Availability and Management of Groundwater Resources
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Lecture - 38
Measurement of Rainfall, Index of Wetness, Infiltration Rate (Continued)

Welcome you all, in the part 4 of the module 8 measurement of rainfall, index of wetness and infiltration rate. So, in the last 3 part we have discussed in greater detail about the precipitation it is amount of monitoring, how we can monitor it, what are the different types of gauge rain gauge that is the unrecording and recording type. Then we have seen what are the conditions for the fixation of the network stations that is optimum rain gauge network stations.

Whether, sufficient number of rain gauge stations are there or not how can we find out that how many more stations are required. Then only we can get the clear status of the rainfall in the catchment or in the area. So, this thing we have already discussed in the last three parts.

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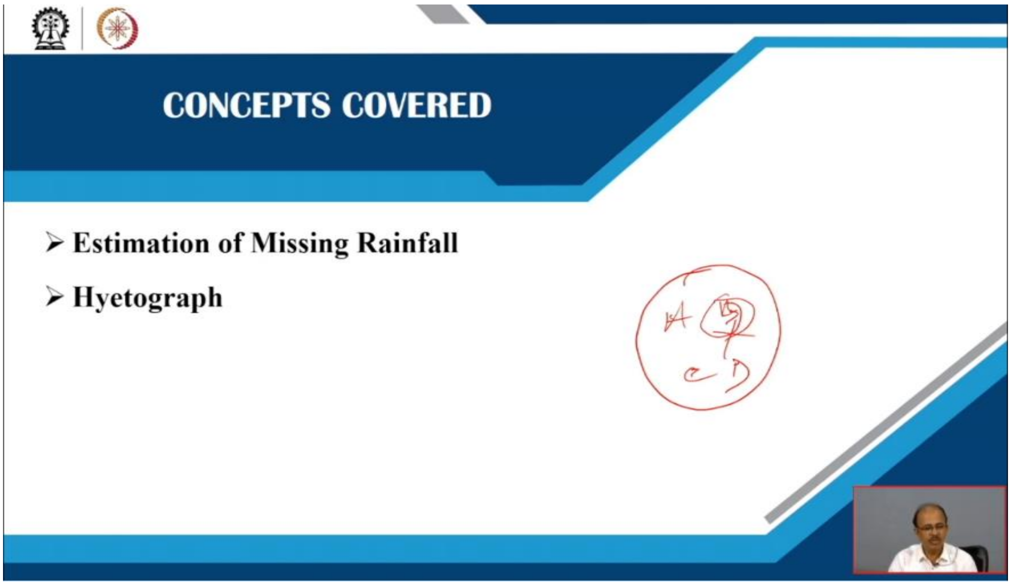

Now, in this part we will discuss in detail about the estimation of missing rainfall and hyetograph. So, it is also very important. In the previous part we have discussed how many number of rain gauge station network is required and whether the required network stations is okay or not, if not then how much more is required. So, this thing we have discussed in the previous part that is part 3.

In part 4 we are discussing suppose on the basis of the optimum number of network stations in any area. Suppose, this is the area and, in the area, we have on the basis of the previous information's we have fixed the station say A, B, C, D, this is stations we have fixed here. So, on the basis of our systematic study we have fixed that for having the total rainfall status of this area, we have to fix the only 4 number of rain gauge network.

So, rain gauge we have fixed at these 4 and monitoring has also started. Now the problem is that while monitoring of the rainfall because we have fixed for say for monthly 30 days network stations. And every day when people is going taking out the volume of water, in rain volume of water and then monitoring the details about the rainfall amount in mm or centimetre. Now, in this course, these are regular your work so it is going on.

But suddenly one stations got some error or stopped, suddenly what happened one is your rain gauge network this has become your some error has come out here and because of this it is not giving the correct reading of the rainfall or it has totally stopped while working, then what to do? This usually happened that we may miss some of the rainfall data from the established network stations.

So, what to do? So, this thing we will discuss in this part and then we will discuss the hyetograph which is one of the important graph through which we are getting about the information of the rainfall amount.

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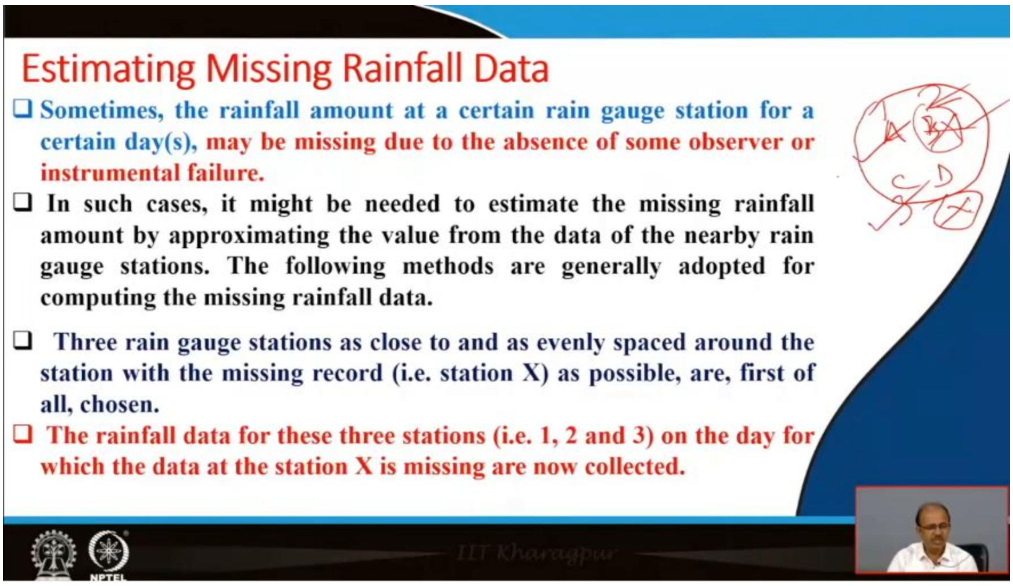

So, see estimate for missing rainfall data for estimation of the missing rainfall data it usually happens with any range network station which has been fixed. Why it is missing? Because of the absence of some of your work or some instrumental failure is there. So, data we are not taking even the observer, which is regular routine to go and collect the sample and monitor and write down the value of the rainfall amount is also is main option.

Then also you would not get the range network stations rainfall data all or some instrumental failure has started. So, only in both the cases we may fail for getting the correct figure of the rainfall amount. So, what is happening in such cases it might be needed to estimate the missing rainfall amount by approximating the value from the data of the nearby rain gauge measuring stations, so it may happen.

So, what is suppose this is the network your area and in the area A, B, C, D these are the network rain gauge network stations and, in some stations, suppose say this station it is not working because it has become your some error has come here. So, it is not working or the operator has not visited this place, so this data is missing now A, C, B, D no problem these data are with us but the B data, B network data is not just missed for say for five days or three days or whatever.

So, in this case what to do? It usually happens generally it happens because even you are fixing the network your rain gauge, it is also suddenly stop for working, so because of some instrumental failure. So, in that case is there any scope to know about the near about figure of the rainfall because, see rainfall is not that it will remain in one house it will go one roof of the house no if rainfall is just taking place.

So, it will be at the area yes, the consideration of the plane hilly mountainous areas these are very important for the for maintaining your rain gauge density but sometimes while the network is okay no problem with the network stations are also there as per the guidelines. But some of the readings have been missed. So, in that case what to do so there are some methods. So, which are we are adopting for computing the missing rainfall data.

So, in this case for computation of the missing rainfall data 3 rain gauge stations as close to as evenly spaced around the station with the missing record. So, generally with the missing record just the 3 rain gauge stations are fixed and this first of all these are chosen. The rainfall data for these 3 stations 1, 2, 3 on the day for which the data at this registration X is missing are now collected.

So, suppose 1 is 1 another 2 another 3 and this is X, so here the data is missing. So, in this case what to do? So, the rainfall data is these 3 stations and these are having the data 1, 2, 3 is available no problem but the X data X stations data is missing.

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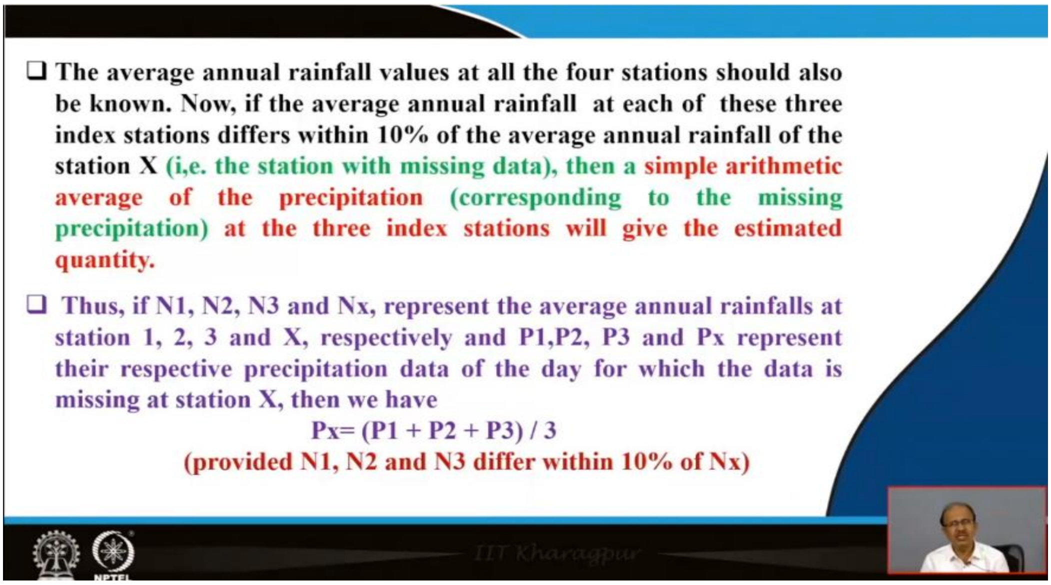

So, what to do? The average annual rainfall values at the four stations should also be known. So, first of all we will do? We will find out the average annual rainfall values of the all the 4 station just we should have the average annual rainfall values. Now, if the average annual rainfall value at each of these 3-index station differs within 10% of the average annual rainfall of the station X, that is the station with missing data.

Then, a simple arithmetic average of the precipitation at all the three index stations will give us the estimated quantity. So, what is happening the average overall rainfall values at all the 4 station should be known it should be known. So, now if the average annual rainfall at each of these three index stations 1, 2 and 3 differs within 10% of the average annual rainfall of the index of the station X.

That is the stations with missing data then a simple arithmetic average of the precipitation corresponding to the missing precipitation at the three index stations will give the estimated quantity. The point is that if N1 N2 and N3 and Nx represent the average annual rainfall at a station 1 2 and 3 and X. These are the stations respectively and P1, P2, P3 and Px represent the respective precipitation data of the day for which the data is missing at a station X.

Then, we have (Px = P1 + P2 + P3)/3. So, provided N1, N2 and N3 differ within 10% of Nx. So, as per the findings we are knowing that Px station the respective precipitation data of the exercise station is missing. So, for this we can calculate why Px = (P1 + P2 + P3)/3.

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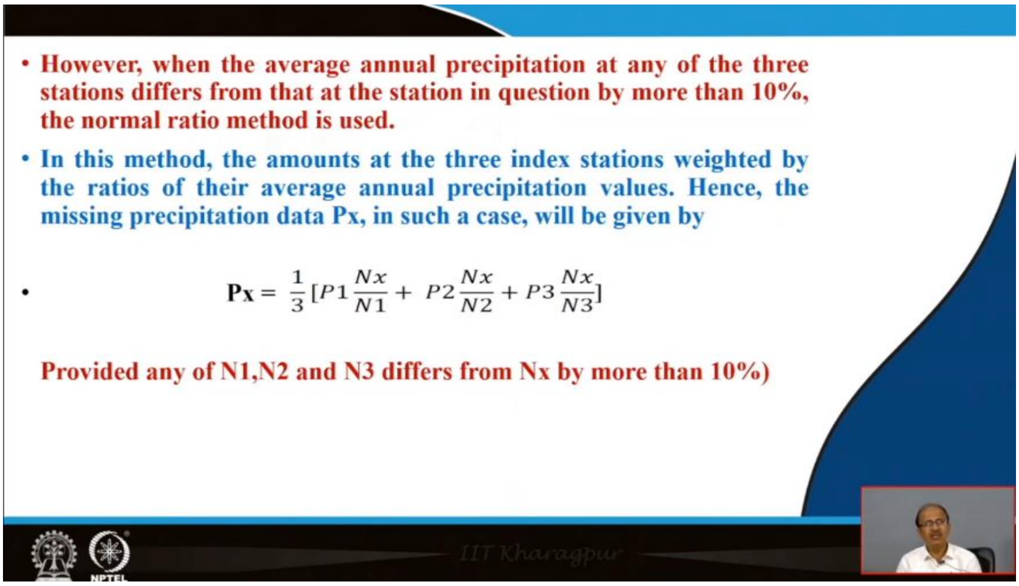

Now, when the average annual precipitation at any of the 3 stations differ from that at station in question by more than 10% then, the normal ratio method is used. This is also important consideration. When the average annual rainfall at any of the; three stations say 1 2 and 3 differing from that of the station in question that is Px by more than 10%. In that case, if it is remaining more than 10%, in that case normal ratio method is used.

And in the normal ratio method the amounts at the three index stations that is 1, 2, 3 is weighted by the ratios of their average annual precipitation. That is method by the ratio of their average annual precipitation value. And hence the missing precipitation data Px in such case will we find out by

$$\text{Px} = \frac{1}{3}\left(P1\frac{Nx}{N1} + P2\frac{Nx}{N2} + P3\frac{Nx}{N3}\right)$$

Now, provided any of N1 N2 and N3 differ from the Nx by more than 10% that is very important. This thing is it should be there that in the N1 N2 and N3 differs from Nx by more than 10%.

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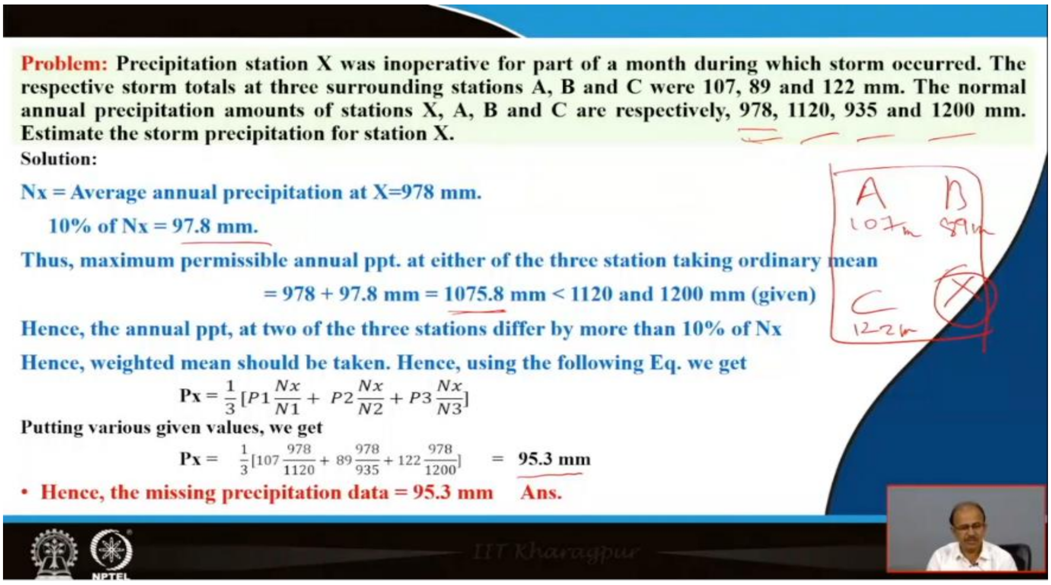

So, now we will discuss another problem with on the basis of this statement that Precipitation station X was inoperative for part of a month during which storm occurred. The respective storm totals at three surrounding stations A, B and C were 107, 89 and 122 mm. The normal annual precipitation amounts of stations X, A, B and C are respectively, 978, 1120, 935 and 1200 mm. Estimate the storm precipitation for station X.

So, just estimate find out the estimation about the rainfall status in the station X. So, for this how when how we will start, we will first go for the average annual precipitation at X. **Solution:**

Nx = Average annual precipitation at X=978 mm.

10% of Nx = 97.8 mm.

Thus, maximum permissible annual ppt. at either of the three-station taking ordinary mean

= 978 + 97.8 mm = 1075.8 mm < 1120 and 1200 mm (given)

Hence, the annual ppt, at two of the three stations differ by more than 10% of Nx

Hence, weighted mean should be taken. Hence, using the following Eq. we get

$$\text{Px} = \frac{1}{3}\left(P1\frac{Nx}{N1} + P2\frac{Nx}{N2} + P3\frac{Nx}{N3}\right)$$

So, putting the values just Px

$$\text{Px} = \frac{1}{3}\left(107\frac{978}{1120} + 89\frac{978}{935} + 122\frac{978}{1200}\right)$$

Hence, the missing precipitation data = 95.3 mm

So, this is the rainfall missing rainfall data of the station X. So, in this way we can find out the missing rainfall data also because that has become inoperative that was not working.

So, in that case we can calculate with the help of this equation we can calculate the missing precipitation data.

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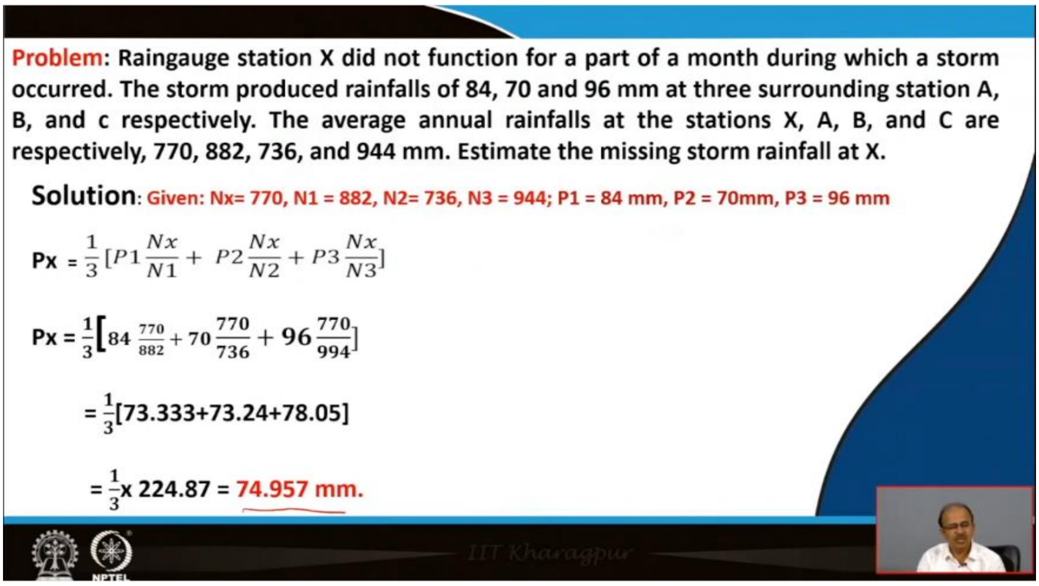

Now, next problem Raingauge station X did not function for a part of a month during which a storm occurred. The storm produced rainfalls of 84, 70 and 96 mm at three surrounding station A, B, and c respectively. The average annual rainfalls at the stations X, A, B, and C are respectively, 770, 882, 736, and 944 mm. Estimate the missing storm rainfall at X.

Solution:

Given: Nx= 770, N1 = 882, N2= 736, N3 = 944; P1 = 84 mm, P2 = 70mm, P3 = 96 mm

$$\text{Px} = \frac{1}{3}\left(P1\frac{Nx}{N1} + P2\frac{Nx}{N2} + P3\frac{Nx}{N3}\right)$$

$$\text{Px} = \frac{1}{3}\left(84\frac{770}{882} + 70\frac{770}{736} + 96\frac{770}{994}\right)$$

$$\text{Px} = \frac{1}{3}[73.33 + 73.24 + 78.05]$$

$$\text{Px} = 74.957$$

So, this much mm of the rainfall is taken place when this just the station X become and non-functional. So, it was not functioning and the rainfall amount is this much.

So, why other means also we are having the facilities or having the equation through which we can measure the either the number of rain gauge required rain gauge station or the missing rainfall data if there will be any missing rainfall data through the rain gauge. So, that also we can find out.

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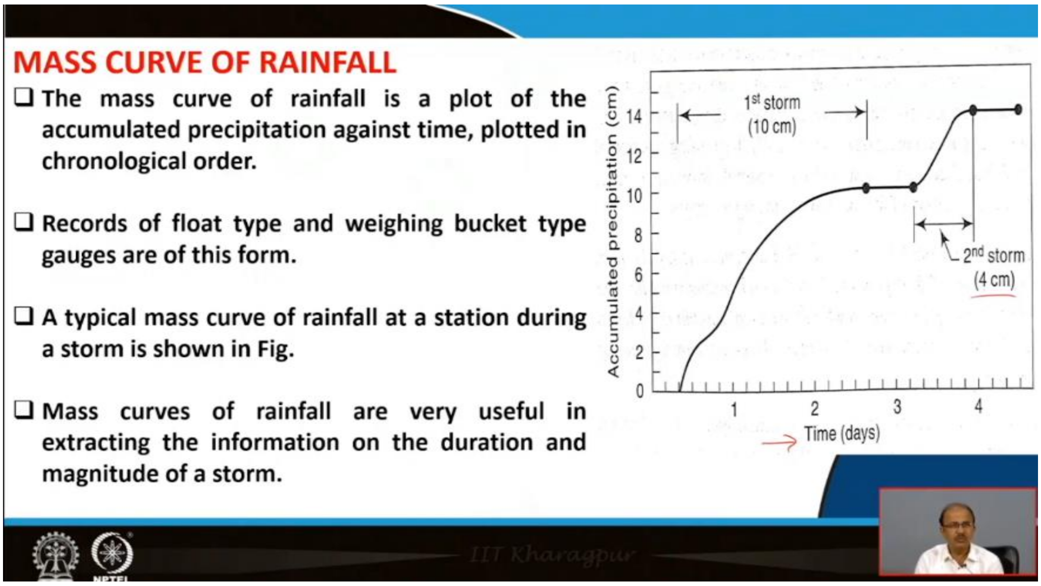

Now, after that this much of discussion we must know about the mass curve of rainfall, this is very important. Because, you have seen the mass curve of rainfall is a plot of the accumulated precipitation against time. So, it is against time accumulated precipitation against time and it plotted in chronological order. Records of float type and weighing bucket type causes are of this form and generally give the float type varying bucket type we have discussed in the type.

And this is the well we are discussing about the rain gauge network, we have already discussed about the float type in weighing pocket type of gauges. A typical mass curve of rainfall at a station during a storm is shown this is the you can see at the first storm 10 centimetre is the time 10 centimetre rainfall has taken place during from here to here this much. And then second storm is for 4 centimetre rainfall this way is there.

So, Mass curve of rainfall are very useful in extracting the information on the duration and magnitude of the stream. How much duration really, we are able to view the duration also, at this time started and up to this time the total rainfall was about 10 centimetre. Now, then in the second type in second storm again at this time it started and it remained at near about 4 and the total rainfall has taken place in the 4 centimetre.

So, when we are getting any sort of relationship between the time versus the cumulative precipitation then such type of curve voltage generated curve is known as the mass curve of rainfall. So, in this way we can get the idea about the time of the total time of the rainfall and total amount also within that very specific time period. So, it is generally shown by the mass curve of rainfall.

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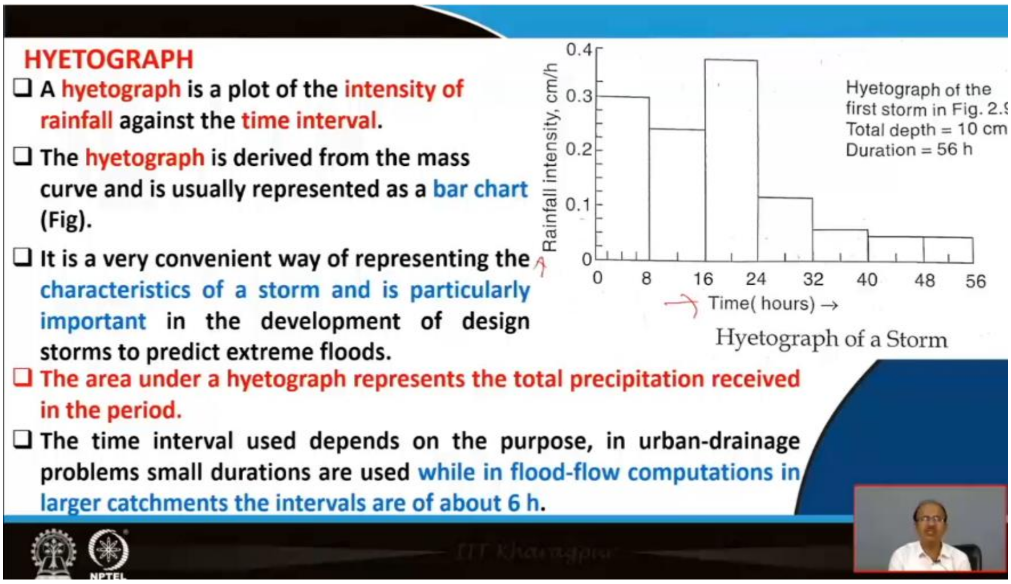

Now, the hyetograph, the hyetograph is a very important graph because it is a plot of intensity of rainfall against time interval. It is just a plot of the intensity of rainfall against the plot time interval. So, this hyetograph you can see here the hyetograph of a time is there in this exercise time is there in this side rainfall intensity is there. So, hyetograph is a plot of the intensity of rainfall against the time interval.

The hyetograph is derived from the mass curve this is it is derived from the mass curve only. And is really represented as a bar chart it is represented by bar chart. It is a very convenient way of representing the characteristic of a storm and is particularly important in the development of design storms to protect the extreme floods. So, for prediction of the extreme floods this hydrograph mass curve of rainfall these are very important source which is just telling about the details event of the rainfall in terms of your extreme flood also.

So, this graph or this hyetograph which is a plot towards a versus intensity and of rainfall and time. So, the area under a hyetograph generally represents the total precipitation received in this period. So, whatever area is coming and this area is just representing the total precipitation received in the period in the specific area and the time interval depends on the purpose in urban drainage.

In the urban range problems small durations are used while in the flood flow computations in broader catchments the intervals are of about 6 hours. So, it is also very important that the time interval used is very important and for the different purpose. So, this type of graph generally represents the total amount of rainfall received within a specific period in a specific location. So, that is why this hyetograph is very important.

So, hyetograph related with the precipitation whereas hyetograph is directed with the surface runoff what we have discussed during the discussion of the surface runoff. So, we came to know about the different types of network stations the how to in the case of missing rainfall, how can we find out the rainfall amount how many in case of fixation of location of range network if suppose any more is required this also we can find out.

So, in this way we have discussed about the greater detail about the rainfall and the index of wetness. Now, in the next part we will discuss about the infiltration. So, with this; thank you very much to all.