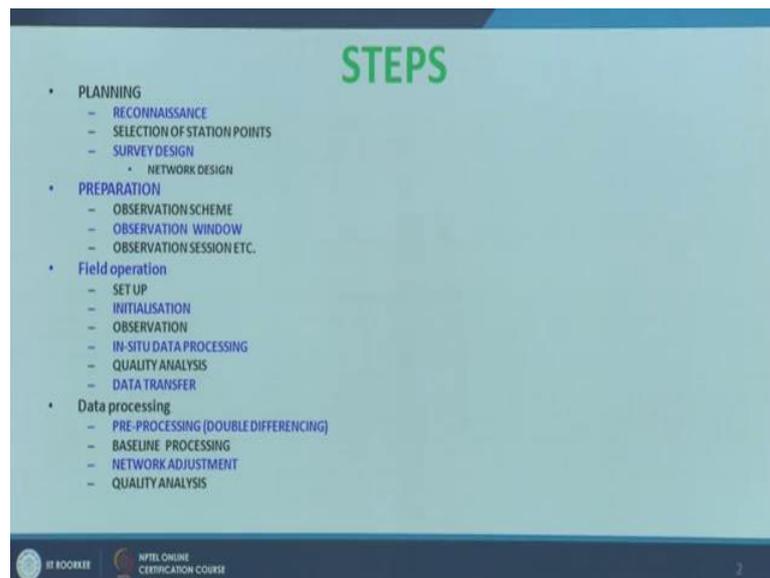


Digital Land Surveying & Mapping
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Lecture - 36
Establishment of Control Point

Welcome students, today is the 36th class of digital land surveying and processing, in this class I will going to talk on how to establish the control point. Actually for digital land surveying and mapping after the specification for land surveying has been decided the first thing we need to do in the field is to establish the control point and in digital land surveying and mapping we do establish the control points using a technology called GPS. So, GPS receivers are used to establish the control point.

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Now, the establishing the control point as I already discussed in the overview that we need to go for planning; planning of establishment of control point; that means, what are the spaces where we want to consider the control points in our study area or in our project area. So, through recognises we do decide about the location of the stations and then after deciding the location we should establish.

Now, the most important point in locating the station is that the station should be free from electrical interference like it should not be near the transformers or high tensional lines or it should be away from some reflecting surfaces like water body reflects or there

may be some other reflecting elements around which may reflect the electromagnetic energy. So, while selecting the station point these points have to be very much careful then the station point should be a stable ground and we should ensure that the location of the station points should be constant or stable all throughout the project time and if possible may be in years to come.

Now, if this station point then we should go for survey design so, there where survey design is another important issue so, after the selection of station points the another important point for our establishment of control point using GPS receiver is to design the survey

Now, survey design actually basically consist of 2 parts one is that how to locate the station points with reference to other station points and what will be the nature of observation scheme generally we will have less number of receiver then the station number then what should be the sequence of placing the receiver that is called observation scheme.

Now, first the network may be radial network as it is shown in this figure; that means, we will be placing the main receiver or reference receiver at this location O.

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PLANNING: SURVEY DESIGN

RADIAL NETWORK

- one of the receivers is placed at a fixed station and the other receiver/s are placed around the fixed receiver taking observation at the ends of the desired baselines.
- No direct observations between any adjacent stations.
- Advantageous from operational point of view.
- Less accurate
- No geometrical configuration checking.

REFERENCE STATION: O
RECEIVER STATIONS: 1,2,3,4,5

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And then if we have to observe 5 stations suppose we have only 2 receivers then we will place one of the receiver at the centralized location and the other receiver may be

keeping at one for some time then 2 then 3 then 4 then 5 like that. So, the observation will be having only some radial along with some radial lines with reference to O.

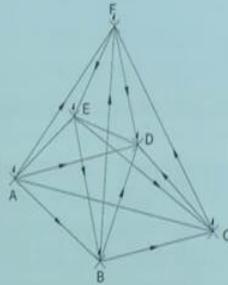
So, these types of observations generally we take for area which is small and we do not need to go for much of network adjustment.

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PLANNING: SURVEY DESIGN

CLOSED NETWORK

- For high accuracy GPS surveying
- Network of closed geometrical figures
- Satisfy : (i) Observation session at each station must be overlapped with at least two others stations;
(ii) Consecutive observation sessions should have at least one common baseline;
(iii) Ties with three to four control points
(iv) Direct observations between existing control stations.

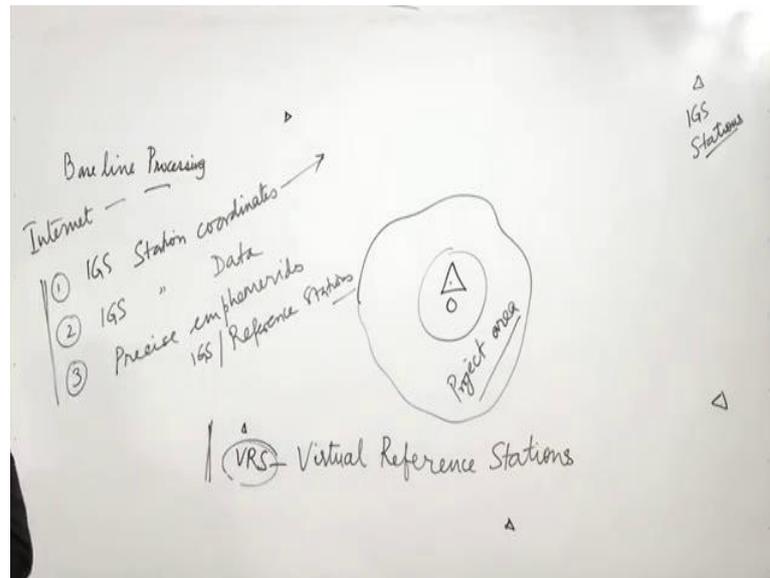


The diagram illustrates a closed network of six stations labeled A, B, C, D, E, and F. Stations A, B, and C are arranged in a triangle, with A at the top, B at the bottom left, and C at the bottom right. Stations D, E, and F are positioned within and around this triangle, forming a complex web of interconnected baselines. Arrows on the lines indicate the direction of observation between stations.

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Another type of network which generally we do prefer to have in any survey work is to closed network and for having the closed network we must have at least 3 receivers and depending upon the area to be surveyed these station points has to be designed and most preferably at least 1 or 2 should be pre determined pre observed stations whose locations and positions as well as height is known that will be useful for taking the network test accuracy test. So, we have to keep it in mind that while we will go for some closed network of GPS stations then OP of this station should be already observed or available stations.

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Now, sometimes for any a project work also single we may also go for a single station like GPBS, one suppose we have the one of this which is then in that case what we do we do take we do select stations all over the world IGS station all over the world and world is spread about this point these are the IGS stations IGS stations and what we generally consider to have the data observed at this station at the same instant of time these are along the same duration what we have observed for O and then subsequently we may process the data sometimes we also consider this type of network where the observed station will be in within our projects this is our project area and the station that will be used for making during processing to find out the location of this is IGS station.

So, there are different ways how it can be done and in this type of virtual reference station VRS virtual reference station. So, sometimes we also considered this I will demonstrate on this point how to do this thing and. So, after we have decided the network of stations.

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PLANNING: SURVEY DESIGN

OBSERVATION DESIGN

- Observation scheme for field observations as per designed network.
- Planned sequence of observation sessions
- Accomplish objective of the project
- Redundant observations for checking and improving precision as well as reliability
- Each stations observed at least twice
- For high accuracy survey all control points should be directly connected.

Sessions	Receivers			
	R1	R2	R3	R4
1	A	E	C	D
2	A	B	C	F
3	A	D	E	F
4	B	D	E	A
5	B	F	E	C
6	B	F	D	C

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Then we should select how we should set up our receivers what is the sequence of different receiver has to be placed like in these one of the scheme here I have shown that there are A, B, C, D, E, F; that means, there are 6 stations we have and we have 4 receivers. So, how we should go for taking the observation and here you can see that we have taking the observation at different sessions; that means, sessions means some duration along which we will take the observation.

Now, in session one, we are taking a; we are placing the receiver R 1 at a station A and receiver R 2 in station E and R 3 in station C and D. So, A, E, C, D, so in this way we are observing, so, you can see if I take the observation simultaneously and all these station then we will be having these baselines these baselines this baseline and these baseline closed network of quadrilateral. So, also that can be consist of 2 triangles like this again these 3 triangles then we can go for a map of network adjustment look closer analysis what we have studied in our network adjustment class.

So, we have to look in to that thing next session A, B, C, F, so A, B, C, F, so this big rectangle we can observing. So, A, B, this is another triangle we can get, A, F, C we can get, F, B, C we can get, F, A, B we can get. So, 4 triangles and then big rectangles we can get as a closed figure. So, we will be able to do a lot of network adjustment or analysis and we can find out many of the errors associated with the observation or the computation or the any other like in quality on the observation we can also remove some

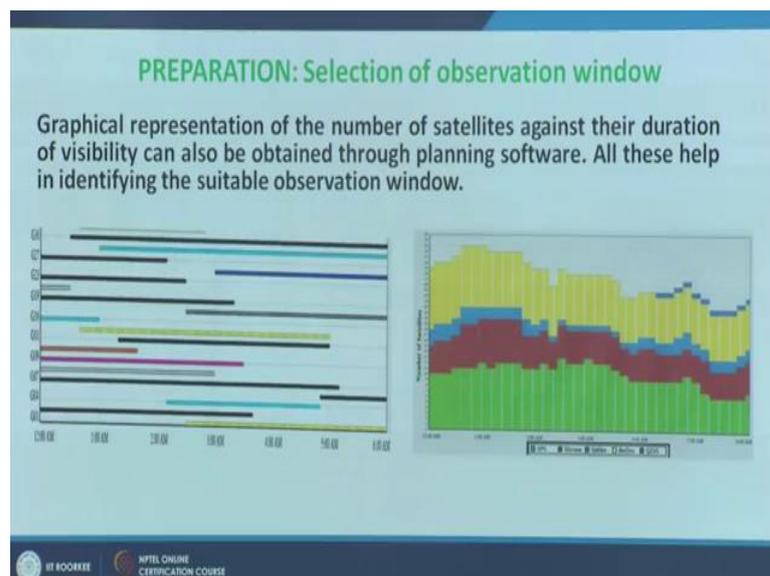
of the. So, a lot of redundancy in data will be available that will make our work easier and better.

So, this is like that we can you will take different combinations of stations observation and that is come that comes under the observation scheme we our main objective of observation scheme is to have all the baselines to be observed and there is a simultaneous observation between defined baselines and a lot of closed network should be available simultaneously and there will be redundancy observation and those will give our work observation will be stronger.

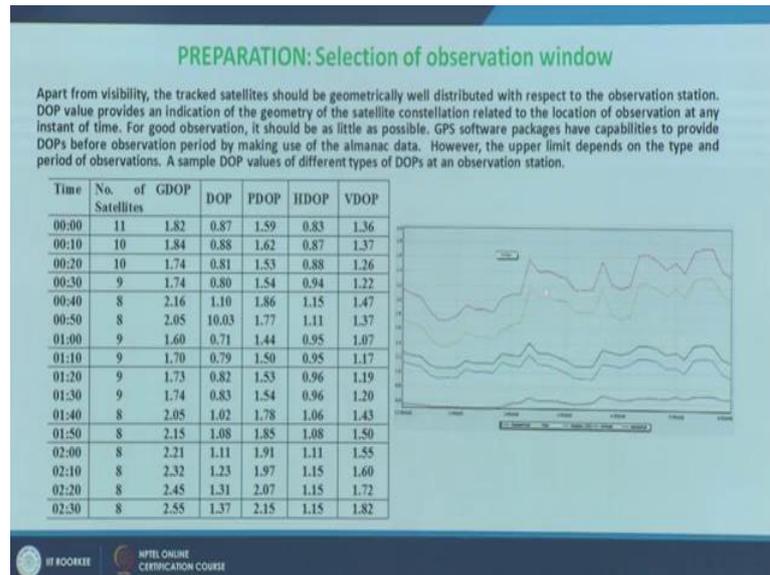
So, these are the things we should keep it in mind while taking the observation then another thing whenever we will before we really take the observation we should also see what is the status of the satellite during that time how many satellites will be visible to that particular station and what will be the duration of visible what will be the quality of the observations.

Now, quality of the observation will be noted will be understood through the DOP values already I had discussed in some other class. So, and for any particular station for any particular day during all throughout the day what will be the different types of DOP value that we can get you can see.

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Here this is the different lines are there and this is the geometrical dope value; that means, g dope this is the line give provides us the dope values and we can see here that is dope value is maximum at this point which is about 2.5 or more 2.6.

Now, we know that dope value should be least the lesser the dope value better it is. So, in this case we can see that this region this region will provide us the best type of observation values if we consider this case here you can see the dope value is least from at this point; that means, around twelve thirty and the dope value is decreasing here is slightly increasing. So, if we have to select a observation window of 1 hour. So, I can see that from this point to this point will be a good time there is least dope value.

So, in that way if we have this dope plot for a particular place at and over the period of time by looking at these we can identify that at which time or that which time of the day we should go for observation and also if you want to take our observation from twelve hours to eighteen hours then our dope value will be within 2 point eight. So, I think as we know the 2 point eight is also a good number. So, we can very well take our observation. So, dope value is an indicator of the quality of the data and a lower the dope value better it is. So, this is the very important formation for choosing the observation window.

Now, also we can find out from some planning software; what is the number of satellites available which are the satellites available? So, all these information will provide us to select the observation window as well as observation session.

So, in that way we do select and then once the observation window and observation session has been selected and the observed scheme has been designed then we do go for observation and then after taking the observation we should also check the quality of the data what we have acquired and once we are satisfied with the quality of the data then we have to download the data and import the data to the processing software now processing has to be in 2 steps or I can say pre processing and processing.

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DATA PROCESSING

- Data Download/ Import
- Pre-processing: (i) Differencing :
 - (a) Double Difference (DD) observable of base station Only;
 - (b) DD observable of rover stations with reference to base station
- (ii) Cycle-slip detection & repair
- IGS Stations
- Processing :
 - (A) Baseline processing : Using (b) Double Difference observable of rover stations with reference to base station;
Ephemerides – Broadcast / Precise
 - (C) Network adjustment
 - (d) Quality Analysis: Error ellipses

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Now, as we know that the GPS data contains a lot of errors. So, we must make use of different per processing operation to minimize the error first we should go for triple difference observables to find out the cycle slip detection and repair then we should remove those things and then we should also go for double difference observable. So, all this pre processing we have to do and then in that way we can improve the quality of the data also before processing further processing we should also again test about the quality of the data and already I have discussed about how to test the quality of different types of data.

Now, once we are happy or satisfied with the quality of the data we should work further with the double difference observable of the base station only for this type of

processing. So, this is the base station and now we should see what is the duration on which day during which time we have the base station data and during the same time we should search around all over the world about the IGS stations during the same time same day what are the IGS stations where the data has been observed having the epoch less or more than what we have taken; that means, if we have taken observation at 15 second or 30 second epoch the epoch of observation from other station IGS station should be either if it is thirty second then it should be less than 30 second.

So, like that we first we have to identify the IGS station around the world where the same day and during same duration or more than the duration, but in this around the duration that has been taken and those data has to be downloaded in the software and along with the data now in case of control point establishment we want to have the position very precise. So, to have the precise information about the control point we need to go for precise ephemerides and broadcast ephemerides.

So, also we need to download the precise ephemerides from the internet site. So, all the precise ephemerides for all these stations along with these base station has to be available in the same file and in the within the software.

Now, it will be preferable to make use of scientific software for our establishment of control point; however, if scientific software are not available we can go for commercial software, but that will provide us less accurate GPS position.

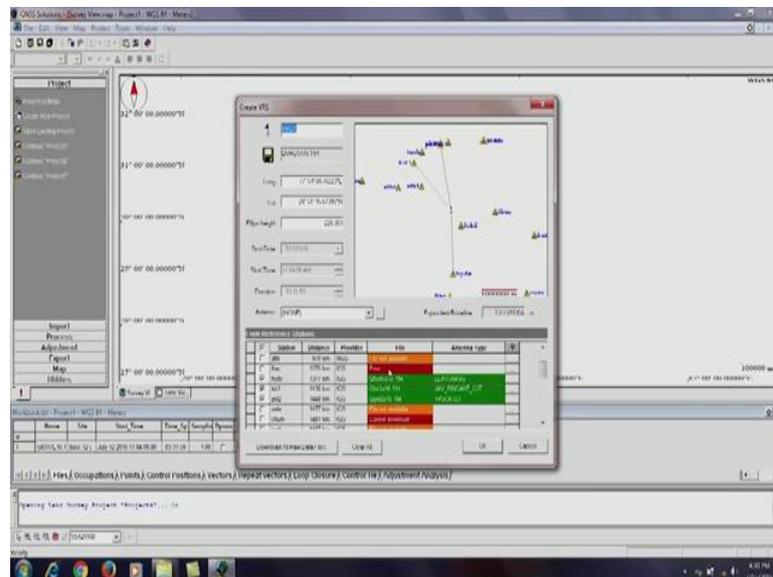
Now, once this data is available then we should go for processing now processing for GPS is done through network adjustment. So, first what we have to do we have to go for baseline processing baseline processing; that means, first we should go for baseline between the IGS station and the our reference station then these baseline like this then we can put together all these baseline and we also need to know the IGS station coordinates. So, IGS stations coordinates are available also internet. So, from internet from internet we need to know IGS station coordinates IGS station data then precise ephemerides or ephemerides of IGS station IGS station as well as our reference station. So, all these thing we can get from internet.

So, now these IGS station fixing these IGS station coordinates we can find out the coordinate of this first station after doing the software provides us the error ellipse around our station error ellipse presents the amount of error associated with the any

station and we should see whether our error ellipse satisfy the requirement of our specification. So, that is the way how we go for our establishment of control point.

Now, I will demonstrate you how we really do this establishment of control point we will make use of some commercial software called pop handle through which I will like to demonstrate the varies steps that we can do establish the control point or to establish or to find out the location of the baseline reference station and from the location of the reference station also we can do the adjustment for our other control points of our project area.

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So, to start with first we have to create a new project suppose project 4 is the object which we will like to name as the; and to the modified default settings let us take whatever default settings are there except miscellaneous under miscellaneous we take this B R s maximum range as 3,000 kilometre I have to import the data which we have collected in the field so and that data has already been transferred to this office computer from field computer and that is kept in a folder and from that folder I will import the data to this project work. So, this is the file which is our base data.

Now, with this base data I am importing it is there now we have to go for this BRS and so if we click here then all these station will be checked. So, and we are trying to download the data files of these stations particularly in which stations the observations

are available for 12th July because 12th July is the day on which the data for this our base station has been collected during this time start time and duration.

So, now the software is checking whether this IGS station also has the data for this date and during these hours. So, only those stations for which the data will be available then only will be considered there can be considered for our further processing so, in order to know that we need to carry on this process. So, now, you can see here at for some stations files are not available; that means for this station AFKL, data has not been collected during the observation period which we are looking for; for this station, there is some error in downloading the data, but you can see here that some stations like HYDE KIT3, PUL2, the data is available for that period and also it has been downloaded during our this processing.

Similar to that there are some stations for which there will be data available, so among those the stations we have to select which are the stations we will be looking for our data further processing now in doing that actually we should first see that we should like to have the stations around our station in such way. So, that the stations provide us a good network as we have discussed in the closed network.

So, in this case I can see that the station here these, these and these will be good. So, let me select those stations from here then you will see the network. So, I will like to go for KIT3 then IISC, CUSV and another is NOVW. Now you can see that this will form a good network of triangle and. So, I am selecting these 4 stations as our reference data to get the location of these stations.

point now of course, in this processing you can see there are big ellipse circle which are the error circle and actually we need to reduce this during our further processing. So, that these errors are not moved.

Now, with these I got let us say what is the output that we can get from land survey report.

Student: (Refer Time: 31:11).

So these provides us the location of the base station as 77 degree, 54 minute as the east and that latitude like this and hide this like this. So, this is the data which we got as the location for our reference station, so for further processing will be using this as our known position.