Surveying
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Module - 2
Lecture - 2

Basic Concepts of Surveying

Hello! So we are again in another lecture on basic surveying, and this is the lecture number 2 of module 2. Our module 2 is on basic concepts of surveying.

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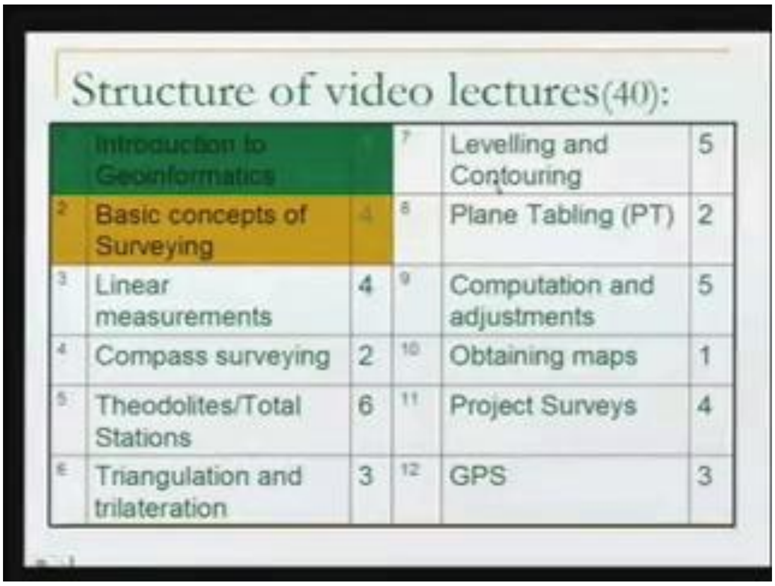

Let us go back to the entire structure of the video lecture. We have already done our module 1; we are, at the moment, talking about module number 2.

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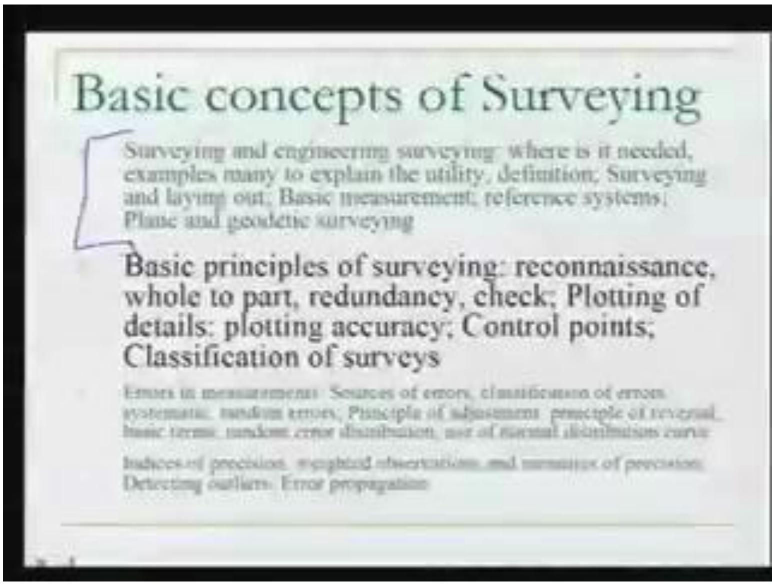

In module number 2 - we have already discussed this particular part in our last lecture - so, what we were talking in our last lecture, let us just recapitulate that. We defined the surveying and also, we said that how surveying is of concern to the engineers - maybe mining, maybe civil, any - and basically, our aim is to measure the geoinformation. Now, we saw many examples; we started from the building construction, the town planning, example of Euro tunnel, example of a bridge, example of a road or route alignment, and using all those examples, we understood that how surveying is useful for an engineer.

We cannot do surveying or rather, we cannot do any project without surveying, because we need to bring the ground into the laboratory - this is what we saw yesterday - then only we can work on the ground. Working is the planning, the designing - all those aspects. Once the design is complete, then what we do? We take that design to the ground – so, again, measurements are involved. So, we need to do that thing. So, we saw it yesterday, where the surveying is required.

Then, there are two types of surveying: one is the surveying and the other one is the laying out. Surveying is bringing the ground into the laboratory, doing the measurements there in the ground, making the map, doing some other kinds of measurements of geoinformation and then bringing it in the laboratory. Then, once it is in the laboratory, we have worked upon it -our design and planning, other things -

we take it out, so that part was called laying out. Then what we discussed? We discussed that surveying is basically about the measurements and we cannot measure without any reference. I gave you also an example of a child, one-year child, and his father was telling me that his child is of this height (Refer Slide Time 02:47), then he told me he forgot - he forgot to put the other hand, the reference, because child of one year cannot be of this height. So, the reference is required: well, (Refer Slide Time 02:58) he is this height, he is this tall. So, the reference is very important in any measurement, and we saw that how reference is important for measuring the geoinformation.

We need reference for measuring the geo information; now, what is the reference? Reference is a mathematically definable system. The geoinformation is on the surface of the earth; can we use the geo information as such, or rather can we use the earth surface as a reference? It is not possible, because earth surface is not definable; we do not know the characteristics of the earth surface. We cannot put any equation for that, so we cannot use the earth surface as such.

So, what was the other thing? The other thing was, we thought of a surface which is physically adjusting, that is, the equipotential surface or a surface which is always perpendicular to the direction of gravity. This surface is also called the level surface or geoid. And the physical surface which is the geoid is the mean sea level, or the surface of the water body, because all over the water body, there will be equipotential everywhere - the potential will be same. So, the surface of the water body makes a surface which we say geoid. Now, we can make use of this geoid again as a reference, but we had a problem. The problem was: the geoid is also not definable mathematically, because geoid is basically controlled by the distribution of mass within the surface of - within the earth; because the mass distribution within earth controls the way the gravity vector is all over the earth, or the gravity forces; because the mass distribution within the earth is not constant; it is not uniform. So, our geoid surface is again, mathematically not definable.

Nevertheless, one important thing that we saw yesterday - that was about the height or the elevation. In surveying or in any engineering, we mean by height, we say a point is higher than the other point provided the water will flow from this point to this point

(Refer Slide Time 05:10). So when we are talking of the geoid or the level surface - a point which is on higher level surface and a point which is on lower level surface - the water from the higher level surface will always flow to the lower level surface. So, we can make use of geoid for measuring the height.

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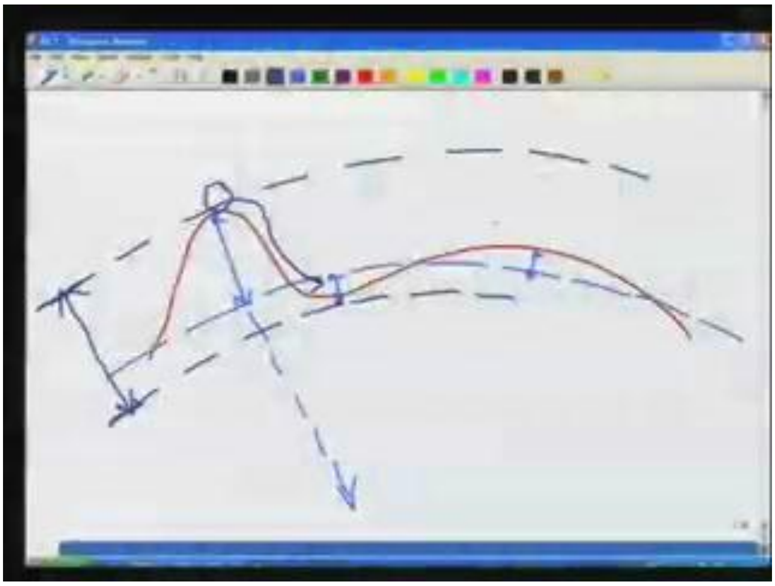

What we did last time - I am going to draw the surface of the earth here (Refer Slide Time 05:39) and the geoid in this, let us say, like this. Here in this part, it is the surface of the sea, maybe. So what we can do now, we can refer the height of point from the geoid. So that’s the direction of gravity (Refer Slide Time 06:03). Similarly, here, for this point (Refer Slide Time 06:09), we can refer the height of this point from the geoid. Also, same thing here, like that. Now, what we are talking, we are talking that there is another level surface here (Refer Slide Time 06:23); equipotential surface, there is one more equipotential surface passing through this (Refer Slide Time 06:29), and as we see that, if we put a water droplet here (Refer Slide Time 06:35), it will flow in this direction because this level surface is higher than this level surface. So what we say? We say this point is higher than this point by this amount (Refer Slide Time 06:54). So, the two points are separated, or the difference in elevation between two points, is the separation of level surfaces which are passing through those two points.

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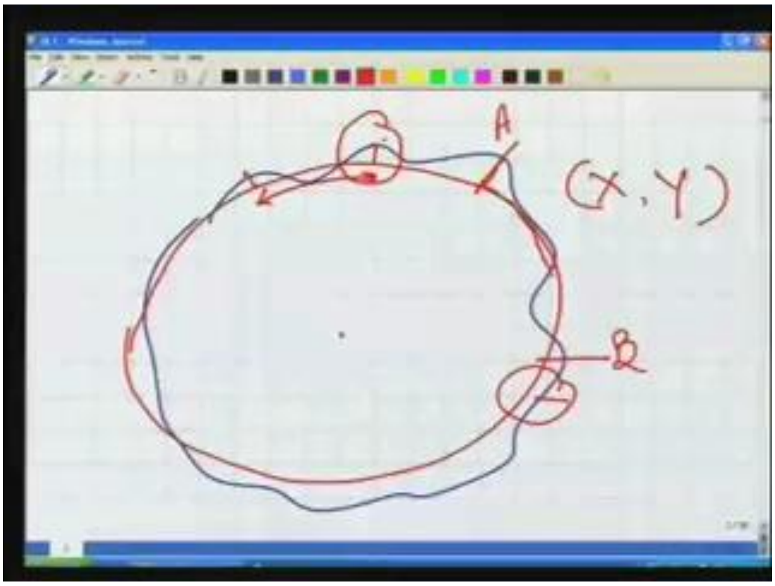

So, in any engineering survey, we use the geoid for measuring the elevation. Well, when we are talking about the geoid, how about the X and Y? Yes, we can use a geoid for measuring the elevation, but what about the X and Y, the positions? So what we did for that, we considered that, for our earth, if we can fit an ellipsoid (Refer Slide Time 07:36) - this is an ellipsoid which is fitting best to the surface of the earth. Now, this is an ellipsoid for which we know the mathematical equation, and what we can do, we can project our points on the ellipsoid. So now, the distance between these two points (Refer Slide Time 07:57) is actually the distance here in the ellipsoid. We know the equation of the ellipsoid, so we know the characteristics of the ellipsoid. So, we can use the ellipsoid for measuring X and Y.

Now another thing, why we need a reference - as you know, the Mount Everest is the highest mountain in the world - how come? Why not the Alps? Because both of these have been measured using the same reference. If both of these are measured using different references, we cannot compare these two. So, the Mount Everest is somewhere in one part of the world (Refer Slide Time 08:31), while the Alps are in other part of the world, so, in order to - in order to compare these two, we need one single reference which is passing through both of them, and then only we can compare the elevations of these two, or the heights of these two. So, for this purpose, we need one reference system. Well, we are talking that our reference system is ellipsoidal here (Refer Slide Time 09:04), and any two distances that we are measuring between points A and, for example, point B here, is the distance along the curvature. But, of course, the distance between the point A and B should be measured considering the curvature of the earth, because this is how physically they are. But this is true only if we are talking about a very large extent, large area - this is not true if the area is very small. So, for our engineering surveys - because in case of the engineering surveys our areas are generally smaller.

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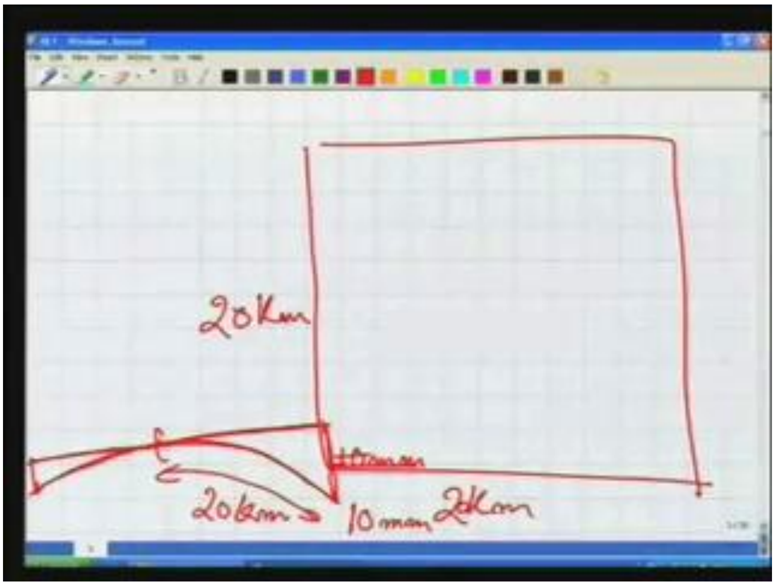

You know, an engineering project, for example, let us say: if it is 20 kilometre by 20 kilometre, then the separation of geoid (Refer Slide Time 09:50) or the ellipsoid or the curvature of the earth form a horizontal plane. Plane in 20 kilometre is only 10 mm. I am sorry, not this way - but these surfaces means, the distance in the length of the chord and the length of the arc is only - for 20 kilometres, the difference is only 10 mm. What is the meaning of this? The meaning of this is, when we are doing engineering surveying or when we are doing the surveying for a small area, we need not to consider the curvature. Why should we measure along the curvature? We can – rather (Refer Slide Time 10:44), even if you are measuring along the curvature, because the distance which we are measuring on the ground, we can measure the distance by making a line which is horizontal, and we measure this distance along the horizontal. What we are doing? We are not considering the curvature of the earth; rather, the other way - we are considering our earth to be flat. So, for small areas like this, we can consider our earth to be flat, and we can easily carry out the surveying.

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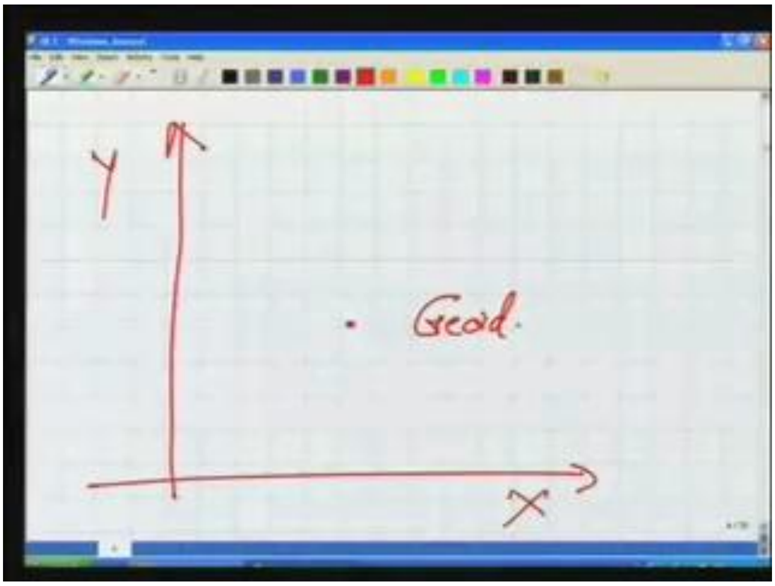

So, flat means, in that case, our reference plane for X and Y will be like this (Refer Slide Time 11:18) - X and Y - while the Z are being measured from geoid.

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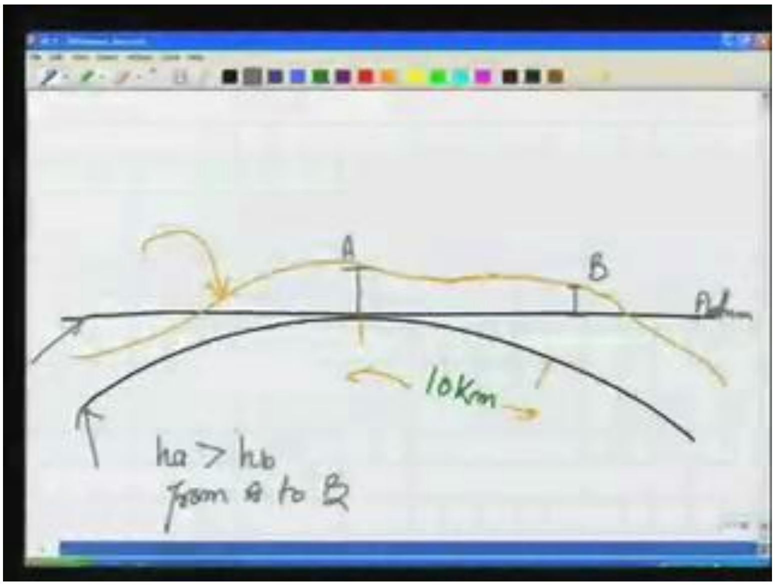

I will give one more example - here is the earth (Refer Slide Time 11:31), as you can see – that is the surface of the earth, and this surface here (Refer Slide Time 11:39) is the geoid, and here is the flat plane which is tangential to the geoid at this place. Now, in this example, what we are seeing: if we plot our point, let us say, or rather, we measure the height of the point - that is, the point A (Refer Slide Time 11:59) and a point B - from the flat plane or the horizontal plane. By projecting these points here, we measure this height as - at the moment what we have seen , these two values, so what we see in this case, the height of A is more than height of B from the datum. What is the meaning of this? The meaning of this is, in this case, the water should flow from A - from A to B because, if we are considering the earth to be flat, we are not measuring elevations from geoid; rather, we are measuring the elevations from a flat plane or a horizontal plane. In that case, the water should flow from A to B. Well, let us look at the geoid or the lower surfaces; equipotential surfaces. The equipotential surfaces in this case, passing from A, will be again parallel to the geoid, so we can draw it like this (Refer Slide Time 13:19) and also from B - passing from B - will be like this (Refer Slide Time 13:30).

Well, what we observe? One thing, very interesting: if you are looking at the equipotential surfaces, in that case, the equipotential surface or the level surface which is passing through B is higher than the equipotential surface from A. What is the meaning of that? The meaning of this is, the water will actually flow from B to A, not from A to B, which is the case here. So, what do we mean by this? We mean by this is, if we are taking horizontal plane for measuring elevation, our elevations will be wrong. It might happen that we are giving the elevation to a point - as here, in this case - A, more than to a point B, this height, the water flowing from B to A. So, we must always measure the elevations from the geoid, not from the horizontal plane.

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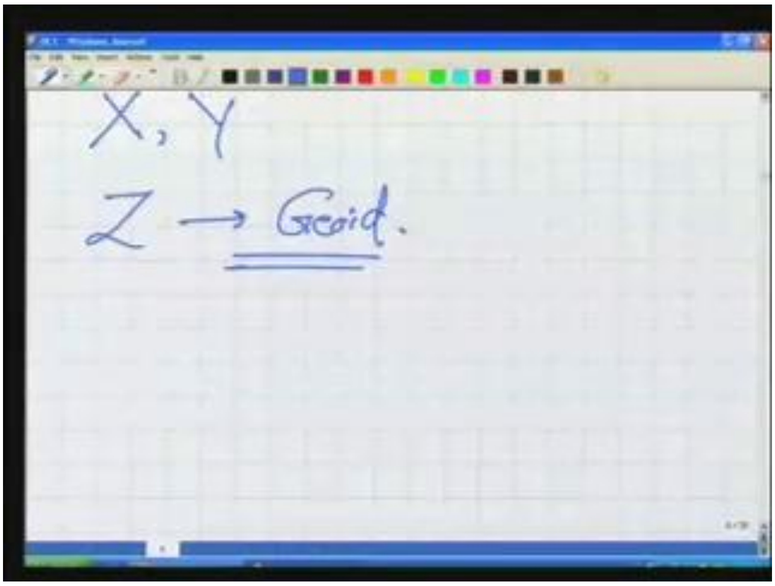

It is said that in all our engineering surveys, we can consider our earth flat for X and Y, but for Z, we must measure from geoid. So, this is an important concern; we should keep that in mind. This is what called we have discussed last time. These are important concepts, that is why I wanted to repeat these.

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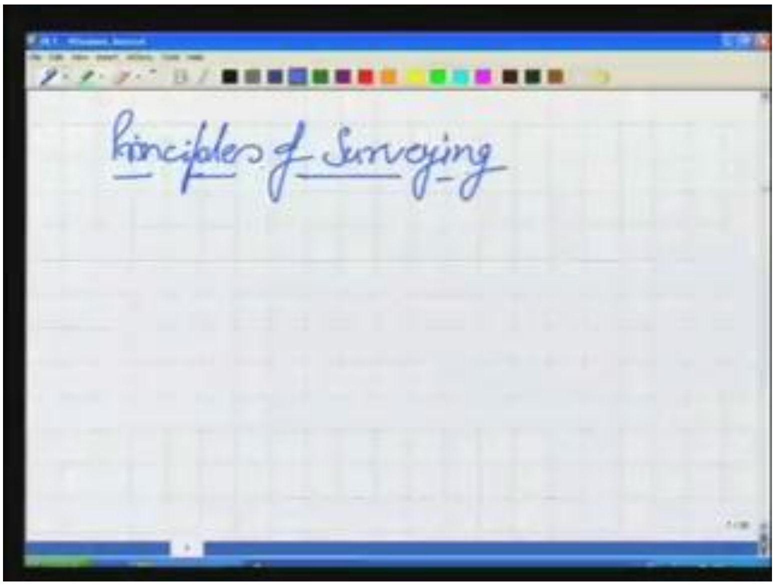

What we will do today, today we will start our discussion with some principles of surveying. Now, what is the meaning of this? The principles of surveying means, there are some things which we should keep in our mind always, whenever we are doing surveying. And in order to explain all those things, what I will do, I will give you an example and we will start with that example.

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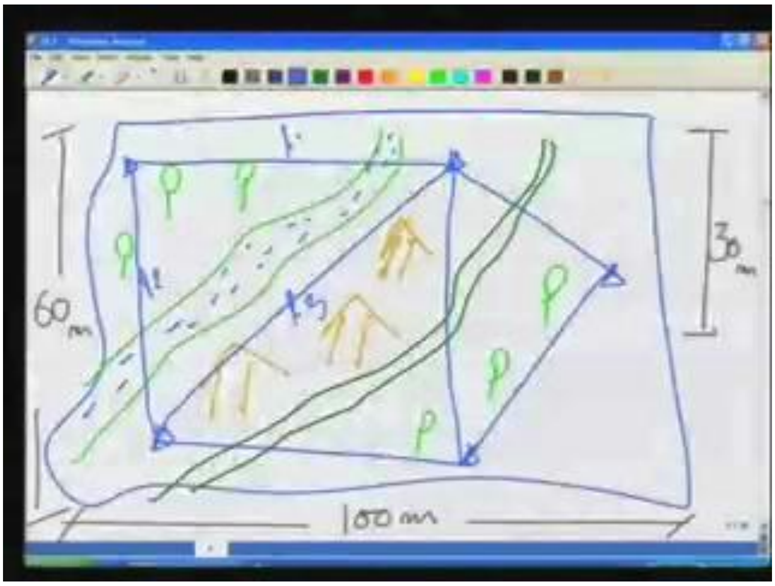

The example is, let us say, there is a field, an area, a terrain, and in this terrain - it may be of any size there in the ground. There are some rivers here (Refer Slide Time 15:51), there are some houses - let us say there are some houses here - there are some routes as well. We have got some more trees - this is - any terrain could be like this, while here is the river or a small rivulet . You can just think of any area in your surrounding – so just think of that area. Our job is, we want to make a map for this area. So while we are going through this process of making map for this area, we will go through many things which are very important and very basic for the surveying.

Now, what those things are? Well, number one: when this job is given to you, I ask you, ‘Go to the field and make a map’, and I give you, let us say, a tape - tape means something with which you can measure - and the length of this is 30 metre. A tape having 30 metre length - I give you that tape, and I ask you to make a map of this area. Again, to simplify the matter, let us say this area is of around 100 metre by 60 metre in height. So it tells you about the extent - now you can visualize any area, any garden in your surroundings, and you are given a tape and you are asked to make a map. What will you do? Now, the number one thing which you would like to do, you would like to go to that area, observe it - isn’t it? Just have an idea, what kind my area is, also, what kind of techniques should I use for my surveying - can I use very good instrument; should I use very good instrument - that kind of stuff - and can I reach each and every point in my area; is every point accessible or not.

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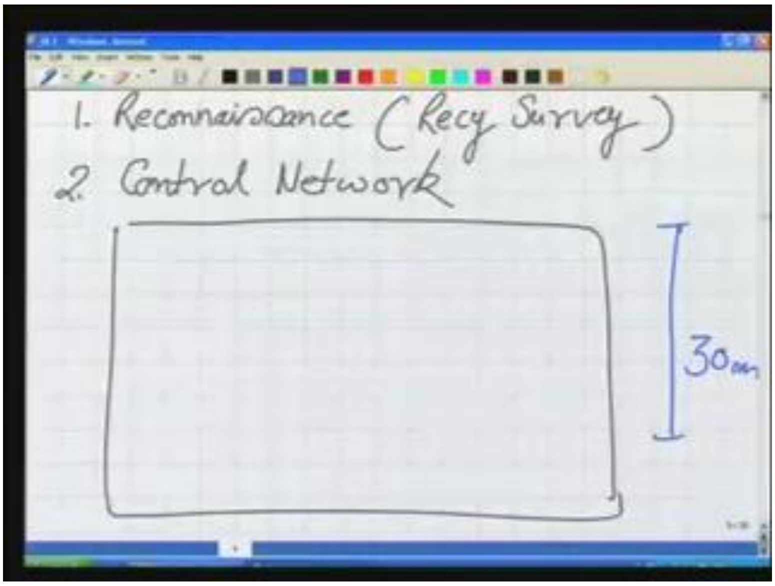

So that part, the very first part which we do is called ‘reconnaissance’. Reconnaissance survey - and sometimes that is also referred as ‘recy’. So, you go into the area, you do this recy, and by doing this recy, what you try to do? Well, you try to have an idea of the area. Once you have done the recy, the second thing that comes into picture is: you establish a control network. We will talk about it. What the control network is; what is the meaning of control network here? Control network means something which will control your entire survey. Now, I will tell you how we will do it here, in this case. Let us say for the same area, I am drawing it here again (Refer Slide Time 19:01). You decide that, because you have given - you are given only a tape of 30 metre length, and you have to make a map of this area. It is not that you start from measuring individual trees - the distance between two trees, the distance between two houses. For example, in this area (Refer Slide Time 19:25), how will you make the map? It is not that you start measuring the differences like this: between the trees, between the rivers, between these trees, from tree to the river, from tree to the boundary - these individual measurements. No; first you have to establish a control network.

Well, the control network could be - let us say that you establish a control network here (Refer Slide Time 19:46), another point here, another point here, another point here, one more point here. I am considering here that it is possible for us to measure the distance across the river using the tape – it is a small river; you can do it. Now what - by doing that, what you have done? Your network will look like a network of triangles (Refer Slide Time 20:05); we will explain this thing. Let us say, that is your network (Refer Slide Time 20:11). You will understand very soon the utility of this. You decide about it; this network is also decided at this stage of reconnaissance - you decide about those points which will become your control point. Now, why we want to do it? We want to do it because by establishing these some points and measuring the distance between these points very accurately, what we can do, we can take this skeleton of the area in the laboratory. Now what is the meaning of that? Once you have gone into the ground, you can do these measurements easily - isn't it? - because you have got the tape; you spread the and measure these distances. The only thing is, keep your tape horizontal, because we consider our earth to be a small area; to be flat. So, by keeping the tape horizontally between these two points, I can measure all these distances – l_1, l_2, l_3 (Refer Slide Time 21:12) and similarly. So all these measurements are known to you. Well, bringing the skeleton of the area into the laboratory - how do we do it? How do we plot that?

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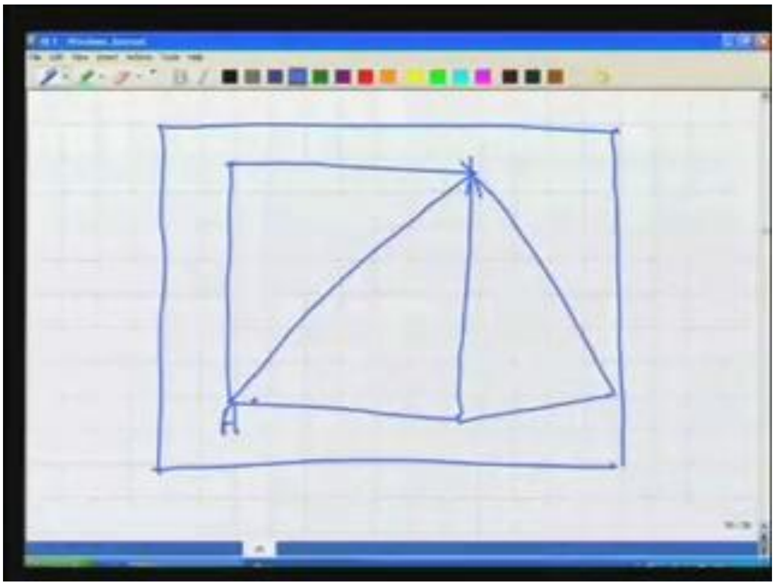

Well, we do it - let us say we have a sheet of paper here (Refer Slide Time 21:37), and we want to make our map in this sheet. We will start from our very first point, the very first point, for example, let us say what A. So what we do - in our sheet, we will locate this A just arbitrarily – 'A' (Refer Slide Time 21:55). Now from A, we know, as we had observed in the ground, that we have lines going this way (Refer Slide

Time 22:05). So what we do, we draw a line l_3 and l_2 and again, from this point, we take an arc. From A, let us say the very first line is drawn here (Refer Slide Time 22:19) – l_1. We can measure the angle also; I am not talking about the angle now. And from here (Refer Slide Time 22:27), we can take the arc of rest two lengths, so this point is fixed.

Similarly as per the triangulation figure there (Refer Slide Time 22:40), we will draw the rest of the triangulation figure. What you have done, just by the measurements of these lengths there in the field, you are able to draw the skeleton on to the sheet. So the skeleton of the ground is here on the sheet; is on the map. So what? What we learned from this? We learned one thing, one principle here, that is, establishing control network.

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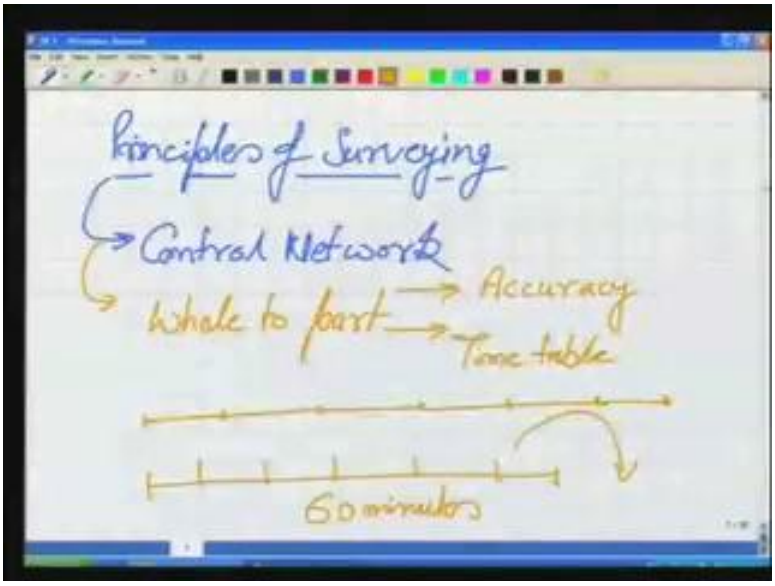

In the case of the principle - the principle what we learned here is ‘control network’. Always, before we begin our survey, we should establish a control network, and the control network controls our survey - we will see in a moment how.

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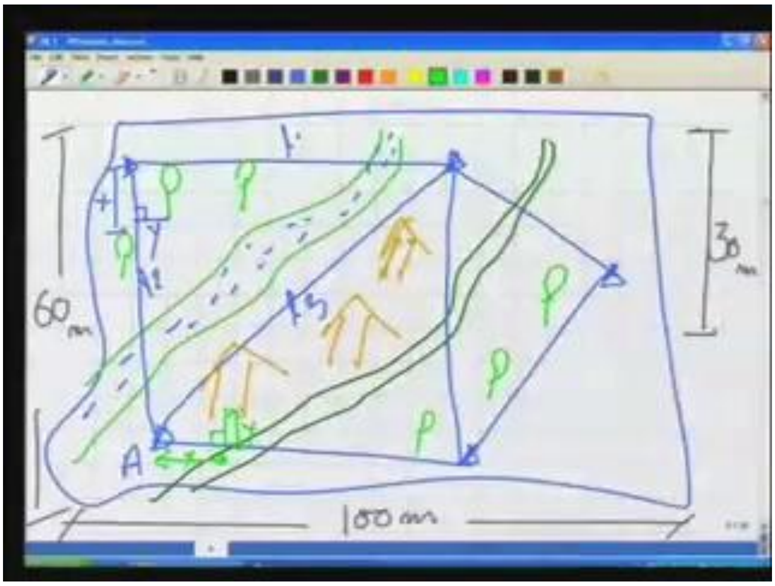

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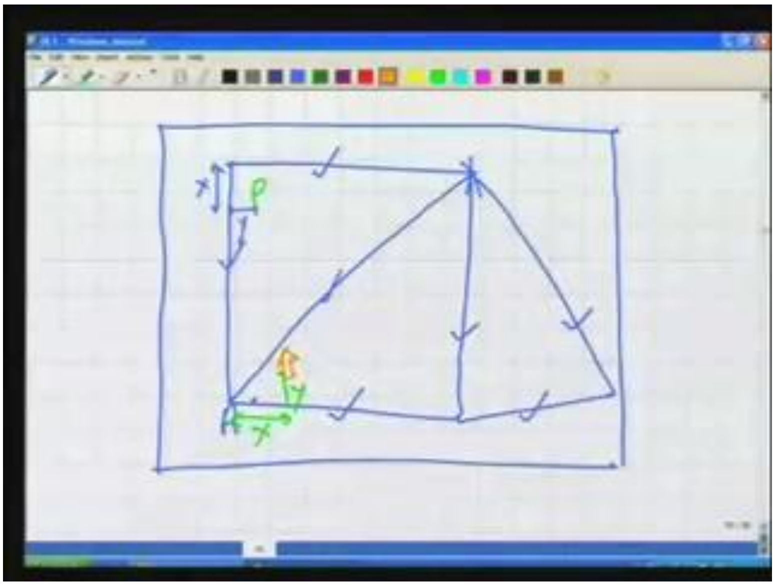

Now, in our area, what we want to do, we want to measure the individual things. To measure the individual things, what I can do now: from any tree, I can drop a perpendicular here (Refer Slide Time 23:47), isn't it? What I know: along this length (Refer Slide Time 23:52) - a certain X - the distance of a tree is Y. So what I will do, I will do the same thing here (Refer Slide Time 24:04), along this, at a certain length X, we have the distance Y, and at that Y we have a tree. So what we have done? We have now plotted one tree. Similarly, I can plot the other trees also. For example, let us say, for this house (Refer Slide Time 24:26), I take the measurements of this house from this line by drawing a perpendicular, I measure this X, I measure this Y - by measuring this X and by measuring this Y, what I can do, in my map (Refer Slide Time 24:44), there is the X and here is the Y, and we know there is a house here. What I have done? I have plotted the house also. Now you will start realising the significance of the control network.

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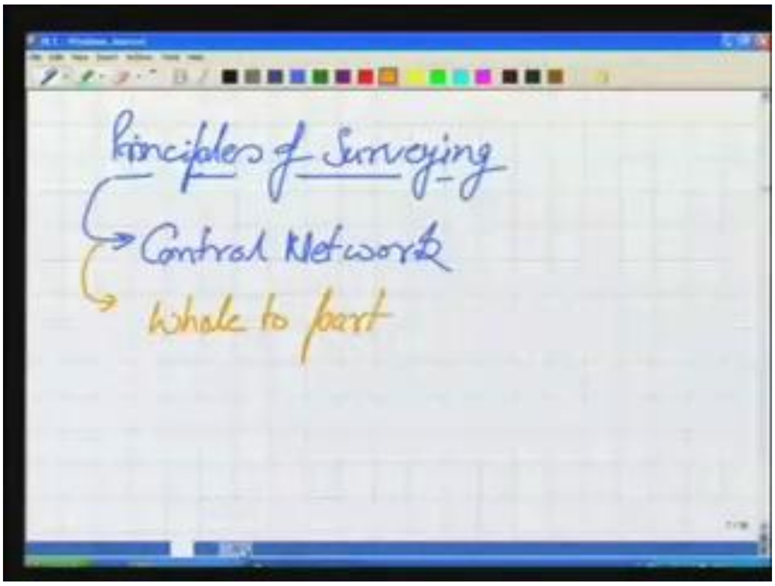

Now, some principles which we must follow and we must keep in our mind always: one principle that we say is 'working from whole to part' (Refer Slide Time 25:12). It is a very important principle, working from whole to part - what is the meaning of this? The meaning is as we saw also here - what we did first? We mapped the skeleton of the area. The meaning is, first we mapped these distances; we did not go to the individual features, we did not start measurements from individual features, individual trees – rather, we mapped our area first in a big way, we measured these distances very accurately, the l_1, l_2, l_3, l_4, l_5 - all these - we measured them very, very accurately and then we plotted them here (Refer Slide Time 26:01); we brought the skeleton of the ground here on our map. So this is - you know, what we did, we are working first in the whole; the skeleton of the area we are bringing here. We are not bothered at this stage about the features. But in the second stage, now working from whole to part, now we make use of the control network - these triangulation figures - and then we start plotting each and every detail.

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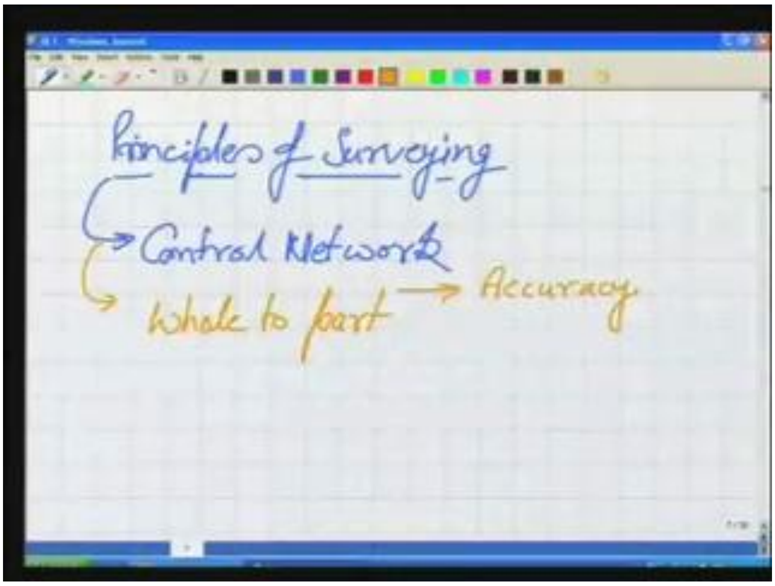

Now what is the advantage of this; why should we do it? Now, for this principle of working from whole to part, one advantage is accuracy. Why? Now, you take it like this: see, in our first control network, the triangulation figure, we measured that very accurately and we made use of that in order for plotting. So our these stations (Refer Slide Time 26:55) or these survey stations are transferred here very accurately because we took utmost care in measurement of length. Now, after that, even if we are slightly careless in measuring this Y (Refer Slide Time 27:12), it does not matter, because it is not going to affect the plotting of this house (Refer Slide Time 27:18), because these two are two different things. So, plot of the house or maybe plot of any other tree here - if we are plotting by measuring the distance here (Refer Slide Time 27:30) and this distance - so we can say X here and Y here. So, by this, I can plot this tree - again, this is an independent plot, so this particular plot, it does not affect at all the accuracy of this (Refer Slide Time 27:48) plot. We may be slightly wrong in measuring this, so it is not going to affect the entire - you know - the rest of the map.

So, our errors are not going to accumulate; they are not going to add up, while, if I start doing the mapping - let us say I start doing from part to whole; in doing it from part to whole, what is the meaning? I measure the distance between these two trees (Refer Slide Time 28:10), I measure the distance between these two trees now, I measure the distance from here to the river, from here to the river - you know what I am doing; any little error which I introduce in measuring the distance will be accumulated in all the measurements which I follow later on. So, in working from whole to part, we maintain the accuracy; we restrict our surveys with a certain accuracy, so this is a very important thing.

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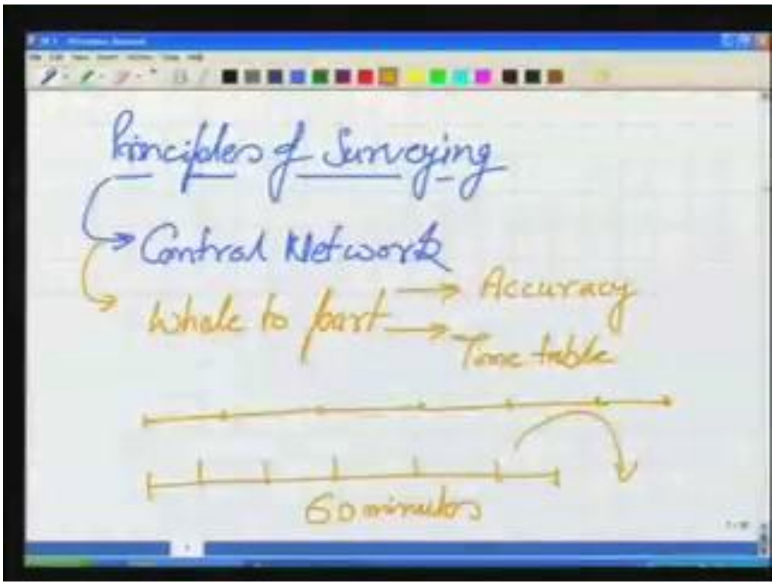

I can give you some more examples of this working from whole to part and these examples are from our daily life. Now, one example could be, let us say, the timetable (Refer Slide Time 28:49). It does not have to do anything with the surveying but to understand the concept of working from whole to part. The timetable means, let us say, for this lecture, I was given a time of 1 hour. So, what I have been given? I have been given, ‘Okay, you have got time of 1 hour; 60 minutes’ and I have to plan my lecture in this 60 minutes. So, what I do? Well, I have got 60 minutes; now I plan my first part of the lecture (Refer Slide Time 29:24), second part of the lecture, third part of the lecture - I plan within this 60 minutes only. It is not that I am going to, you know, go over the 60 minutes, because I know my boundaries; I know the whole. Had it been otherwise - I have not been given any time - what I would do, I will plan my first part of the lecture (Refer Slide Time 29:41), second part of the lecture, third part, fourth part - without knowing my boundaries, I might spill over. So, that is the idea – that is the very, you know, we should understand, because in our life also, many things we do where we implement this principle of working from whole to part.

Now, the next principle. We have talked about one principle that is very important, and the control network is a part of that - that is, working from whole to part. We discussed one more principle, that is, the reconnaissance; observing the area beforehand. The next principle: now, here itself, if one of - because what we have done, we have taken utmost care and we measured these lengths - what if some of these lengths are measured with errors? What will happen in that case? Let us say this l_3 (Refer Slide Time 30:31) - when we measured it on the ground, we measured it with some error. What will it do? If we measured it with some error, it will distort my skeleton of the area. All the measurements later on which I carried out will have some error now; my map will be distorted. So what should we do? How can we avoid this kind of thing?

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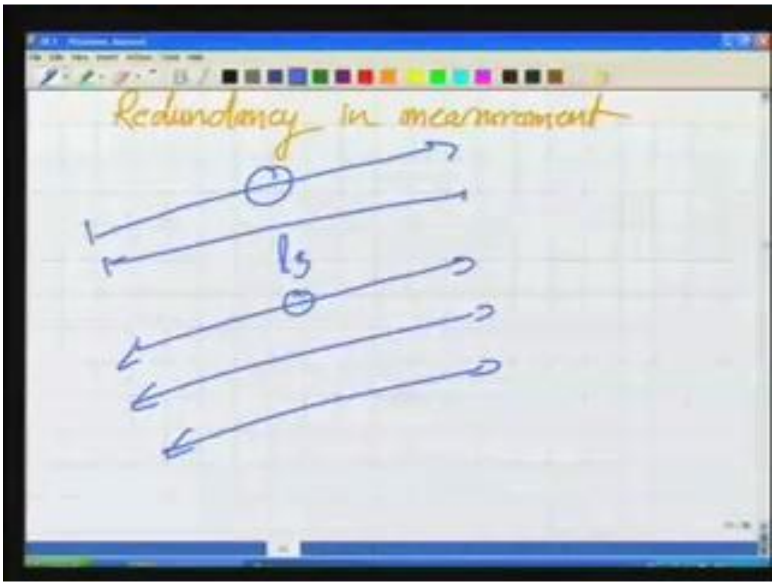
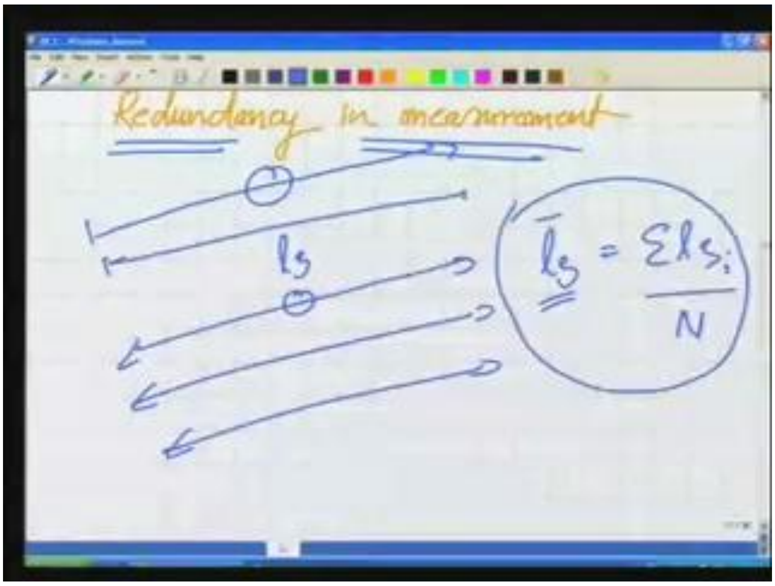


To avoid this kind of thing, there are two ways: number one, we say 'redundancy in measurement' - what is the meaning of that? The meaning of that is, if you are measuring a length l_3 (Refer Slide Time 31:20), we should measure it a number of times. You measure this length from here to here number one time, second time maybe from this way, maybe third time, fourth time . So what you are doing, you are taking a number of measurements for the same length - why? Because maybe one of the measurement is wrong.

(Refer Slide Time 31:47)



The other measurement is the redundant measurement, but it ensures that your final value, which you will get as the average of sigma l_{3i}, and number of the measurements; what number of measurements you have done. So, if you are taking the average of all these measurements which you have carried out for the length $l_{3,}$ your value is more accurate; you are more confident about your values than taking a single measurement. So, we should always keep in our mind that we should have redundancy in our measurement whenever we are doing the surveying; whenever we are doing any measurement.

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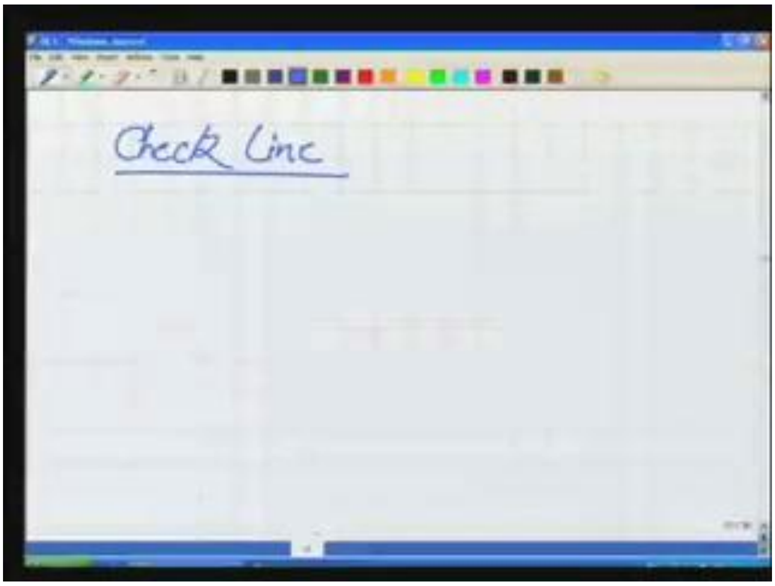
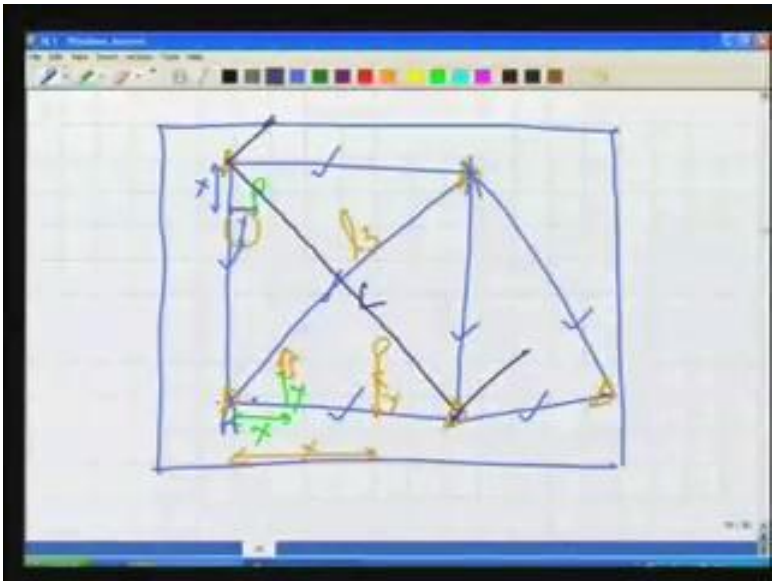


The second one - the second one is - now here only (Refer Slide Time 32:26), we carried out all these lengths and we plotted them here (Refer Slide Time 32:29). Is there any other way? One way is the redundancy; we introduced redundancy, but is there any other way of checking the accuracy of this system? Well, one more method is possible, and that method is, we say, check line.

(Refer Slide Time 32:54)



Now, what is this check line? Here, in this diagram, had we also measured there in the ground, let us say this line (Refer Slide Time 32:57), what we are doing? We are not using this line, which I say capital ‘L’, for plotting my triangulation figure; I am not using it for that purpose - I am using this check line later on. Once I have plotted my network here, all these points are plotted, then, I check the distance between this point (Refer Slide Time 33:26) and this point in the network, and I compare it with the check line which I had measured in the field. If my survey is correct; if my skeleton is correct; accurate, then the measured line here in the map should be same as the line which was measured in the field. If it is not so, then we suspect there is some error in our skeleton.

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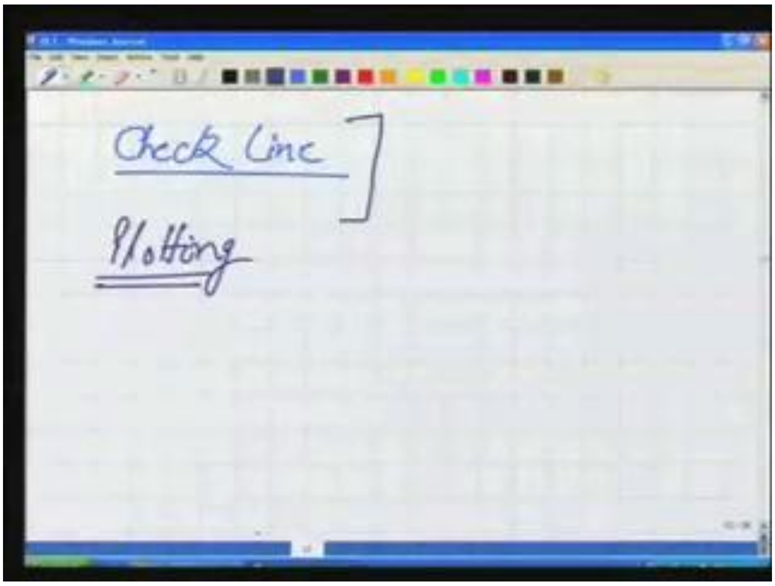
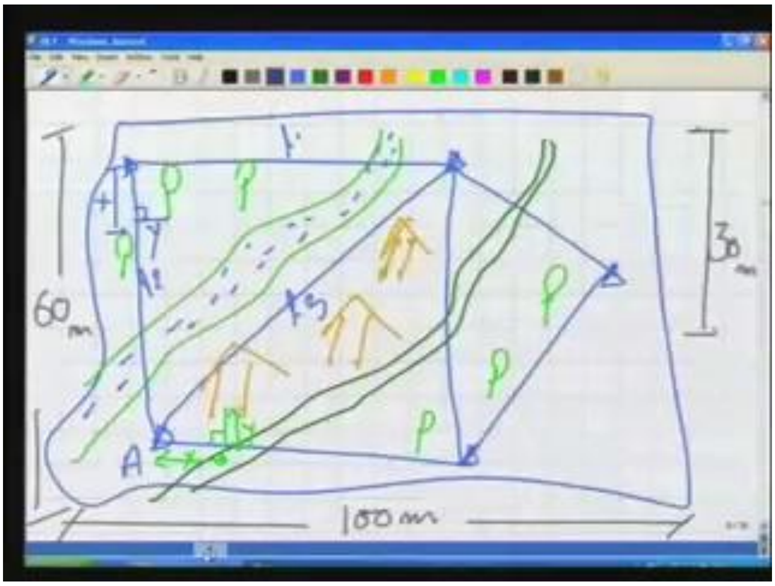


So always, we can have either one or more number of control - check lines in our survey, so we should always go for the check line. Now you understand what is the purpose of the check line - so that we can check the accuracy of our work later on. Now, having said this, we will talk about some more principles which we should keep in mind whenever we are doing in the surveying. Well, next thing comes to our mind is about plotting of the survey, because so far, we were just saying that we have made a map, but there are some things, some important points which are involved which you should keep in mind whenever you are doing the plotting.

(Refer Slide Time 34:48)



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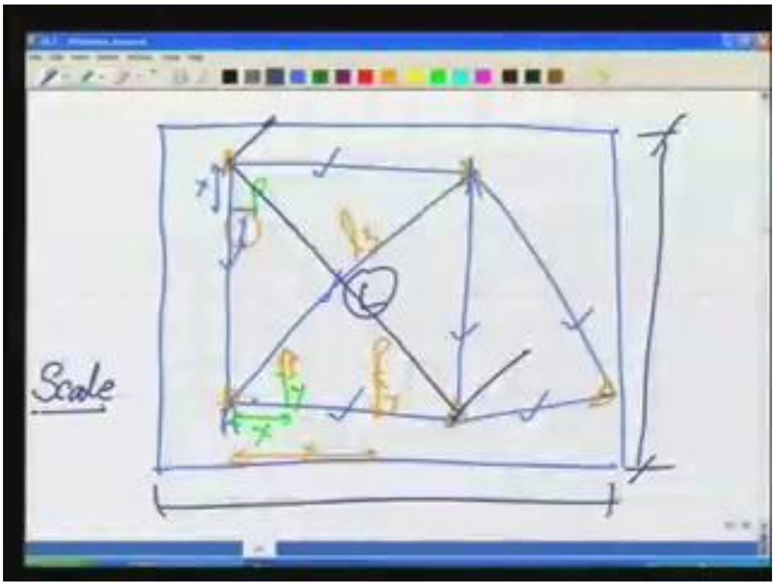

What those things are: here, in this plot, before you make the plot, see the ground; look at the ground size - it was 100 metre by 60 metre - huge area. And what you are trying to do, you are trying to bring that into a sheet - you know the usual size of the drawing sheets; it is very, very small than the actual ground. So how to bring that ground into this sheet? Well, you know the answer, I believe - you have to talk about a thing called ‘scale’. Scale means, we want to convert the distances which are large, there in the ground, into the smaller distances for here, in the map. Now, about this scaling - what are the scales, what are their types?

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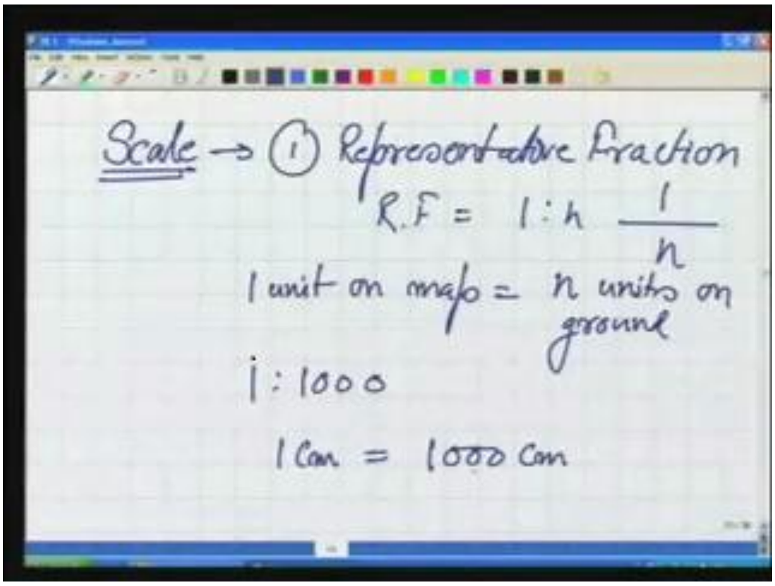

Number one way of representing the scale is by representative fraction. What is this? We write this representative fraction - also it is referred as 'RF' - as 1: n (Refer Slide Time 35:52), also, many times, you can write it as 1/ n - what is the meaning of this? The meaning of this is, one unit on map is equal to n units on ground. Well, let us explain it - if our map scale is 1:1000, the meaning is: 1 centimetre on the map is equal to 1000 centimetres on the ground. So, a distance which is 1000 centimetres there in the ground, we are representing here in our map by 1 centimetre. So, this is how we represent the scale.

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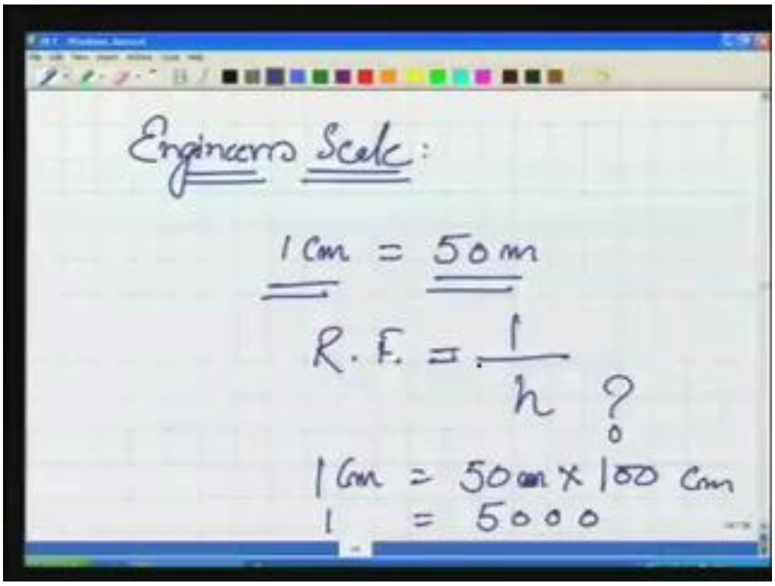
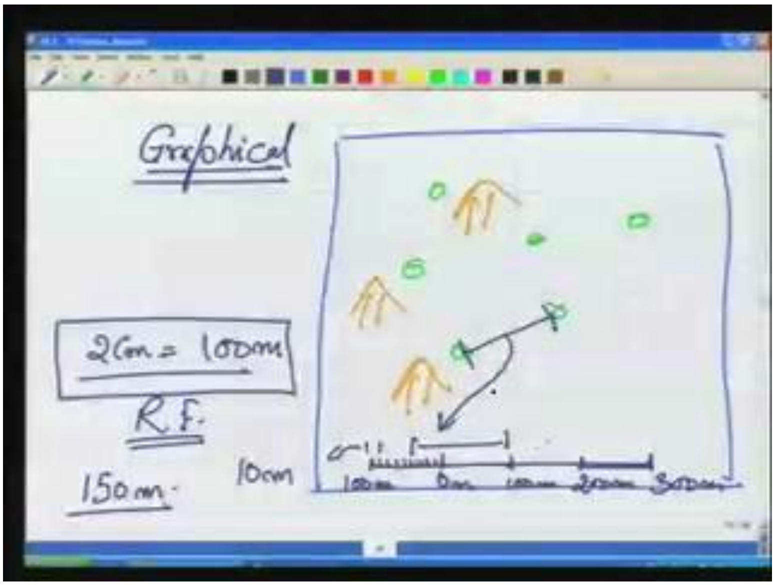


There is one more way of representing the scale which is called 'engineer's scale'- what is this? In case of the engineer's scale, we represent it as such. For example, let us say we write 1 centimetre is equal to 50 metre - what is the meaning of this? This is not another way of writing the scale; it is the same thing, in fact. It is the same thing as the representative fraction, but this is another way we write it down. Now, here in this case, again, the meaning is: 50 metre there in the ground is equivalent to 1 centimetre here on the map. What you can do, you can easily find the representative fraction for this (Refer Slide Time 37:34): 1/ n, and you must compute what will be the value of n. How can you compute? You just convert this also in centimetre: 1 centimetre is equal to 50 metre, multiplied by, let us say I write it in centimetre, 100 centimetre, so 1 is equal to 5-0-0-0 (Refer Slide Time 38:00). So, the value of n is

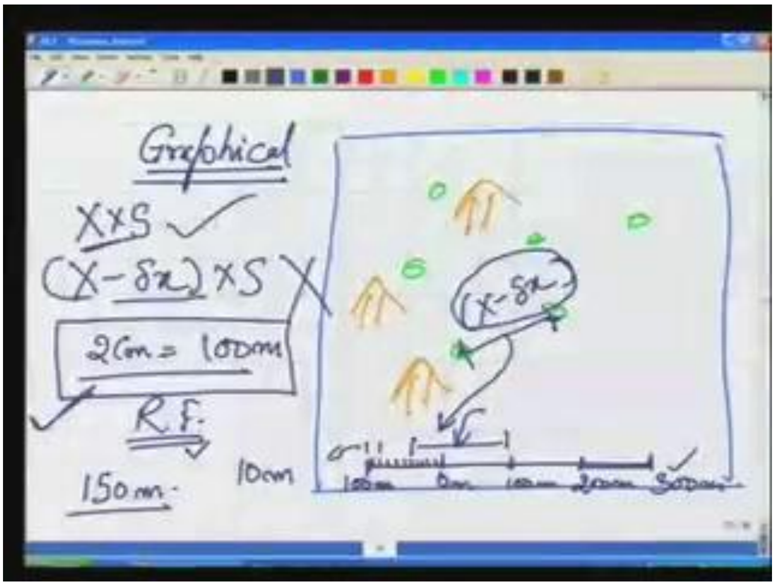
5000 here. So, we can convert the scales like this; we can convert the RF into the engineer’s scale and vice versa.

(Refer Slide Time: 38:17



There is one more way of writing this scale that is called the ‘graphical scale’. Well, what is the graphical scale? Graphical scale is, if you are making a map like this - this is the map (Refer Slide Time 38:31) - and in this map we have plotted some details, whatever these things are. So, there on the map itself, what we do, we plot our graphical scale (Refer Slide Time 38:51). Now, what is the meaning of this? The meaning is, here, in our map, we say - we make a line, and on this line we write - for example (Refer Slide Time 39:06), 0 here, 100 metre, 0 metre again, 100 metre, 200 metre and 300 metre. Further, we divide this first one in ten parts (Refer Slide Time 39:20), so each of these is 10 metre. Now, what is the meaning of this; what we are doing? We are writing in a scale on our map – now, any distance between these two points (Refer Slide Time 39:40), if I can measure this distance, what I can do, I can bring this distance here (Refer Slide Time 39:47). If I keep the distance here, for example, this way (Refer Slide Time 39:52) – isn’t it? What I have done, I have brought this distance and kept it here. So, you can measure the distance between these two to be 100 metre plus, one, two, three, four, five - 150 metre. So, graphical scale is nothing but a graphical way of showing your scale. Because here, in this case, the distance is 2 centimetre, so what we have done? 2 centimetre is equal to 100 metre (Refer Slide Time 40:25), so we can write the corresponding engineer’s scale also, we can write the corresponding RF also. So, the only difference in this case is that we are showing the scale by drawing a line on the map itself.

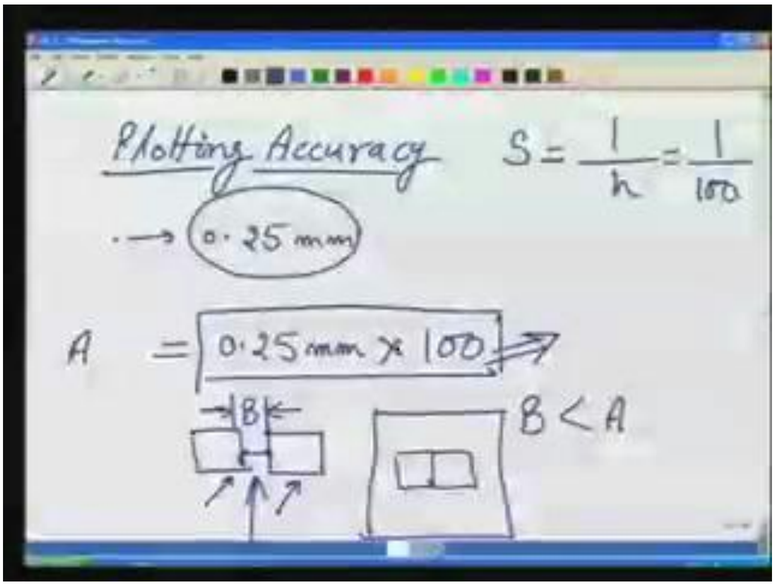
(Refer Slide Time 41:39)



Now, what are the advantages of this? One very big advantage of this is, for example, let us say an engineer's scale is given to you for this map, and there is no graphical scale - it is just bare map without having any graphical scale, and the scale of the map is given only by engineer's scale. Well, after some time - the map is made today, and after, let us say, 10 years, 20 years or so - the map has got shrunk, or maybe it has expanded - because it is paper or whatever the material there - maybe with moisture, with time and all that, it may shrunk or expand. If it is so, what will happen? If this map has shrunk, the distance between these two points which was earlier at - now because it has shrunk, will not remain anymore X (Refer Slide Time 41:40), rather, it will be minus delta X. Now, if that is the case, and now, if you use your engineer's scale in order to determine the distance between these two points there in the ground using map - so, what you will do, you will use not X; you will measure the distance between these two points (Refer Slide Time 42:02) at X minus delta X, you will apply the engineer's scale or the representative fraction on this distance. So what will happen? You will compute a distance which is wrong, because there in the ground the distance is not X minus delta X – rather, the distance is X multiplied by the scale (Refer Slide Time 42:23), not X minus delta X multiplied by scale - no, this is wrong; this is correct (Refer Slide Time 42:34).

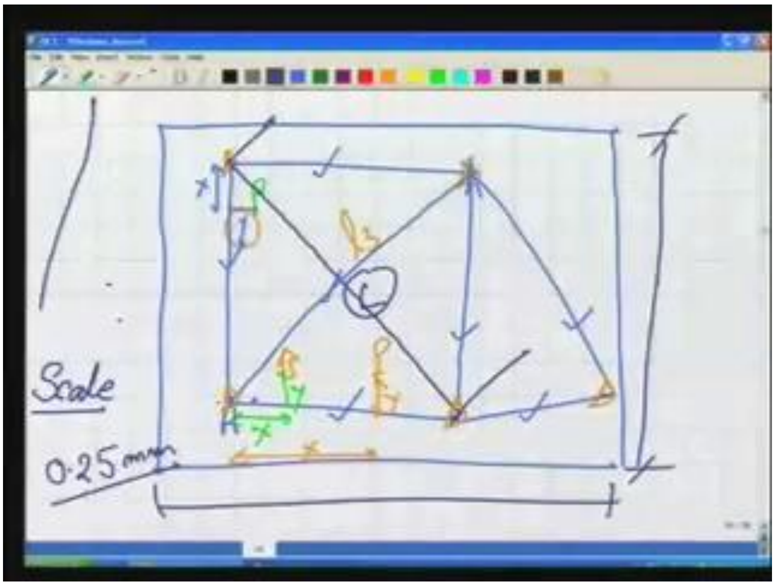
But we will do it like this, because what we are measuring on the map is X minus delta X; we did not know what was the X unless we know the amount of the shrinkage. Well, if you have a graphical scale on the map, what is happening there now? Whatever is the amount of the shrinkage which has occurred between these two points (Refer Slide Time 43:58), we can assume the same shrinkage is taking place in the graphical scale also. So, in the graphical scale, it also shrink by the same amount. So, what we can do? Even if you are measuring X minus delta X, we will measure it here (Refer Slide Time 43:16). Because this scale has also shrunk by the same amount, the distance which we will compute between these two points there in the ground will be the same distance; equal to this (Refer Slide Time 43:26). So, that is one big advantage of the graphical scale.

(Refer Slide Time: 43:45)



Well, some more aspects: when we are talking about this map plotting of the map, there is one more important thing that comes into the picture, and that is, we say, plotting accuracy. What is the meaning of this?

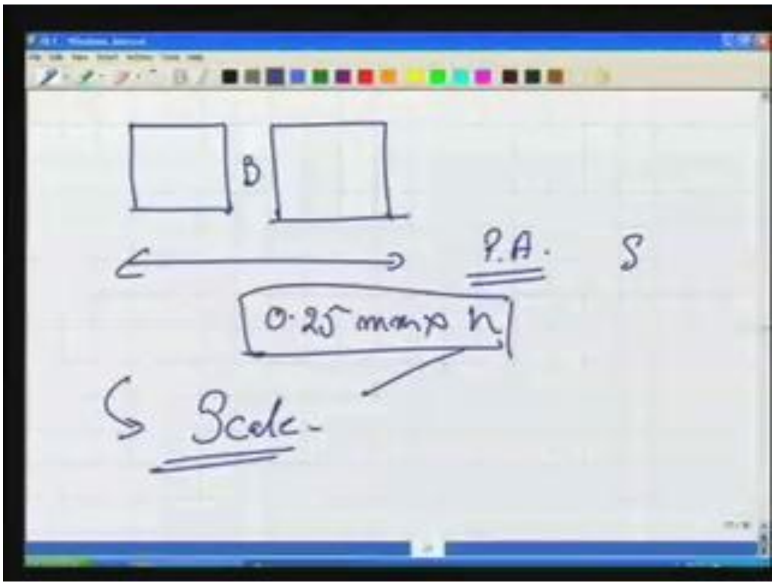
(Refer Slide Time: 44:00)



In your map, the best that you can plot is, let us say, a dot, and the size of the dot, generally - if you are going to be very, very careful - the size of the dot is 0.25 millimetre; using the best possible plotting pen, you can draw a dot of 0.25 mm diameter. Or even if we can say, a line, the thickness of the line is 0.25 mm. What is the meaning of this? Does it convey anything? Yes. Well, when we are talking about the plotting accuracy, there is a dot, and the size of this dot is 0.25 mm on the map. What it is equivalent to, there in the ground? Well, it will be equivalent to - if you are writing the scale as 1 by n, let us say, where n could be any number for example, let us say, 1 by 100 (Refer Slide Time 44:57). What is the meaning of this? A dot of this size there in the ground will be equivalent to 0.25 mm - millimetre - multiplied by 100 - isn't it? So, what is this; what is the meaning of this? There in the ground, if there are two objects - let there be one object here in the ground and there is another object (Refer Slide Time 45:32). If the distance between these two objects in the ground is - let us say this particular value is (Refer Slide Time 45:45), we write it as A, and the distance between these two is B (Refer Slide Time 45:52). If B is less than A, what is the meaning of this? If B is less than A, even if we are measuring this B in the ground, can we plot these two objects separately on one map? Once I am plotting the map, I plot my first object (Refer Slide Time 46:15) - where I plot my next object? To plot my next object, I cannot go here, because the distance between these two is within this line itself (Refer Slide Time 46:24).

So, my next object will be also plotted like this, together (Refer Slide Time 46:31) - isn't it? So, what I mean to say, I mean to say the plotting accuracy is very important. It depends upon the scale; depending upon the scale, there will be a certain value there in the ground - this particular value (Refer Slide Time 46:47). Depending what the scale is, this particular value will change here. So, whatever is this multiplication - the A value - there in the ground, if the objects or the features are smaller than the size, we cannot show them here in the map. Or, if the separation between two objects, as we saw here, is less than the plotting accuracy there in the ground, we cannot show these two objects separated, here in the map. So, we should always keep in our mind that to what extent we should go and map. This is very important, this plotting accuracy - should we measure very accurately in the ground, as in the previous examples?

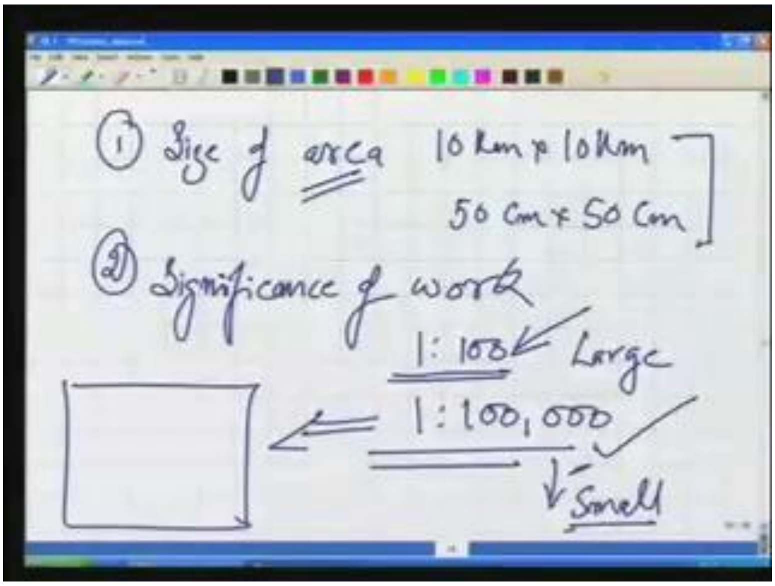
(Refer Slide Time: 47:33)



Should we measure these two objects (Refer Slide Time 47:35) at distance of B - should we measure these two objects as separate objects there in the ground, or should we measure them as one? Well, the decision is to be taken by your plotting accuracy - what your plotting accuracy is, what your scale is, because what you do? You compute multiplied by your scale n (Refer Slide Time 47:58) - any distance, any object, any separations there in the ground which is less than this value should not be measured, because we are not able to plot it. We will be able to plot the things which are more than this only. So this is very important; we should always keep in our mind that what information we should measure in this field that is controlled by the scale.

Having seen all these things - because what we have seen so far? We have seen some principles of surveying. For example, in any mapping exercise we must do the reconnaissance - number one, number two: we should establish a control network because we want to work, always, from whole to part, and we fix the control network in our area first. I gave you the way we can do it by triangulation; we will see it later on that we can do it by many methods. We established the control network, we measured it very accurately so our skeleton is fixed. We can bring this skeleton into the laboratory; plot it. Now we work in part; we measure the individual objects, and then, while we are doing the plotting, we need to see about the scale - what scale is to be chosen. Well, I have more question here - how to decide about the scale? Can you think of some point?

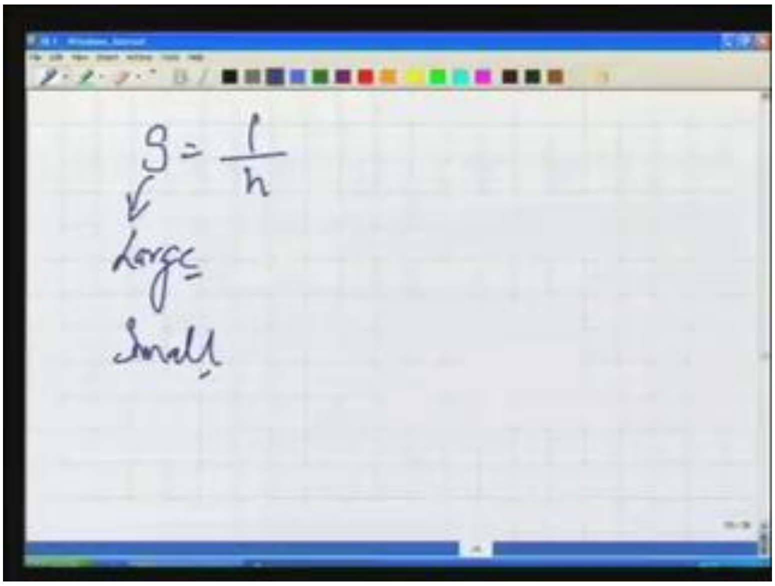
(Refer Slide Time: 49:27)



Well, the scale will be decided by: number one, size of the area. If there is an area - for example, 10 kilometre by 10 kilometre - and you have plotting sheet of - let us say 50 centimetre by 50 centimetre is the plotting area. So what will be the scale? You know you can find the scale, but this is not the only criterion by which the scale is decided, size of the area; many times, it is 'significance' (ddd 49:55). What is the meaning of 'significance of work'? When you want to go for higher scale, when you want to go for lower scale - sometimes, you want to go for higher scale; you want to plot it 1:100, sometimes you want to plot it 1:100,000.

When you want to plot it 1:100,00 the meaning is, you want to plot a map of entire state; of entire country. For example, for the entire Uttar Pradesh - you want to show in one map so we will go for a scale like this, because plotting at this scale, we can bring the entire state in our plotting area. Plotting area is generally a drawing sheet or may be slightly larger than that. So, the entire state comes in that, and here, in this case, if we are talking about this scale (Refer Slide Time 50:49), what we are interested in? We are interested in a synoptic view of the area, not in the details, because you do not expect to see individual houses, individual roads, individual trees at this scale. But if you want to have a very, very detailed map; you want to see the individual tree, individual building, their rooms - everything - you need to go for a scale like this (Refer Slide Time 51:16). Now, out of these two, this scale is called large (Refer Slide Time 51:19), while this scale is called small.

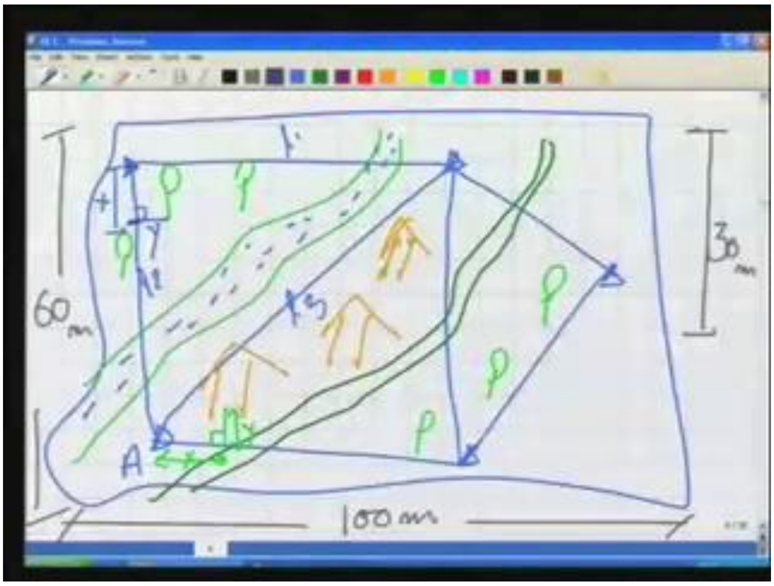
(Refer Slide Time: 51:36)



We must keep in mind the value of - because the way we are writing the scale; the scale is written as S; 1/n (Refer Slide Time 51:35), so depending on this value of S, the scale is said to be either large or small. If S is large, it is large; if S is small, it is small. So, we should know that when we say the scale to be large, when we say the scale to be small. In large scale and in the small scale, the amount of the information will be different.

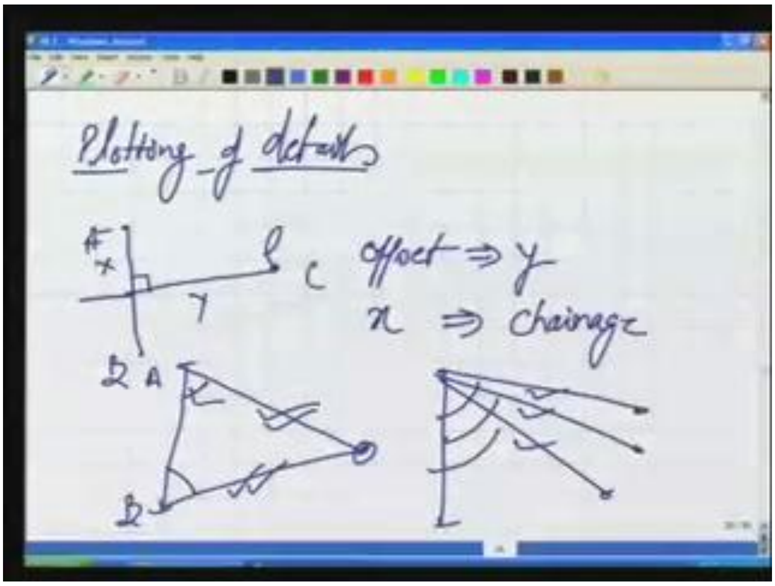
Now, something about - because we are doing some kind of repetition, you know: after talking about the scale we talked about the plotting accuracy, how plotting accuracy is important because we can decide what level of information is to be captured in the ground; is to be measured there in the ground - it is decided by the plotting accuracy or scale. So, we should know this thing; we should be aware. Then the other thing: whenever we are doing any measurement, we must do the measurement by some redundancy; we should have redundant measurements. Then the other thing: we should always have the check line because we want to ensure after doing our work, we can check our work; the accuracy of our work. So, we must have the check lines in our work. So, these are all important principles of surveying we should always keep in our mind whenever we are doing any job.

(Refer Slide Time 53:19)



Now finally, how we plot the details - some little bit about it; this is very simple. Plotting of details - how do we plot the details? As we are doing in the map also, we saw it here in number 10 (Refer Slide Time 53:15) - we plotted some of the details. What we did in that case, for example, for this tree (Refer Slide Time 53:20), we measured the distance from this point to this point - X - and then from here we drew a perpendicular and we measured along this perpendicular the distance Y. So, making use of these two, we can plot the scale. Similarly, there are many ways in which we can plot the details. Now, what these ways are?

(Refer Slide Time: 53:02)



For example, let us say, if we have a line, we know these two points (Refer Slide Time 53:45) A and B, a third point C can be plotted by dropping a perpendicular and measuring this X, as we did in the earlier case - so this is called an offset. While the X - offset is Y - while the X is called chainage. We will talk about it later also. So, at this stage, we have an offset of Y, and at that point, we have a tree - this is how we can plot the things. Well, the other way round (Refer Slide Time 54:30): on the same point A and B, we can plot a third point now by many ways. You can measure either both the angles (Refer Slide Time 54:35) - this point will be fixed, we can measure one angle and one length - this point will be fixed, we can measure both the lengths - this length and as well as this length (Refer Slide Time 54:47) - this point will be fixed, or we can go in the polar way. For example, from this point (Refer Slide Time 54:54), you can plot many points now, by measuring all these lengths and all these angles. So, all these details can be fixed. So we just know that how can we make use of simple geometry for plotting the things in the field. We will talk about these things more, later on.

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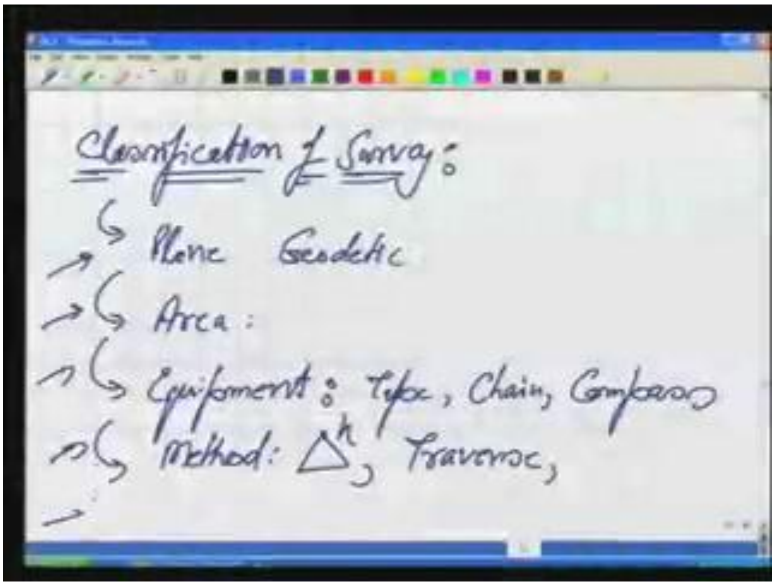

Finally, a little bit about classification of survey: you should look in your books about this, because this is nothing very important. About how we classify the surveys, we have seen already: plane, when we consider our earth to be flat, or geodetic. The another classification is as per the area - for what kind of area we are doing the classification? Is this a town, is this a village, an agriculture area - so we do the classification based on area. Also, we can do the classification based on equipments - what equipment we are using. Are we using tape, chain compass, theodolite, total stations, GPS - as we will see later on. So, we can classify our survey this way also. Then, we can classify using the methods; the techniques. The meaning is, are we using triangulation or we are using this traverse - we will talk about all these things later on - or we are using any other methods for doing our surveying. So our surveying can be classified by all these various categories, and one more classification is possible, which we say, by the function or the use. Who is using the survey; who is doing it? Is this a military survey, is this an agricultural survey, is this an hydrographic survey - you know, who is the organisation who is doing that survey, and what is the purpose for the survey; is this some mining survey or is this a survey for any geographer? So, depending on those; the functionality for which we are doing the survey. So, we can classify our survey. This is not very important; not very important concept is involved in this, so I would advise you to go through your book, the text book, and read about this.

So I will finish my this video lecture here, and we will continue our discussions in the next video lecture. Thank you very much.