other? So, we to store only the listing of the data in the computer rather we also store their relationships. So, this entire topology you know the data as well as the relationships once we store into the computer that we say as TIN on that topological data model. Now, the use of this is if you are doing any you know work on this thing. I know if I am selecting a point I know what is the next point to it what all points are the neighbours for that point. So, we know that relationship. So, this is another way of creating a digital elevation model of storing the data or the topography in the computer here is one example of displaying the DEM.

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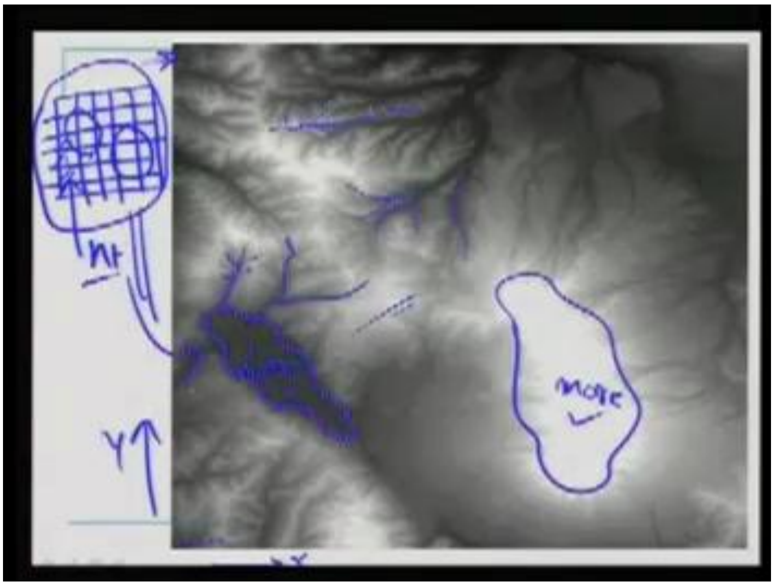

Now, here in this case as you can see the DEM is being displayed, now what is the meaning of this? As we know a DEM is now the digital numbers or the heights are arranged in these grid shells, so each grids hell has a height value. Now, what we have done here this the y axis and this is the x axis this particular map is formed of several points. And each point, the pixels we say each point is given a colour either white or black depending what is the height. If the height is more, it is given white colour or if the height is less it is given a black colour and in between the grey shades are for intermediate heights. So, if we display this DEM where we have the lower heights and the higher heights. We display it on the computer screen; the display may look like this. So, it is very interesting you can see in this that this is the hill top while all these are the drainage networks through which the water will flow. Now, this is the bottom may be a little pond here and all these are the you know channels the water will flow through these and the white lines for example, here is the ridge line.

So, this is a DEM which has been now displayed. So, we can interpret several things using this DEM. So, what we saw today? We saw the indirect method of contouring. Then we looked into the applications of the contours how we can you know make use of the contours for different kinds of applications. The applications what we discussed are only a few there are many more applications of the contour. And all those things which we are talking for the contours can be done for the digital elevation model also. Using the DEM we can determine the area of inundation the volume reservoir, the inter-visibility. Using the DEM we can do those things more efficiently and more accurately. So, in all the GIS packages you will find they are several routines which will operate on the DEM. In order to generate these things you know the inter-visibility the user map volume of the reservoir or slopes, aspect, anything.

Thank you very much.