

**Digital Land Surveying and Mapping (DLS&M)**  
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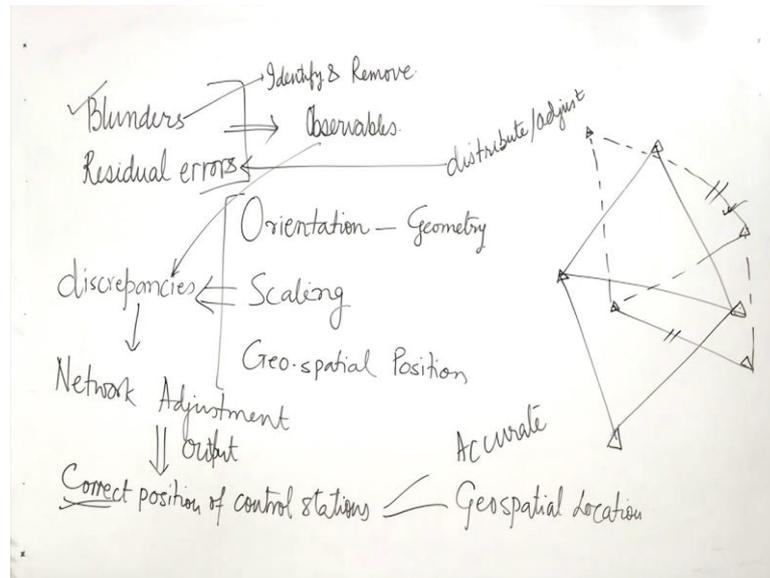
**Lecture – 15**  
**Network Adjustment**

Welcome students today is the 15th lesson, today I am going to tell you about the network analysis. Actually what happens in GPS already we have seen that we will go for point positioning or base line processing. Now after finding out the position of any point we go for it is accuracy testing and then when we find that the point is accurate enough in position then we go for base line processing, and also we may find that the base line a chip the accuracy which we are looking for the particular project.

In spite of this you may sometimes find that the mutual position of the different points or different control points stations or the relative orientation of different base line may not be as desired. So, we need to go for network analysis to find out whether the mutual position of the control points are or not, and also sometimes we find that there are some blunders available in the observation which may in spite of all the pre processing and error correction they may still be present inside the data.

So, we need to clean those blunders and also sometimes the residual errors in the observations may be strong enough to disturb whole of our GPS positioning results; that means, the accuracy achieved may not be of sufficient quality. So, on the this conditions we need to go for further analysis of the GPS data; that means, further processing of the GPS data that is done through network analysis. So, in this class we will be going for network analysis of GPS surveying.

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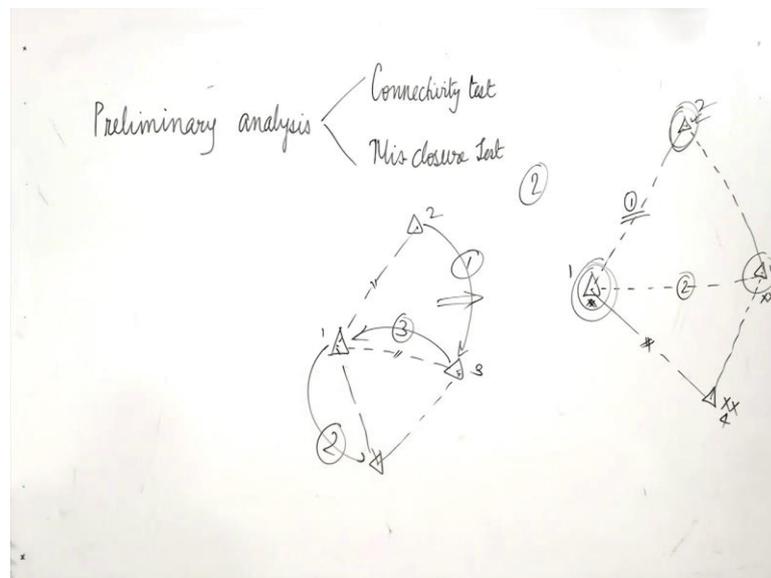
Now, discrepancy arises due to orientation or that means, the geometry may not be the geometry of the figure. Suppose I have 3 stations like this or 4 station like this actually in the field, but after processing I may get the thing, I may get the location like this now actually this is we want, but we find like this. So, this clearly says that the orientation of this is not as desired. So, sometimes when it is the suppose there are 4 stations so we have a rectangle like this, but we may if there is an error in this like this.

Now, you can see this rectangle is well shaped, but this rectangle which we found is not of well shaped; that means, geometry has been jeopardized. Sometimes the you can see the area of this is more than the area of this; that means, our desired the scale of the processed figure is less than the scale of the smaller scale it shaped it is size is less. So, discrepancies arising out of the scale, then also sometime now you can see here the geographical position of this is totally different from this. So, scale scaling then geospatial positioning of the figure. So, there may be discrepancy in this. So, these discrepancies; now these discrepancies we do take care through network analysis or network adjustment. Now the and usually these discrepancies arises out of 2 thing, one is that blunders in the and residual errors these are the. So, these are the 2 factors or these are the 2 because of these 2 presence in the observables, that we may get these discrepancies.

Now, due to the presence of blunders and residuals sometimes the network which we will be getting through a processing may not close that is called mis closure. So, and in through a network analysis we need to identify the blunder and to remove it we need to identify and remove blunder from observables, we have to distribute or adjust residual errors among all the points or components of the network, and the output of the network analysis will be correct position of control stations. Now for the word correct we have 2 points to be noted one is that the locations are accurate as well as it is geospatial location, geospatial location is as desired or in desired place.

So, the control station the location of the control station at the desired location in accurately we will be able to get through network analysis. So, this is the objective of network analysis; that means, we have to find out the very accurate location of the control stations as per their geospatial location, relative location and this is being achieved through 3 stages of analysis that is called first is preliminary analysis.

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Preliminary analysis we have to do now a during preliminary analysis we do fine whether the base lines of the GPS data all observables available are worthy for network analysis or not.

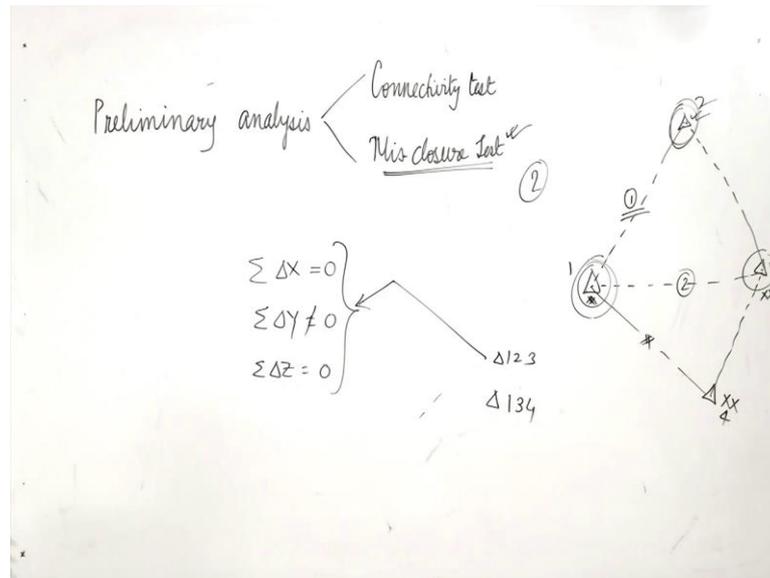
Now, in to conduct do this thing there are 2 things we need to do 2 operations we need to do, one is called connectivity test and the other is mis closure test or closure test. Now in the under connectivity test we see whether these stations suppose I have 4 stations where

the observations are taken. So, suppose 1 3 4 now suppose I have 2 receiver. So, I will take the observation between these 2 station first then I will take the receiver from here to here. So, I will take the up to now you see the observation of 2 and 3 has common with this station. Now keeping 3 and it is position the receiver at 1 will be shifted here then we will take the observation here, then the observation at 3 and 2 will be common.

Now, from 2 I may shift this instrument to 4 and if we take the observation between 3 and 4 then the observation at 4 and 3 will be common, and then the receiver from 3 to 1 all should be so the observation from 4 and for 1 will be there. So, in these case we will have the overlapping observations. So, now, all these base line has been observed properly, but suppose I have take if I take an observation 1 and 2, but then after taking 2 2 the receiver is coming to 3. So, I have taken the observation 1 and 3 then if I shift the receiver from 1 to 4, then we will take the observation 3 to 4 and then if I shift the 3 1, 3 to 1 this is the first shifting, this is the second shifting, this is the third shifting. So, I will be taking this. Now how if the observation is like this now you can see the there is no overlapping of observation between 2 and 3, now this is open. So, if we have the observation like this then the connectivity test will fail in this case, in this case connectivity test will pass it will be fail. So, if the connectivity test fails during our preliminaries then we have to find out between which stations we have no observation and we have to go back and we have to take observation between this 2 station with some overlapping with other station. So, that is what is connectivity test to see whether all the base line has observations, and some overlapping observation between 2 stations are no there are not.

Then we have to go for mis closure test now as I told you that the observation in this case the connectivity test is passed.

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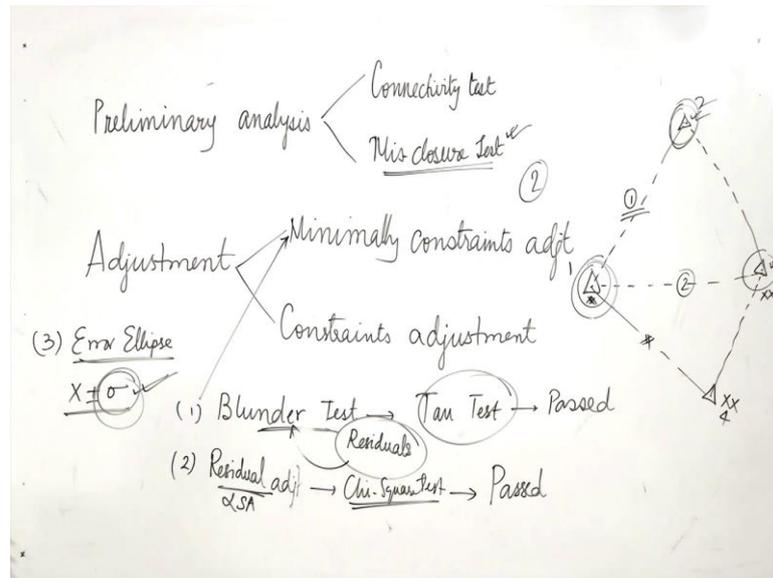


Now, I have 2 triangle 1 2 3 you can say this is a closed triangle, another triangle 1 3 4. Now if I take the change in and this coordinates are denoted by cartesian coordinate x y z.

Now, the change in x coordinate from this point to this point from this point to this point and from this point to this point the summation of that should be equal to 0; summation of y equal to 0 and summation of z coordinate change in z coordinate should be 0 in ideal situation for now if this condition fulfills; that means, the our figure is closed, and if anyone of this is not equal not equal to zero; that means, there is some error in closure that is the mis closure test and invariably the all this will not be equal to 0. So, there will be some mis closure. So, what we should do then we have to see whether the mis closure is within permissible limit or not; if it is within permissible limit then we can go forward for our next step or if it is not then we have to go for further again go to the field and take the observation and we have to find out the locations, and we have to find out the coordinate of the different stations and we have to test it till it passes.

So, once preliminarily analysis is successfully done for the network and it is data, then we should go for next part that is called adjustment.

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Now, adjustment of network adjustment is also done in 2 steps: one is called minimally constraint adjustment, and the other is called constraint adjustment. Now minimally constraint adjustment actually in minimally constraint adjustment, anyone of this station coordinate of anyone of this station is considered to be fixed and then we do find out the coordinate of others and in doing that first we should go for blunder test or you have to find out whether any blunder is present in the observable or not that is called blunder test and that is done by a test called popes tau test. Now this is one of the test there may be many test I mean many software different types of test can be done. So, I have only telling that blunder test will be testing whether blunder is available, and that blunder test is being carried out on the residuals. Residuals of the parameters we will take care as an input to the blunder test and find out whether any of the residuals is blunder or not.

If it is then corresponding to that residual we have to find out which one is the observable and that observable has to be taken out from our observables and we should go for again blunder test and again we have to see whether our observables are free from any blunder or not. So, this thing has to be iterated till all the blunders from all the observables are taken off.

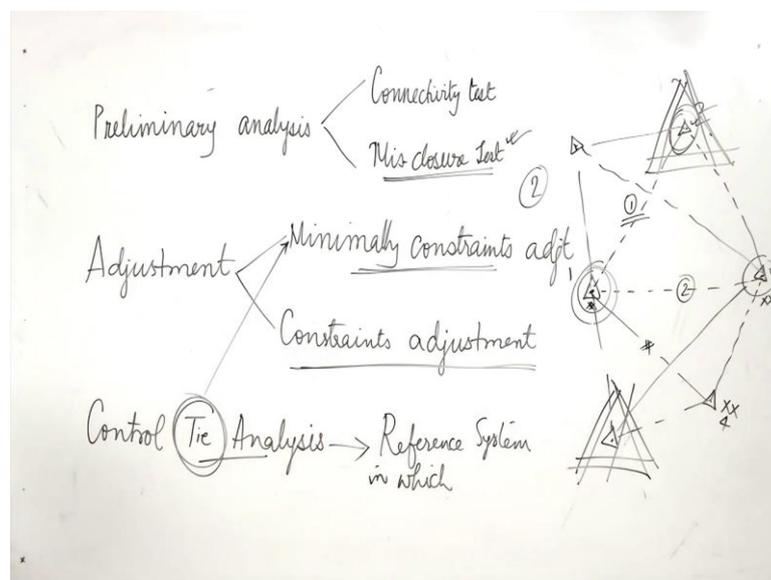
Once the blunder test has been successfully done; that means, tau test has been successfully passed, then you should go for residual tests or residual adjustment. Now that is done by chi square test, residual adjustment is done by using a method called least

square analysis through (Refer Time: 18:16) all the residuals get adjusted and then we should carryout chi square test whether our distribution of residuals are satisfying the criteria that is to be observed for our adjustment or not.

Now, once till it pass we should continuously carryout and till it as it passed then we should go for the third test, that is error ellipse. We have to find out the error ellipse are in position of all the control points; that means, the location plus minus sigma. This is the error ellipse and we have to see whether these errors are within the specification desired specification or not. If it is not then again we have to go for improvement in data and in worst case we have to go back to the field take the new data and you have to do all this at (Refer Time:19:38) steps again and till we find our position satisfy the error permissible error. So, in these way minimally constraint adjustment through minimally constraint adjustment, we get the position of the relative location of the stations within the desired specification.

Now, as the minimally constraint as well done or completed then we go for constraint adjustment.

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Now, in case of constraint adjustment apart from the stations which we observed, we need to have some more stations whose position is already known or whose position with respect to some reference system are already available with us. Sometimes many of this station one of this station or two of this station because sometimes we observe this we

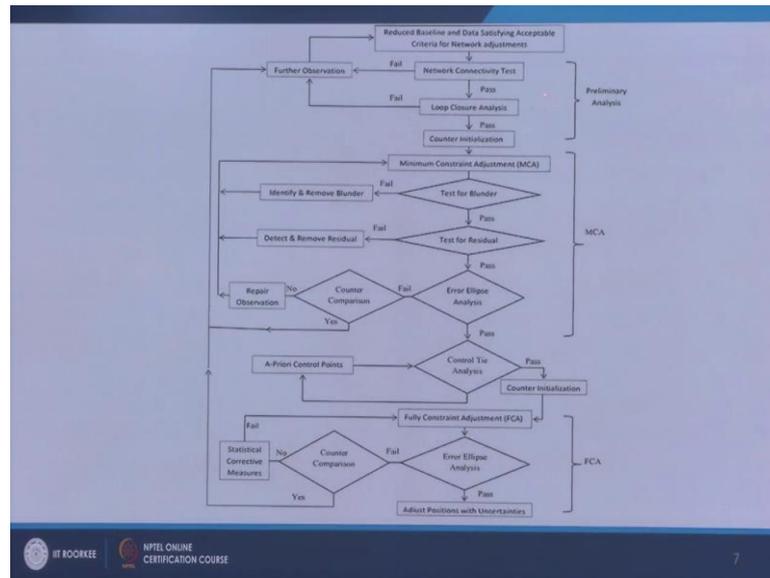
take observations for in n numbers of may be 5 may be ten may be 15. So, out of those huge numbers of stations sometimes we take observation at some stations whose position is already known with respect to some reference field. So, now, those stations suppose I have taken we have some station like this. So, we have taken like this suppose of this this is the station whose and suppose this is the station, these 2 station already control points it is location with reference to some reference field is already known.

So, in constraint adjustment we will take these 2 station location as the known points and with reference to this we will try to find out the location of all other stations, and we will go for all those adjustment which we are done in minimally constraint and find out whether there is any blunder available or not and whether these conditions of error ellipse satisfy or not. So, till we will have to go on doing it till these conditions are being satisfied; that means, error ellipse condition has been satisfied.

Now, after we complete this constraint adjustment, then we go for 1 more thing that is called control tie analysis. So, in control tie analysis what we do, we do take some local reference station or a station or in to control tie means we will tie with the reference system in which we want to have our coordinates. So, the reference system in which we want to get our location we need to have some stations in that reference system, and then with reference to that station we will go for minimally const adjustment to that and we will control we will tie our station to that reference system. So, that is called control tie analysis, and in after doing that we will get the location of the stations in the reference system which we are looking for, and the locations which we will satisfy the requirement of our specification.

So, ultimately the output of the network analysis is in achieved. So, now, here you can see whatever we have discussed till now that has been given through this flow chart.

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And you can see here that the network analysis starts with the reduced base line and data is satisfying the acceptable criteria of network adjustment, with that data it starts and then minimally analysis which consist of network connectivity test and the closure test and then minimum constraint analysis where or minimum constraint adjustment where test for blunder test, for residual test for blunder if it passes then test for residual if it passes then error ellipse analysis; then in some cases the control to analysis can be done after minimum constraint analysis or in some cases it can also be done after the fully constraint analysis. So, fully constraint analysis is same or another adjustment. So, here you see that error ellipse analysis we do and it is satisfy then the adjusted position of the point has been arrived.

So, with these I want to conclude about the network analysis, this is in short I have given and anybody want to study in detail you may study the book and some review questions are given which you can prepare yourself and to summarize today's class network associates with proper improper mutual orientation, wrong scaling factor, misrepresentation of the geospatial location with respect to reference coordinate systems as discrepancies. Discrepancies are due to the precedence presence of residual error resulting in mis closure in network. So, network adjustment involves testing and involve a blunders distribution of a (Refer Time: 27:00) as well as computation of final coordinates.

Network adjustment consist of preliminary analysis adjustment consisting of minimally constraint and constraint analysis and statistical analysis. In preliminary analysis you determine the stability of the network connectivity and closure test in minimally constraint adjustment anyone of the station help fixed during processing in constraint adjustment, a priori continuous of a control point is being considered or help fixed and statical analysis is being carried out through tau test and chi square test and finally, control tau analysis being conducted to fit the network to local regional and national control network as desired, with these I want to conclude today's class next class we will be on quality assessment of GPS surveying.

Thank you.