Surveying
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Module - 8
Lecture - 2

Plane Tabling

Welcome to this video lecture series on basic surveying. Presently we are talking about plane tabling which is in our module number eight, and today we will be in lecture number two.

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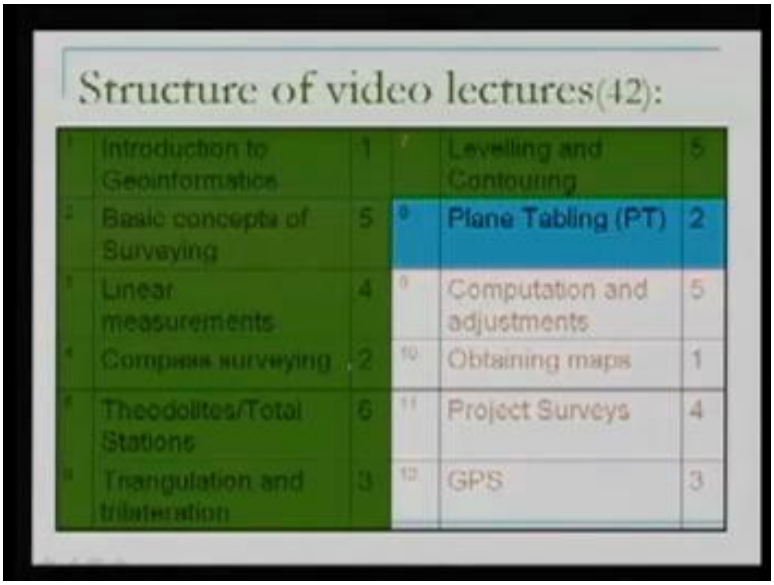

This is the entire structure of the course the full video lecture course.

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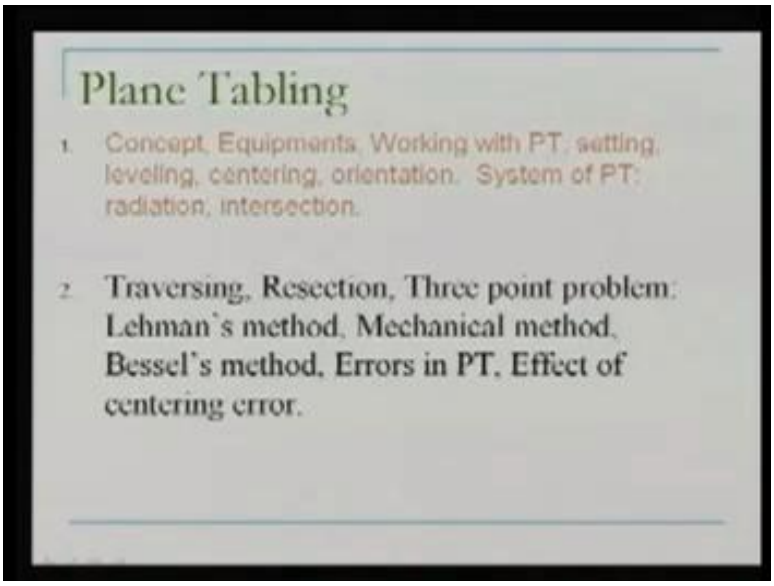

What we have discussed so far in plane tabling? We talked about the concept, why we need to do plane tabling? We do it for filling the details. Then we looked into some instruments, the equipments which we use in the plane tabling. Then we went into the methods. Well we have the methods of radiation intersection in order to plot the details. Before that we need to set up the plane table level it and oriented. We have also seen the methods of orientation how to orient the plane table. What we will you do today? We continue further and we will talk about one more method of plotting the details which is called traversing, then a very interesting concept resection, three point problem. We will look into the methods, Lehman's methods, mechanical method, Bessel's method in order to solve three point problem.

Then a little bit about the errors in the plane table, more importantly if we mis-centre the plane table what is the effect of this centreing error? This is what we will talk about today. So let us begin with the method of plotting the details. We have seen two methods so far like the radiation. In the case of the radiation what we do? We take using the alidade, for example we are standing here I have got the plane table and on that plane table I keep my alidade. Through the alidade I sight a particular object, I draw a line along the straight edge of the alidade. We say that as resector. Once that is done or the ray once that is done to the object or to the feature we measure the distance actually on

the ground and by measuring the distance we convert it onto the scale at which we want to make the map and plot the point.

So this is the method of radiation. The points are plotted, we need to measure the distances to all the points. We have seen the problem with that and we eliminated that problem in case of intersection. In case of intersection we just occupied you know one point took many to various features there then we occupied the another point. We measure only one distance between the point which is first we occupied and the next point. We convert this distance onto the scale and using this distance only we orient our table at the second point by back sighting. So that was the procedure for intersection and by the from the second station all the resectors they will intersect the resectors from the previous station and those points of intersections are actually the features. So this is how we are eliminating the distance measurement on the field. However there is some limitation.

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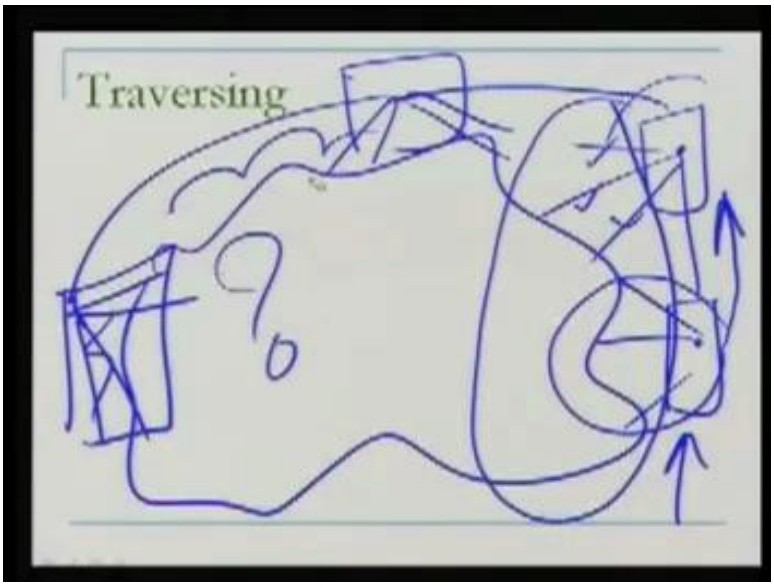

The limitation is if for the example we (( )) a big feature okay and we want to do, we want to occupy one point and the second point. Our plane table is here. Second time it is

here and we are plotting these details by intersection okay? So what we can do by intersection? We can plot only a little part of it. How about this part? How we are going to plot all these because our plane tables are only here so this can be realized now if we replicate the same process, you know what we did; we occupied one point made some resectors then we are moving to the second point again we are drawing some resectors then possibly we can move to the third point again draw some more resectors then the fourth point again draw the resectors. So that way what we are doing we are rather forming a traverse so this method of plotting is called the traversing. So we will see one example of the traversing now. How we plot in the traversing, okay?

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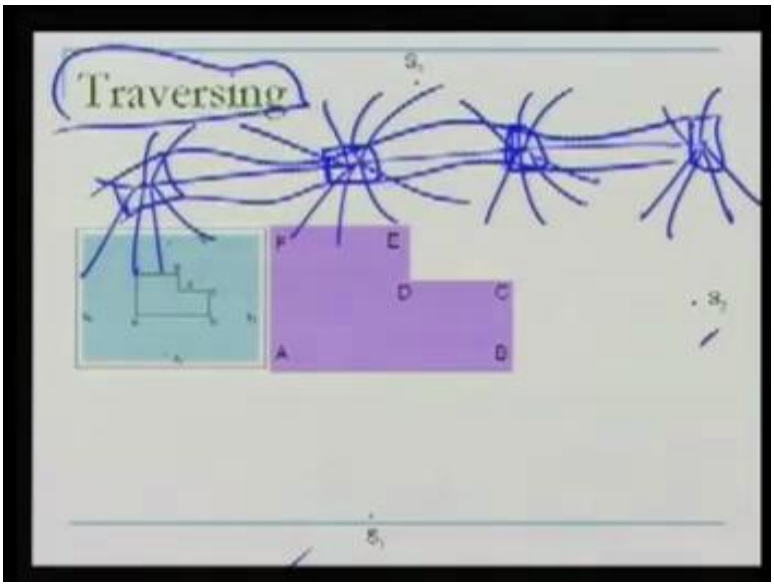

We have taken a building here and in this building these are the corners we occupy, let us say point S1 and we have also taken a decision that after S1, I will occupy S2, then S3 and then S4 and I can complete or rather cover this entire building. We keep our plane table here. This is small. S1 here, this is S1 because my plane table is over the ground point. S1, so this point is S1. Okay, now what we do from this S1? We draw resectors. Resectors means we use the alidade and start drawing the resectors. First we sight the station S4, okay? We draw this particular point, I measure this distance. This distance is measured, okay, because this is the distance between our main stations. So we measure

this distance and then we plot this point here. So this S4 is plotted. Then next I am drawing a resector to the corner A, then to a corner B. Right now I am not plotting this A here, okay? Because I am not measuring the distance from S1 to A.

Similarly for B also I am just drawing resectors. So I have got resector here and here, but still we do not know where these A and B are on my sheet. This is not known to us. How we will know it? We will know it by intersection once we shift our plane table to the other station. Well let us do it. Before doing that of course we will take a sight to S2 also and we will plot this S2 on my sheet here because this is my main control stations. S2 is plotted. Next we take this plane table to S2 so if I take the plane table to S2, you remember what was there in the plane table? Right at this moment in the plane table we have S4 plotted, S2 plotted and this resector and this resector, these are plotted.
So when we carry the table to S2, we will have all these on our table. Well at this S2 we will orient our table by the back sighting. Back sighting means we are keeping the alidade at S2 and we are keeping it in such a way that the straight line about the straight edge of the alidade passes through S1, or if the other way around I can say we keep the alidade in such a way that it's as is passing through S1 and S2. Then we rotate our table at this point in such a way that S1 is bisected. Once that is done, the meaning is we have oriented our table. So the table is oriented. Now once the table is oriented we start drawing the other resectors, okay? So resectors to B, well this was the resected to B at S1 station and here is the resected to B as you can see at S2 station. So the result of these two the intersection is point P. So our point B is known here so we have plotted the point B.

Next we will take some more resectors. For example to the c and I have got a resector now to c. Well next to e and then we will again take of sight to this station s3 because we want to now shift our table here. Same intersection we would like to do by shifting the table to s3. Well the table is now shifted to s3. Once the table is shifted to s3 again we will orient the table here by back sighting this s2 because s3 and s2 both are known on my table. Once the back sighting is done, the orientation is done again. The job is now to take some more resectors for example to the f corner of the building over here, then to the e corner of the building then to the c corner of the building and wherever they intersect

with the corresponding, ones you know the corresponding resectors. All these points are now been plotted. Similarly we can take our table to s4 point and there in the s4 point also we start drawing the resectors. Okay. So we are drawing these resectors here now. So all the points of intersection as we can see here, now the corresponding resectors, they intersect here, okay? By joining all these points what we should be able to get? We will able to get the map of the area.

So for a large building, which cannot be covered from only two stations by intersection we rather take a full round, we make a traverse. So this is the method of traversing. In this case we have taken a large building but the same thing can be applied for other cases also. For example if there is a road, okay? We can start from our plane table here, then we move to the next point, then we move to the next point, then we move to the next point. So what we are doing actually? We are forming a traverse and by this traverse we are also plotting the details on both the sides of the road. So these are resectors, wherever they'll intersect on the table we can plot the road so we can go for this traverse in different cases.

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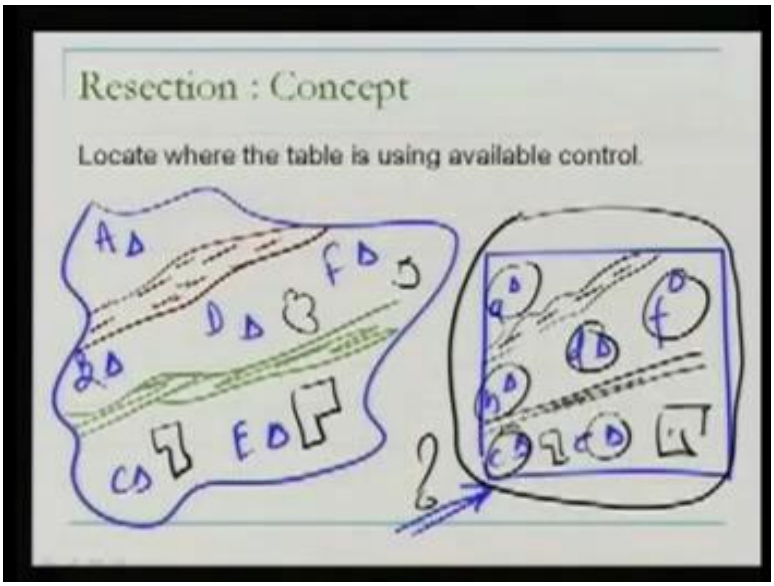

Well let us look at the new concept and this is the concept of resection. What we know by this time? We know the methods of plotting. Now here is the very important concept which we should see. As we have discussed before also in the case of the plane table, we have already mostly some controls available. Now what is the meaning of this? Let us say over there is a ground. In this ground by some method, we established a set up controls. This method could be triangulation or traversing or any other method and this setup control is plotted on our plane table. The meaning is well, we have got these controls plotted here. Now this is our drawing sheet and this drawing sheet is attached to the plane table. If this is A, B, C, D, E and F, the points on the ground the corresponding points are plotted on the sheet as we have discussed previously. Also you know concept of whole to part. What we discussed, the control network brings the skeleton of the area. Okay the control network is done very accurately, so the skeleton of the area is fixed very accurately.

Next what we need to do? We need to fill the details, you know, whole to part. We want to work in the part. Well let us say this particular area has a road or may be a river. There is part of river here. These are the features, these are the features there on the ground or may be some houses or whatever. Okay. May be some trees. Now have been established this control a, b, c, d, all that. Now what we want to do on my sheet? On my plane table, here I want to plot the river. I want to plot that, I want to plot the road. I also want to plot the buildings where these are now. The question is how to do that there in the ground?

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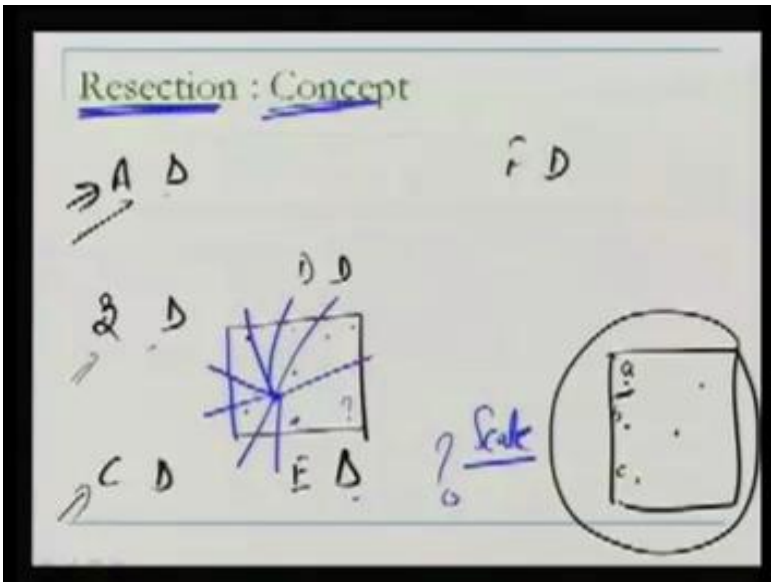

What we have there in the ground? In the ground if you go with this plane table, we have A, B, C, D, E and F. These are the stations. Now in my plane table as we saw, this is the plane table and in this plane table we do not have anything but only these locations plotted, these control networks plotted. So the plane table looks like only few points plotted there. We know the corresponding points there on the ground, that this point small a is corresponding to this point. Now so here we know this small a is corresponding to a point there in the ground similarly b, c and others. Now when we take this plane table to the field in order to plot the details, for example let us say I am occupying somewhere here and I have got these stations plotted. In order to start plotting as we have seen in the method of radiation, let us say we want to do method of radiation in order to start plotting, what should I do?

Number one, I must orient my table. If my table is not oriented I cannot plot and if I plot, my map will be distorted. Number two, I must also know where I am on the plane table, okay. What is the meaning of this? I am occupying, with the plane table, this point of the ground where I am standing right now but on the plane table we have the controlled network plotted within that control network. The idea is if we see again here if we are occupying this particular point here. Okay we are occupying here. Now where am I in the

plane table? Am I here, am I here or am I here? Here one thing you can guess very well because of the geometry. A, B, C, D, E, F we have this plotted here. A, B, C, D and E here and F. Okay we have these points plotted. We are somewhere in between B, D, E, C. So we are somewhere in between B, there is A, B, D, C and E. That means we are somewhere here but where exactly am I? Here? Here? Here? Also these distances could be very large depending on what is your scale.

At what scale we are making the plot? This, even this much distance could be very very large. So I need to pinpoint my location on the plane table exactly. At this procedure, this procedure in which we make use of available control points which are plotted on the sheet as well as which are there in the ground, in order to locate where I am on my plane table is called resection. So this is the resection because we need to do it once we locate ourselves, okay? Yes we take a decision here now. The decision is fine, I have found somehow, whatever the method that I am here. Then I can start plotting. If I am here my table is oriented. I can start plotting that little house or the rework or the road network by drawing the radiators or the resectors and plot measuring the distances. So resection is very very important thing now.

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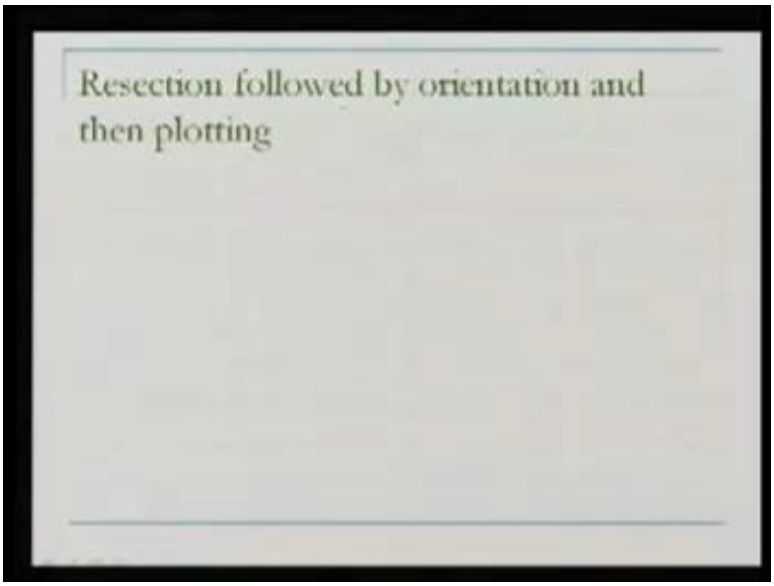

We have seen this that the plotting will be followed by orientation and resection.

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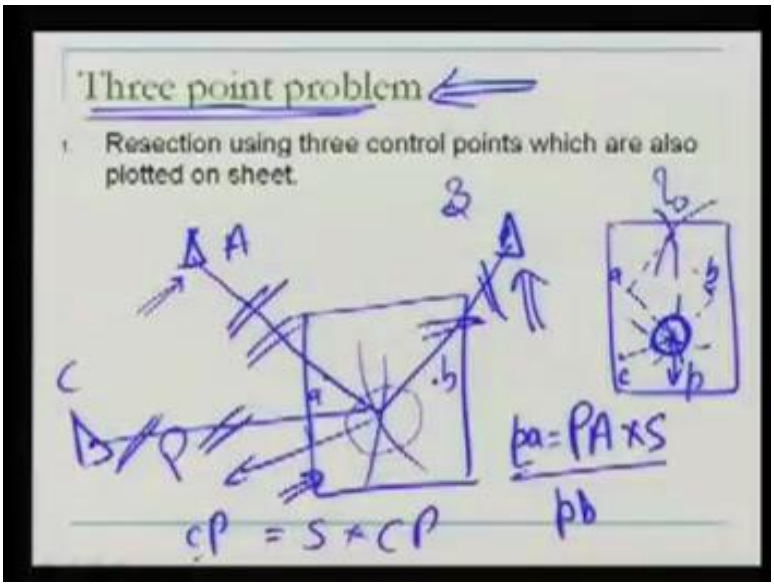

We are looking into how to handle this problem, okay? If we have three points known, this one problem of resection is called three point problem. Why it is called three point problem? Let us say there in the ground we have two points first a and the another one is b. These are the two points okay and these two points are also plotted on my sheet a and b. Now we want to determine if we are occupying somewhere here with this plane table. A and b plotted on the plane table and these are the points in ground. These could be the corner for the buildings, some trees, some triangulation stations, whatever, this capital a and capital b. This is our drawing sheet or the plane table. Now I want to know where I am. Well the approximately we can guess we are somewhere here but where exactly? If I can measure somehow the distance from a to this point and capital b to this point, okay? I can take the arcs in order to locate myself. What is the meaning of this? If I can measure this distance and this distance I will convert these to the scale. If this point is capital p, so a small pa is capital pa multiplied by this scale okay?

So this small pa, I will take an arc here. Similarly with the small pb, I will take another arc so we can locate this point small p, yes? We should be here but at the same time these

arcs will also cut here. Okay? So which of these two solutions is possible or which one is correct? So in order to avoid this condition what we do? We take rather a three point, third point also. This is c and we measure this distance cp also and we convert it by multiplying by this scale into small c small p. So from a third point also which is small c we take another arc so that fixes our point. Well we are definitely on this point so this is method of resection and this is why we need three points for a unique solution. Now how we do it? We do not do it by measuring the distances. You know in the ground it may not be always possible for you to measure these distances. These distances could be of order of five kilometres, two kilometre. It is not always possible to measure these distances. We are looking for some method in which we can do it and the solution is also feasible in the field what the solution could be. Well let us look at that solution now of that three point problem.

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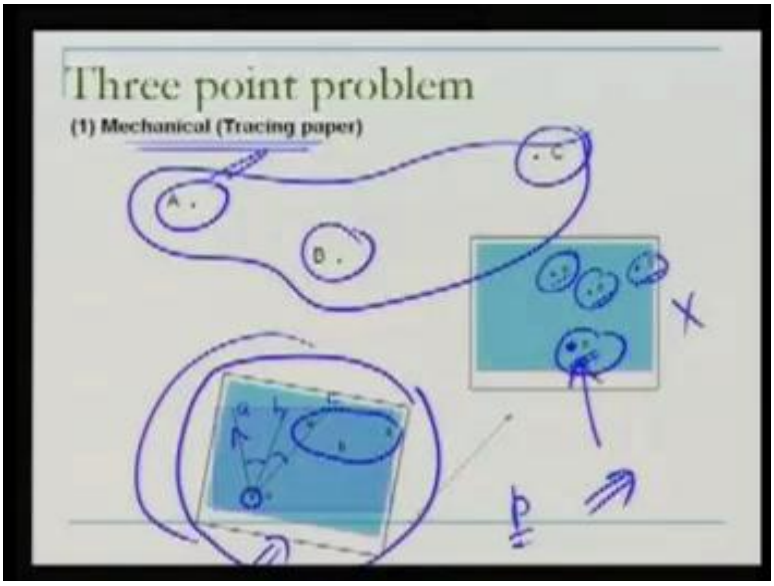

To solve this three point problem the very first method that will discuss is tracing paper method. What we do in this method? Let us say there are three points and this whenever I am saying capital letters you know these points are there in the field. These may be the triangulation stations or these may be the corners of the buildings. These may be the electrical poles or they these may you know some telephone poles something, some

permanent features which we observed as the control point, okay. So these are the control points. This A, B and C as well as we know this control point is also plotted on our sheet, a, b and c. So they are plotted on our sheet also. What we are looking for? You are looking for to orient our table right now. You will observe that the table is not oriented because this ac line is not parallel to the ac line, these two are not parallel.

So we are looking to orient this table. Once our table is oriented we can determine very well where we are just by drawing some resectors. Well let us do it now. In this particular method of tracing paper method, we make use of a tracing paper and we put it on top of the plane table. Now under the tracing paper we have these points a, b and c plotted on the plane table. Now we choose any of the point on the tracing paper so this is small p is marked on the plane table and what we do from this small p? Without having any concern for these points at the moment we draw resectors to A, to B and to C.

This is very important. What we are trying to realize here? See we have now three resectors to a and b, b and c. So somehow I have found alpha and beta angles between these resectors. Now one thing very important here; see we are where? Where our position should be if we are occupying with reference to these A, B and C? If my plane table is here so on my sheet with reference to A, B and C I should be somewhere here, okay? So on my sheet I should be somewhere here and if my actual location is this, you know, as we know if my plane table is oriented corresponding to A, B and C. I had a small a small b and small c and that is the point p where I am. Now this angle is alpha, this angle is beta. Now one thing which is very important here in this tracing paper method; what we did in the tracing paper method as you can see we put a tracing paper here. That was our sheet which is not oriented or the plane table. We put the tracing paper here and on tracing paper we started drawing those resectors and what we are getting here? We are getting these three lines and the angle between these three is alpha and beta and this alpha and beta are same as the alpha and beta here. Know why it is so? Because the distance from plane table to those points control point is very large a little bit shift here it is not going to hamper it much.

So the alpha and beta wherever I do on the plane table alpha and beta will be nearly those values, which are same as the actual alpha and beta. So by doing this we have realized these two horizontal angles. Next what we do? I am showing it here but in fact we do this particular procedure over here also only. We do not do it here but in order to show the procedure I am just taking it here otherwise this procedure is done on this point. Well this alpha and beta and these resector this is the resectors resected to a to b and to c. Right now these three lines are drawn on the tracing paper. Okay. So what we can do now we can shift the tracing paper here and there as well as rotate it in such a way that these three resectors they pass through their corresponding points on the plane table. Let us do it. We are doing it here, please look at carefully. We just shift here in this case, okay? This could be also rotation. We rotate our tracing sheet or we shifted here and there in such a way that these three resectors: the resector here, here and here, they pass through their corresponding points.

This point is A, this point is B and this point is C, which are on the sheet. So just by shifting it was achieved in this case. Well what we have realized now? This point p with reference to this a, b, c, where it should be? It should be at this point. What we will do? This point small p is still marked on the tracing paper. So we will pick this point down on the sheet. So by picking it we will mark that point on the sheet and we will remove the tracing paper. So what we have got at this moment? We have got now a, b and c which were already plotted on the sheet and this point p which we have not found. So basically what is this p, this small p? This small p is the location of plane table with reference to our control. It should be here so with reference to our control the plane table is located at this small p, that is what the meaning of this. Well once we have found this small p what to do next? Well in the next case.

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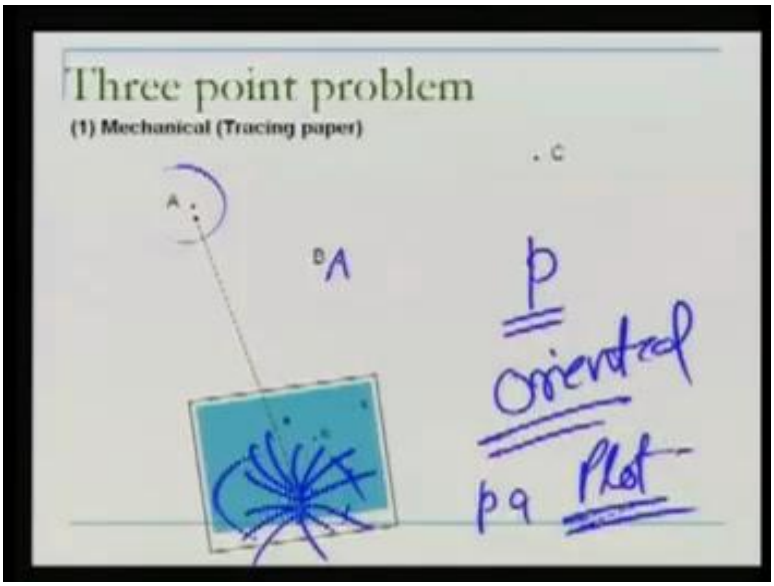

Let us say we bring this table because we had seen here. Also as i was telling you we do this particular procedure over here only, alright? So what we have found? We have now a, b, c and this small p located. We keep the alidade. This is the alidade here, we keep the alidade along pa. This is the point pa and this will not pass through a there in the ground because my table is not oriented. So what we do next in order to orient our table? We will have to rotate our table. So we rotate our table now. So by this rotation we will ensure that our resector is passing through A. At that point my table is oriented. In order to check it what we can do? We can again keep our alidade along small p and small b and we will check that the resectors should pass through B as well as small p and at small c, the resectors should pass through C.

So at this point we know where we are, p as well as our table is oriented so the meaning is we are ready to plot. We can start plotting from this point now. Using this p i can plot the various details by taking the resectors or by measuring the distances and plotting the things. So this is the tracing paper method of solving three point problem, okay? Are there any problems with the tracing paper method? Yes it is difficult to work in the field. You know there may be the winds in the field. So working with the tracing paper putting it there drawing the lines and you know rotating that again it is a kind of trial and error, number one. Then there may be the problem because the wind that is, may go here and

there and we have to look for a solution which you can work with in the field. Can there be a solution which is different than this one? We have one more very good solution which we say the Bessel's method.

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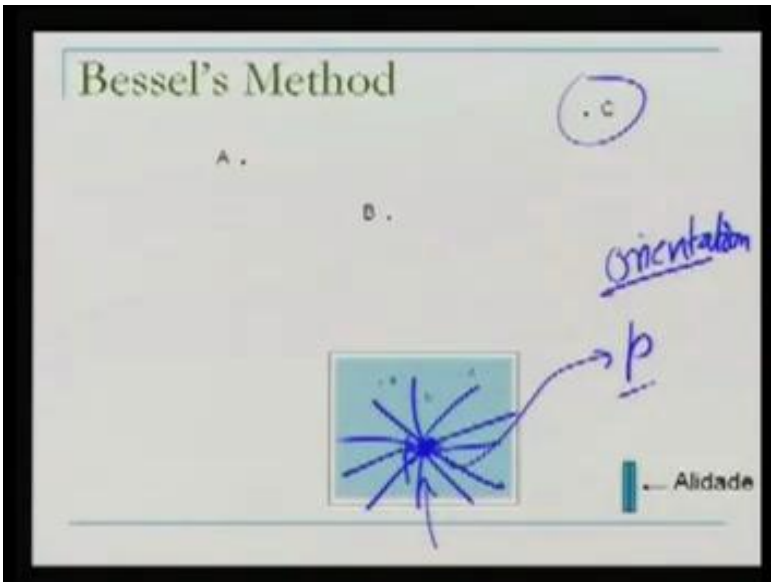

Now in this particular method again, we have now three control points there on the ground A, B and C. These three control points are plotted on my sheet. This is a, b and c. They are plotted on the sheet. At the moment my sheet is not oriented okay? The sheet is not oriented as you can see. In order to do this Bessel's method what we do we have we follow some steps and please follow these steps carefully. We are going to list those steps here. You can find these steps also in any of the text books but following those steps carefully is very important. Number one, number two to understand; as we know the concept, you know what we are doing on the tracing paper method? In tracing paper method you are trying to realize the horizontal angles which are being formed by those control points at the point where we are standing. Somehow we found those angles and then on my sheet by shifting the tracing paper here and there we found the small p because small p should satisfy those angle conditions.

So we know the concept there now here will follow the steps but again it is important to understand the concept of the method. This method is also based on the same concept of the angles alpha and beta as you will see now. So the very first step here is we place alidade at ba. Okay the alidade is placed on ba. Ba is here small. After placing the alidade on ba we rotate the table to sight A. So what is the meaning of this? That means your eye is here and you are looking in this direction. Okay. Now you rotate the table so that A can be bisected. Well let us do it. If you rotate the table so that A is bisected well that is the condition. Well here in this case as you will see A is being bisected by the resector because our eye is now here. You are looking in this direction. Once this is done we clamp the table. The next step is clamping. After clamping the table we rotate the alidade about b to sight C.

Well we rotate the alidade over here, the alidade is rotated so that you can sight C. Let us do it. Well it is how it has been realized and we draw a line and that line we say XY. So in that condition once this C was being bisected by keeping the alidade at small b, we have drawn this line XY. Next we are repeating in similar steps but now what we are doing? We are keeping the alidade along ab. We are keeping at a and at b so our eye is like this here, okay? And we are looking along this line and we rotate this alidade or other we unclamp the table and now we rotate the table along with the alidade okay. The table is being rotated along with the alidade so that B is bisected. Well let us do that. If you do it the table will rotate like this and the B is being bisected again. We clamp the table. So the table is clamped now. Next step we keep the alidade at a to bisect C. Capital C means there on the ground, so we keep it at a and we bisect capital C. So now we are looking like this the table is clamped the table is not moving in order to bisect earlier the alidade was along ab. Now we have to rotate the alidade so that it bisects C. So table is clamped and we rotate the alidade to bisect C.

Now the intersection of XY and this resector it gives us a point c dash, okay. That point is c dash. So once we have this point c dash, we keep the alidade along c dash c. C dash c means c dash c, so we keep the alidade like this and now again we unclamp the table. We have to follow this step very carefully. We are unclamping the table, now keeping the

alidade along c dash c. Now you rotate the entire table. Well let us rotate the entire table now. Here if you rotate the entire table keeping the alidade along c dash c in order to bisect c. So what we will have? We will, we have alidade along c dash c and we are bisecting capital C there on the field. At this stage again we clamped the table. If we are performed all these steps what will you find? What we will notice at this stage, the table is oriented so this is really interesting, how by following these step the table gets oriented.

If you get into this method did you realise: basically again the same alpha and beta angle we are, playing with those angles. We are somehow, we are generating those angles here also and somehow as in the condition of the tracing paper method we are doing something similar to that by following these steps but it is not trial and error. We have our table oriented here. Once the table is oriented what we have we have now our oriented table as well as small a b and c which are already plotted there. Now the question is where am i now? The table is oriented we are clamped the table and table is kept at capital p. We want to determine this small p on the table where am i? Well i understand i should be somewhere here exactly. Now in order to handle this problem, in order to answer this problem we already have the concepts. If you just think of the method of radiation in that we knew small p and we found the small a small b and small c by drawing those resectors, okay.

Here in this case the table is oriented. I know small a, small b and small c on the sheet. I know the corresponding capital a, capital b and capital c there on the ground and now i want to determine the small p, okay? So the job is very easy. How we keep the alidade at small b on the drawing sheet. Okay. At a small b and i rotate the alidade till the corresponding point there on the ground capital b is bisected and i draw the resector. Well the resector is drawn here, that is the resector. Second i keep the alidade at a small c, i can do it for a also at small c, rotate the alidade now table is not being rotated because table is oriented. It is clamped. I only rotate the alidade so that capital c there on the ground is bisected. I draw a resector. Let us do it now here. I am sighting c, drawing a resector so we get a point of intersection here. Obviously as we understand this point of intersection

is the point where we are which we say as small p. So we have our orientation as was already done by Bessel's method and as well as now we know where is small p. So we know this particular point also. Once we know this our job is done. We can now start plotting the various features. Okay. Because we need to know where this point is in order to start our plotting.

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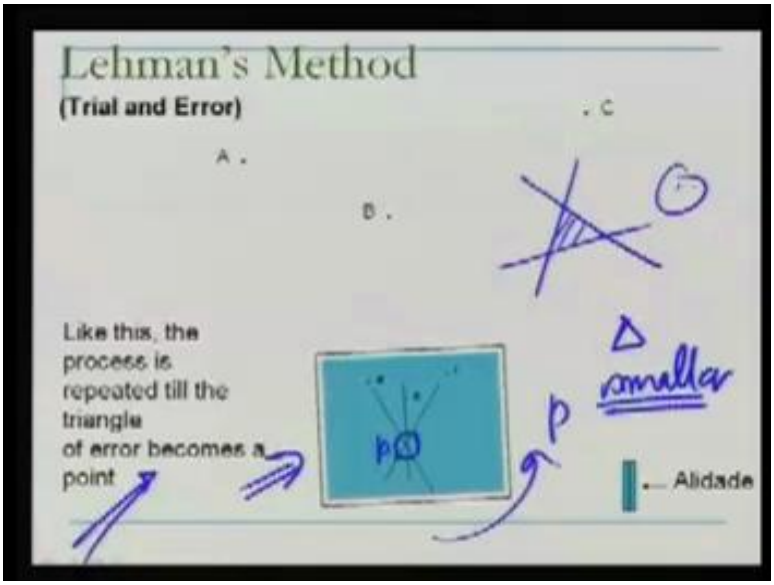

Well there is one more method, which is the Lehman's method. Again it is trial and error method. What we do in this method? Same thing. Three points there on the field which are the control points. We know their location you know this capital A, capital B and capital C, which I am showing you could be anything. The condition here is we should be able to locate that. You carry your plane table put it there and then we look around for the control features which are also plotted. On the plane table have been located those then we start the process of three point problem. We solve the three point problem in order to two things, orient our table, as well as find where we are. Now in this method, the Lehman's method, how we go about? Well this is our table. Let us say our table is kept at a certain point, somewhere. We want to do two things. Number one, we want to orient and number two, we want to resect, means we want to determine that a small p where it is.

Now how we do that in this method? First of all we put our alidade along small a okay? That is the point of small area, the point which is plotted on the sheet this is small b and small c and the alidade is kept on small a. Now i bisect the corresponding point on the field. Table is clamped, table is not moving. I rotate the alidade in order to bisect capital a. Let us do it. Okay it is bisected and i draw a resector. Well the resector is drawn here. Now similarly i do for b, i do it for c. Also, well before i do it for c, if these three resectors, they intersect they will definitely intersect here somewhere. If how they will intersect? Right now my table is not oriented. Again go back to the concept of radiation method. You know if my table is slightly disoriented in the case of the radiation method think of that method. What will happen? These resectors will now form a triangle. They will not cut at a single point. So this is what will happen here. Okay, that we can see here. Here is the triangle of error. This triangle we say triangle of error, which is formed here. If these three resectors, they meet at a single point, okay, resected to a, b and c, then there is no problem. The table is oriented as well as this point is our small p, where we have occupied but this is not a case here. In this case they are forming a triangle of error so whatever effort will be now?

We will reserve first, approximation. Well our point has to be somewhere over here. Where it is? This is what we have to do. It is somewhere around. That is how first approximation. For the second approximation we will do the iteration. So this is why as you know trial and error method. We will try to reduce the error. Well in this case the error means this triangle of error. How we do that? Well in order to reduce that the next step is we locate an area where this point will be. Now how this area will be located? It is very easy. If we are occupying somewhere in between let us say these are the control points A, B and C. These are the control points and our triangle is being formed here like this, this is the triangle of error. You can understand. It is very obvious because we are inside the great triangle. We say this is as great triangle which we are using for orient our resection. Our point p will be also inside the triangle of error. Now there are some rules of this lehman's method we follow. Those rules, number one rule says this thing only if we are inside the great triangle our point p small p will be inside the triangle of error, if

we are outside the great triangle as in the case which we are doing here over here because we are outside the great triangle, definitely our point our point has to be also a small p has to be outside this triangle of error, number one. Number two, the resector are like this the second rule says we have to select next approximate position of this small p in such a way that it is either on left or on right side of all the resectors. Here we are selecting towards the left. Left means it is left of this resector so this full area, okay? Anywhere here left of this resector.

So this total area left of this resector. Also if we consider all these and left of all these what we ended up with? We ended up with, well our point has to be somewhere in this because this is outside the triangle of error, it is towards the left of all the resectors, okay? So our point has to be here. That is the second rule. Then the rule number three it says our point should be selected in such a way; i can find a point, i can keep it here, keep it here, keep it here, keep it here, anywhere in this area, but the next point has to be such that it is as nearer as possible to the triangle of error. At the same time the point should be located in such a way that the distance of the point from the resectors, for example this is the resector to a and thus the distance small ph. So this small ph it should be proportional to PA. What is the meaning of this? The meaning is the point where we are occupying is capital P, so the distance from a to p, we had we can have an idea of this distance; we need not to measure it in order to solve this method but just an approximate idea of this.

So the point p will be in ratio, you know, the distance of this should be proportional to the distance here from resector to B, again proportional to the distance here from resector to C. This distance p, let us say this is hc so, phc this should be proportional to the PC. So we have to find the distances in these ratios, in the ratio of the distance of table from the points there on the ground. Well having done that we will locate the small p. Well let us locate it so that the small p, we say fine let us say it is here. We have found it, so this is our next approximation or the estimated position. Once we have found it we say this is, you know, we are more nearer to our solution, but sill we are not in the solution. What we do next? We keep our alidade along this small p and let us say A, we keep it like this, okay?

Now if I keep it like this and will it bisect A? Right now it will not bisect A, no because this is a different point. I rotate my table now so that it will bisect, that so the table is rotated now. If you rotate it; let me remove this now and rotate it, if I rotate it A will be bisected. Now this is the next approximate orientation of the table or other the better one than the previous one. Similarly I do for I draw the resectors from D, and to C and I again find a triangle of error so the triangle of error in this case is smaller. The meaning is we are approaching the solution. So this is the triangle of error and again as per the rules which we discussed previously. We can now again find a new location of a small p. Another approximation.. Okay, we are more nearer to the solution we find that small p again and then we keep repeating this particular process till this triangle of error it becomes a point or very nearer to a point. So this is where we have now what? Once all we are achieved in this case once this triangle of error it becomes a point, very small that this point is small p as well as our table is also oriented. So we have found our solution the solution of the, you know, we have done the orientation, resection. Now we are ready to plot. Okay. So we have seen now some methods using which we can do the resection. Resection means you know we are doing the orientation as well as finding where we are on the plane table. Now this method will fail all of these fail provide it as we can see here.

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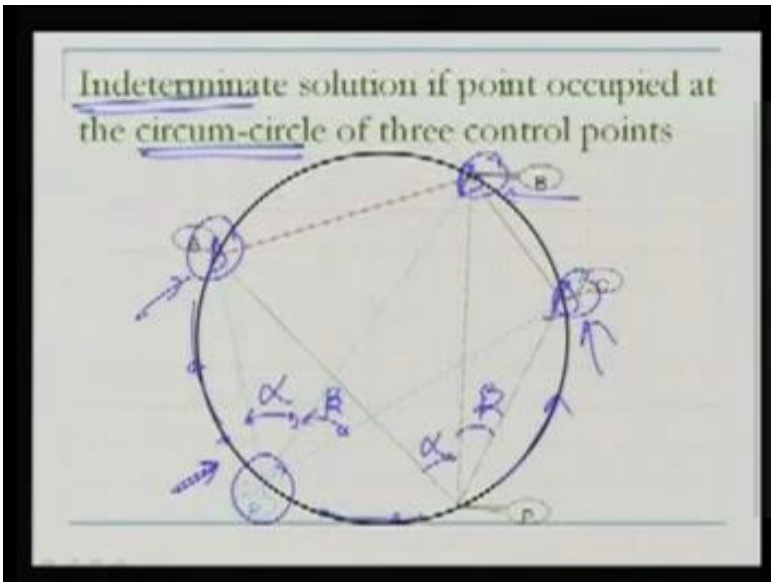

If this is our A, B and C, the points there on the ground, okay. If the point where we are occupying is in this circum-circle passing through these three control points then this method fails or it becomes indeterminate. Why? Right now as in all the methods we have relied on alpha and beta okay? In this case if we are on the circum-circle wherever you are standing okay if you are standing here also still in the angle is alpha and beta. So wherever we go around we will find a solution so because of that the solution becomes indeterminate so we should try to avoid this kind of condition, okay? Next.

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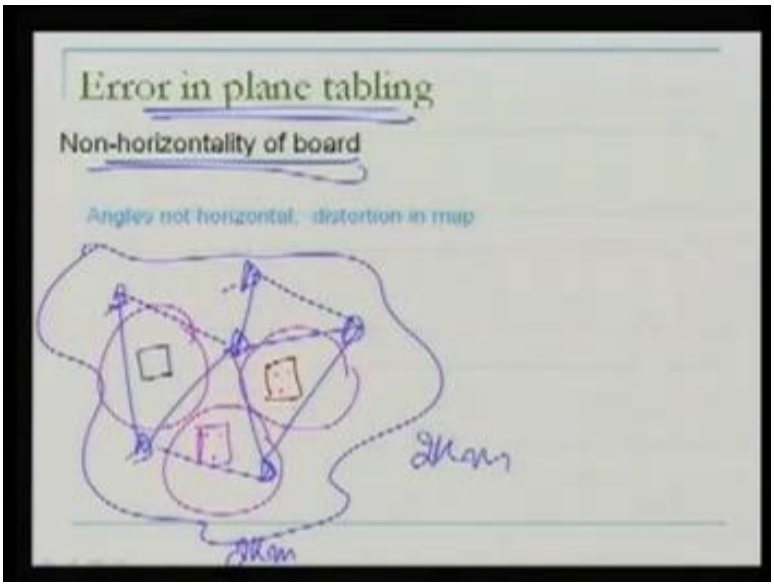

Let us look into the error in the plane tabling. Okay, the very first error is non-horizontality of the board. What is the meaning of that? We say well our table should be horizontal if it is not what will happen if the table is not horizontal, it is inclined, you know. If it is horizontal the basic thing of the plane table is we are by drawing the resectors measuring the horizontal angles but the moment our table is orient inclined now the angles which are being mapped on the plane table are been mapped on an inclined plane not on the horizontal plane so they are wrong angles. What it will lead to? It will lead to distortion in the map, okay. So similarly you know over here my table is horizontal, i have done the plotting the next time i am taking the table to some other place my table is not horizontal, there so these two maps with they will not be comfortable. One very interesting thing about plane is you know as we discussed for a large area if it is an area of two kilometre by two kilometre, let us say we had that control point alright now using this control point now you are going there in the field with the plane table. What we can do? We can sign different people with the plane table. Let us say this is one party over here, there is another party and over here there is one more party and all these parties are using the same control, okay?

They are plotting the local details. These parties also using the same control plotting the local details. What we should be able to do? We can put all these maps together and make the mosaic, make it the complete map and all these maps if the same control has been used the details should match. If my table is you know horizontal here, not horizontal here or different levelling here the details will not match, there will be distortion in the map.

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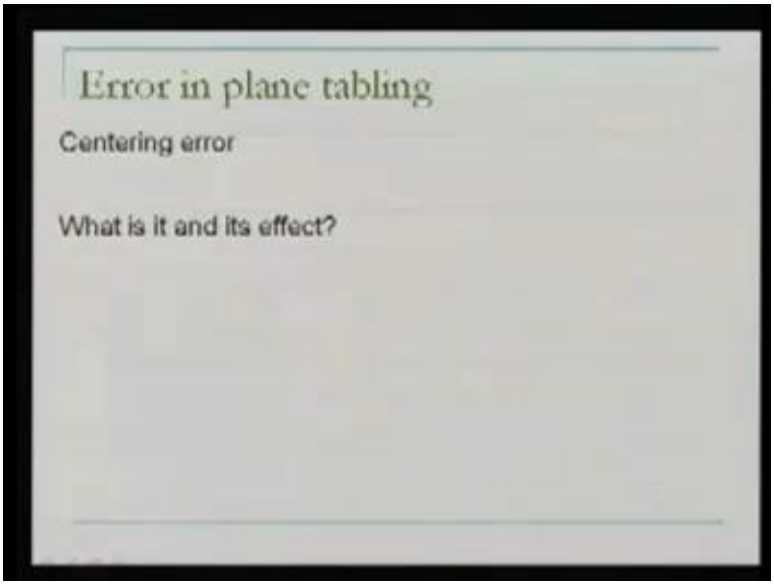

Well the next error is centering error. We will try to understand what it is and what are it's effects.

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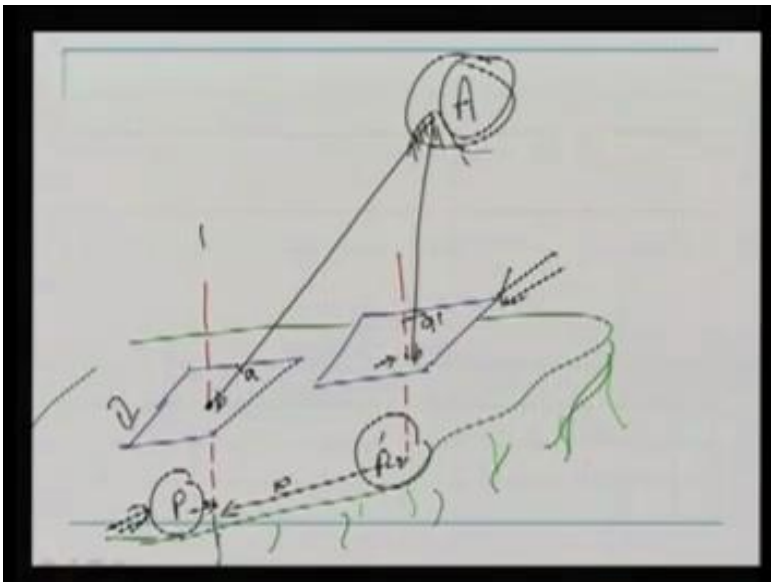

Now what it is? Let us look here, if we wanted to put our plane table over a point p on the ground and if this corresponding p, small p on the table and point on the ground, if they are along the same line you know our table is correctly centered. However if this is small p is over some other point p dash, it should have been over p but it has been shifted. So we say miscentering an error or the table has been miscentered. Now what is the effect of this? What we are doing here? We are plotting the points, okay? So in this case a point a we will be plotted here while here if the table is miscentered the same point a will be plotted at location a dash. Let us look at the same thing.

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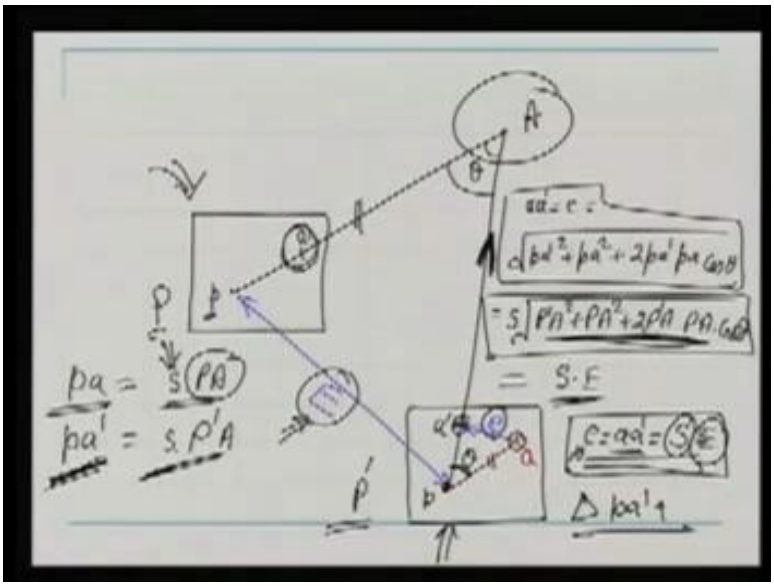

Over here is the first position, there is no miscentering error in this case. Small p is above capital P and this is where this A is being plotted. Okay. In the second case if there is an error of E, now this table is over a point P dash. In this case if we do the plotting, we will plot using this resector and the point will be plotted at a dash. Now what is the error? In order to know the amount of the error in plotting how much this small a has moved from it's position. In order to know that we draw a line parallel to this here, okay? So the a was here it has shifted to a dash, so this small e is the amount of the error in plotting. How much the value of this? So using the triangle pa dash a we can write the relationship here. Okay. Now what we can do because we know p small pa is derived from ground distance by multiplying it by the scale similarly, for p a dash sorry p dash a. P a dash, it is derived like this so we can write further this way. Now here in this case if you look at this this is nothing but the value of E because the angle theta here and here ah is same so what we can write it further we can write it as error in plotting a a dash. How much the points has shifted is equal to scale multiplied by this shift or the miscentering error. Now what is the implication of this?

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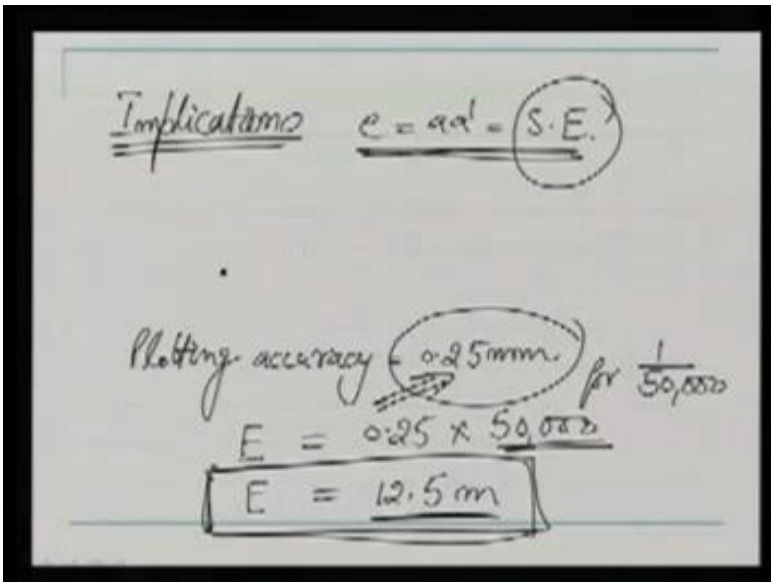

The implication of this as we can see here. Saying you know this A could be at any distance it does not matter. This A could be at any orientation it does not matter the plotting accuracy or the error in plotting error in plotting a a a dash is always same and the value is S into E. It depends upon how must the miscentering error is and what is the scale of plot. Nothing else. Okay. So this is very different from the centering of theodolite. Well if our plotting accuracy of the map is zero point five, zero point two five mm, we take it like that zero point two five mm is the plotting accuracy. How much miscentering is possible within that plotting accuracy? The plotting accuracy means you know a dot here, if this dot is zero point two five mm the minimum which we can plot well we cannot measure within this dot so whatever the error we do in ground corresponding to this dot is not a problem.

So corresponding to this permissible plotting error if you are working at a scale of fifty thousand you find the value of permissible centering error is twelve point five meter. So if you are working at ones to fifty thousand scale you can miscenter your plane table by twelve meters, no problem, is still your plotting within the plotting accuracy. So what we have seen now? We have seen about some methods of orientation, resection, okay? How

to solve the three point problem? What is the effect of errors, particularly this centering error. So here we close this plane tabling. Thank you.