Water management
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Lecture No 24
Border Irrigation System (Contd.)

Okay, we are looking at the evaluation procedure for a water strip and we had seen that what are the various steps to be taken, what are the various level of data which is required for the purpose. Plus look at the various analysis component what we do with this data. How we can make use of this data which has been collected from the border strip or a set of border strips which are been used from the actual area. To do that I think we will be quite appropriate if we take a sample example and go through that sample example which will also give us some in-depth in-depth details on how the data is recorded. What are the elements of data which we have already aa listed in the previous lecture and then we will go on to the analysis what type of analysis will perform and how that analysis is useful in our later on design or even for finding out as the as the manager of the water distribution or as farmer how effectively you are utilizing the water.

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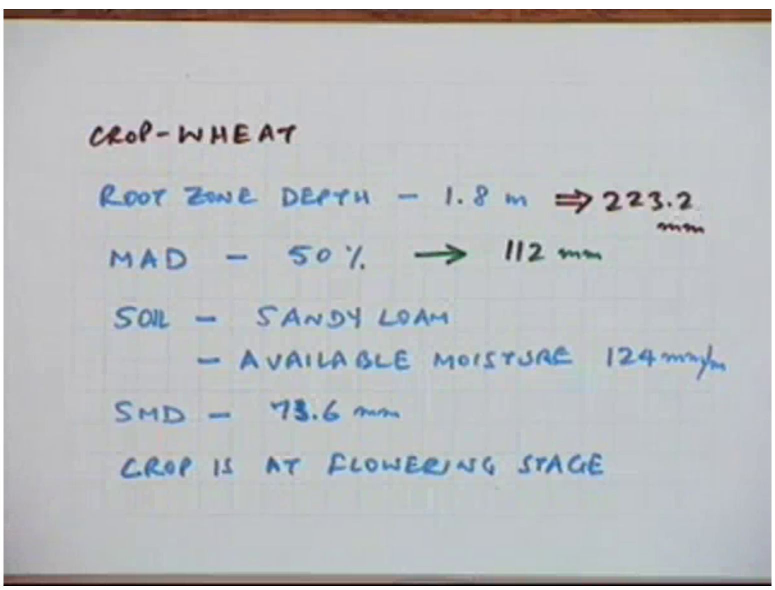

This example which has been taken is the result of actual test run which has been performed on the field and some of the the details the initial details which are important in-terms of knowing some of the quantities these are that that the crop is wheat crop on which test run was performed.

The root zone depth of this crop is 1.8 meters. The MAD MAD is Management Allowed Deficit is 50 percent. And the soil which is in question is the Sandy Loam soil. For this soil it has been found that the available available moisture is 124 millimeters per meter depth okay. So if it is 124 millimeters per meter depth then for 1.8 meters the amount of moisture will be this will be 223.2 millimeters okay. This is per meter depth 124 millimeters of moisture available or 1.8 is around 223.2 millimeters and if you now find out what is the 50 percent of that is around 112 millimeters.

So the Management Allowed Deficit you can have a deficit of up to 112 millimeters in that soil. And this deficit signifies that if you remain within this deficit level the yield of the crop wouldn't get affected. If you go beyond this deficit you mean if you lift the soil moisture deplete below this level or beyond this level then there will be some impact on the crop yield. The other data which is given here is that SMD, the actual soil moisture deficit which was prevailing at that time when the irrigation was done is only 73.6 millimeters okay. The other information which is available is the stage of the crop is crop is at flowering stage. Now initial data which is either observed on the field or is available hmm already existing with the organization of the farmer.

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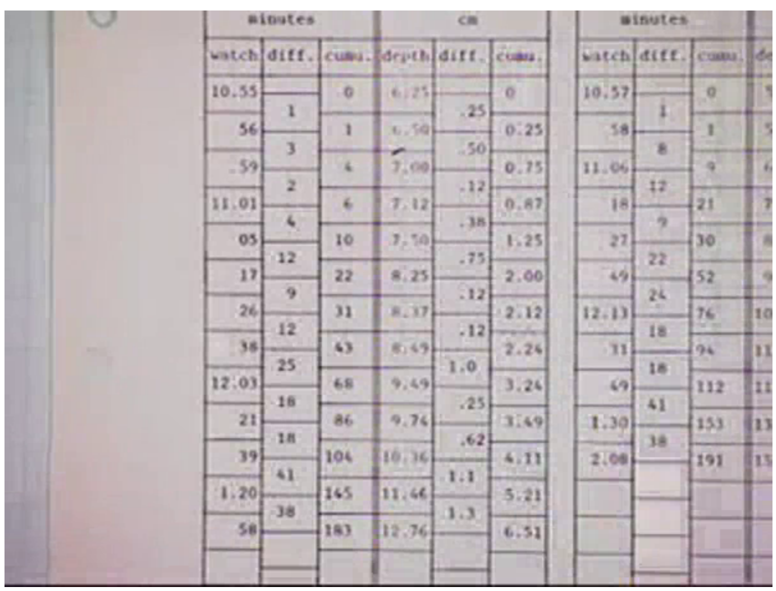

minutes			cm			minutes		
watch	diff.	cumu.	depth	diff.	cumu.	watch	diff.	cumu.
10.55		0	6.25		0	10.57		0
56	1	1	6.50	.25	0.25	58	1	1
.59	3	4	7.00	.50	0.75	11.06	8	9
11.01	2	6	7.12	.12	0.87	18	12	21
05	4	10	7.50	.38	1.25	27	9	30
17	12	22	8.25	.75	2.00	49	22	52
26	9	31	8.37	.12	2.12	12.13	24	76
38	12	43	8.49	.12	2.24	31	18	94
12.03	25	68	9.49	1.0	3.24	49	18	112
21	18	86	9.74	.25	3.49	1.30	41	153
39	18	104	10.36	.62	4.11	2.08	38	191
1.20	41	145	11.46	1.1	5.21			
58	38	183	12.76	1.3	6.51			

This is the data which is taken from the cylinder influentrometric guys. There are different test which has been performed on the field. This is the first cylinder and at location number 2, there are two more observations, so these are the actual observations which have been taken. We will just concentrate on this particular part. What type of observations have been made and what analysis or what is infelt from those observations. You can see here that there is time in minutes. These are the watch are hours at which the observations have been made 10:55 56 59 in the beginning the interval is much closer because the infiltration will be higher and then the difference in time has been noted here. So while making the observation you might be observing only this and the depth. Now this is the depth, the infiltration in centimeters.

So these two observations in the column number one and column number 4. These are the two which have been put and later on then the these have been derived from the observed data. You have the difference in time and then the cumulative values, that after this time how much is the the cumulative time. That cumulated time is also written here. Similarly in the case of depth how much is the depth per interval is 6.25 centimeters and the next is 6.5 after 1 minute. So in that 1 minute is .25 which is the the difference in that this the last column gives you cumulative value of the infiltration.So basically these are the cumulative time and the cumulative infiltration that is what you will need to plot the the data or to analyze the data to find out the infiltration characteristics.

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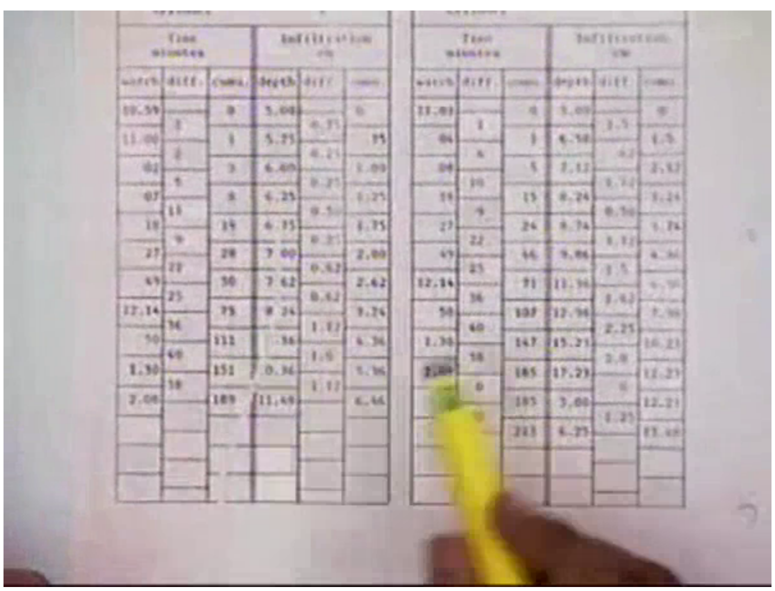

Similarly the other observations have been made and there are two more this side because in general you will find that these observations are required to (())(10:26) for the variabilities in the

the soil characteristics and also to sometimes to do account further inaccuracies which might you might incur while observing the data.

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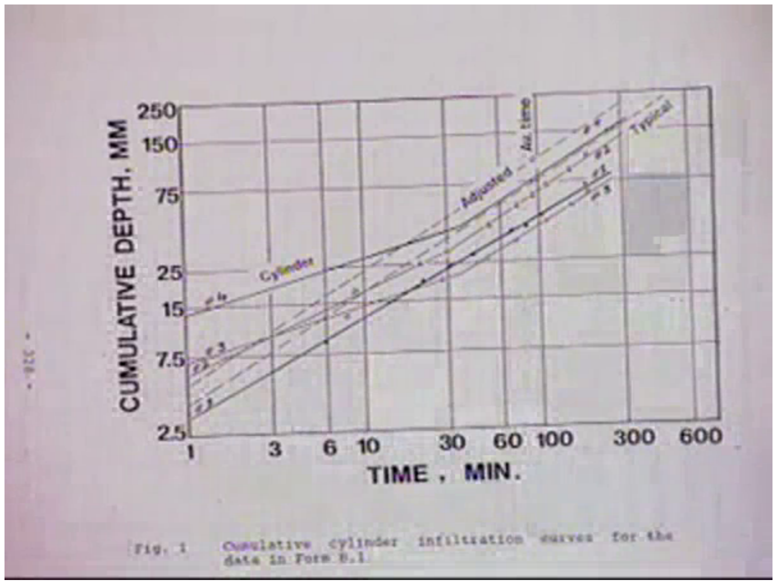

Then this has been plotted over a log log paper. All these four cylinder test, the infiltrometer test data has been plotted and these are the numbers. Number 1 number 2 number 3 and number 4 samples which have been taken and that those are plotted the time versus cumulative depth. Now you're you will see that all these are quite different in terms of scatter. These four different samples are giving quite different values. That's the reason that you will you will lead to arrive at some average value. So the typical value has been interpolated the slower dash time, which is given here. Is it visible? This lower dash line has a typical value which is average value may be. Fine, now having computed this average value you have the you have the characteristics, the infiltration characteristics available with you for that representative area or for that particular field. After that you will have to go in for other observations which are observations on the water movement. How the advance curve and the recession curve will be with respect to a selected stream size.

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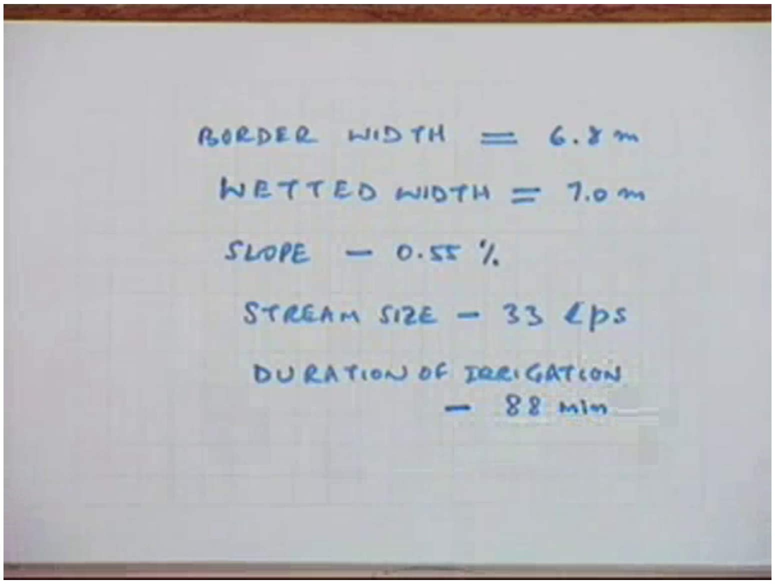

So in this particular test the the various observations which are made before you have started the supply at the upstream end, these are that the Border Width, the border width might be different than what is the the metric width because there will be the ridges will also have some some slope. So you will you can note down both the things. What is the border width that means the clear width between the two ends of the border and what is the the wetted width, in this particular case the wetted width was going to be 7 meter. And then you can also take how this width is changing from one station to the other station when you go into the station which have been installed at those levels how the width is changing if there is a change in the width you will have to again account for that or take average width.

Then the slope again you had taken the observations on the elevation point. What is the elevation at all those stations, that will provide you the slope and this particular case the slope is 0.55 percent which has been observed. The selected stream size we have said that will a stream size a suitable stream size will be selected and that selected stream size will be used on one strip on the other two strips you will have some variation of that stream size may be in one slightly lower and another one slightly more stream size. So in this particular case we are only discussing once strip data. In this particular case the stream size which is used is 33 liters per second. And since is a border strip case it will be per year at width. Per meter or width of the border.

Then the duration of irrigation can be pre decided or at that time when you it again depends on what type of soil you are using and what is the slope in general you might if is a light soil you better stop the water when it reaches around 70 percent of the of the length of the border. Whereas now is the is the other way round if it is the light soil you will let the water spread up to around 90 percent and if it's semi soil you will stop the supply of water when it has the water front has reached around 70 percent of the the length of the border. This is a a thumb rule basically but you can also vary in this case you can in different segments or in different strips you can use different timings of the the supply of water. The idea is that you should have the minimum surface run-off and since in the case of light soils the infiltrations are higher, you will find that if you stop it too early the last bit of the the field might not get any water. So is a function of along with the the stream size is also function of the slope and the soil type. In this particular case the irrigation has been done for 88 minutes.

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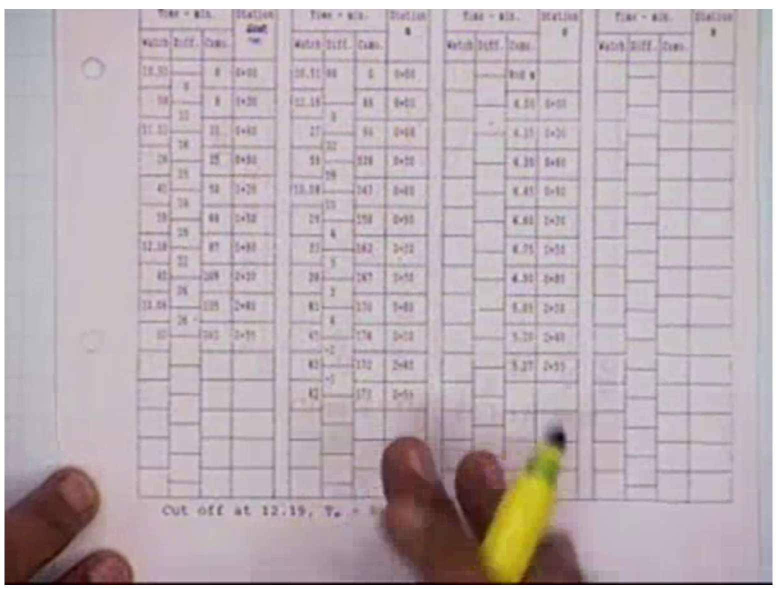

And the data the other data which has been recorded is again this is the data which has been we will we will see you can concentrate on this segment first, this is the first segment, these forms are pre-designed forms which can be used which I was referring to in the last lecture that the pre-designed forms can be used which can reduce the inaccuracies because of the recording of the data.

So here you can again see that this is the watch hours, what hours the readings have been made. And this gives the the at a different statements these are the stations which are 30 meters apart which we have installed on the this particular border strip. In this case in this example the border strip is 255 meters long. So that you can see here that 0 meters is the first station then the next is 30 0 plus 30, 60, 90 and this is 1 plus 20 that means 120 meteres, 150 and so on. Now what we are recording is that at what time the water reaches each individual station. So this is the time when you have started the supply of the water. At the next station the water has reached at 59 minutes, at the next station it has reached at 11:12 and so on. So what you have what you can found in turn is that what is the time taken between the two intervals as a difference and then the cumulative value also can be recorded.

Now these 2 data the distance versus the cumulative time or the elapse time will give you the advance curve. Similarly for the the recession curve you have recorded the data in this particular segment where this is the same thing as this what was the time of start and then after 88 seconds this is the difference at 12:19 which is difference is 88 minutes, so after 88 minutes you have supplied stopped the supply of water. Then you have found out that when the water disappears, from this station. So it didn't disappear till 27 11:27 12:27 so that means at 12:27 the water just disappeared so it has taken around 8 minutes for the water to disappear. So that is the the lag time. That is the time the water has take to the the tensions to reach has taken 8 minutes to disappear from the station.

And then similarly you find out the time this is the at each station what is the time when the water the the session part of the water that got disappeared. So you have noted down that time against each station and that is how it will give the cumulative value that what will be the cumulative at which where water is getting disappeared. So that will this and this will give you the recession curve okay. And along with that this the this segment is used to to get the slope this is the reading of the the elevation with respect to some datum at each of the station and that will give you the slope of the…

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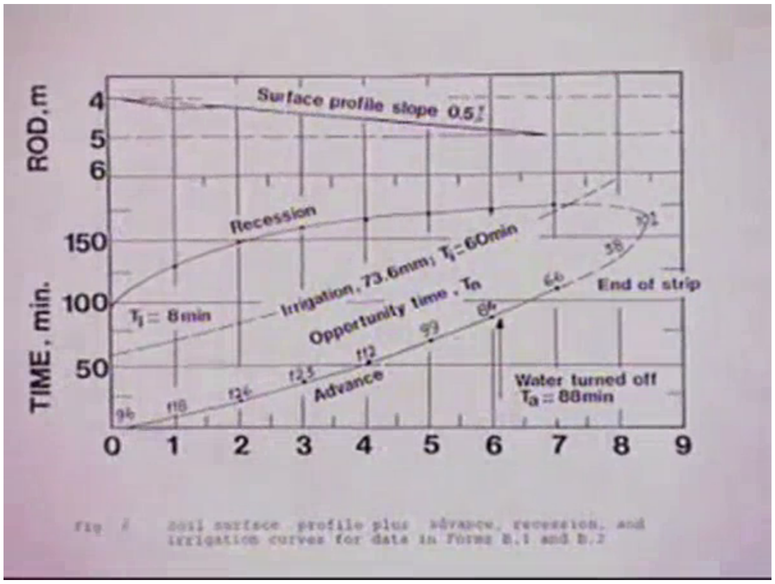

Having observed these basic data then the data is plotted and this is a plot of the data. The same data the way it has been plotted you can see here that these are the stations. Station number at 0 this is up stream end and this is downstream end. And the total length is a coming up to here it's over here. And at each station you have used data of the the accumulative time or the elapsed time and this is the advance curve, this is the recession curve which has been plotted. And these values which has been written, these values are nothing but these are the the values of the opportunity time. The difference between this time and this time. So at each level what is the time at which the water has disappeared, what is the time at which the water was available. And these are the timings at each station for how long the water was available at those respective stations.

Now this gives quite a good picture about what is the what is the time and the since you know the time you can also find out using the characteristics of the soil how much will be the infiltrated water at these occasions. Now there comes a problem and you don't have on this side you have plotted the surface profile against the readings which have been recorded. And sometimes you might find that there is a depression or there might be a hump at some place and that give you the indication whether what type of problem you can face. So if that is observed somewhere in some of the strips you can try to remove in the next, if it is a crop which is already available crop you might not be able to do anything but you will be able to associate your reduction and efficiency or the relevant efficiency to those observed things or those problems which you have observed in the data itself.

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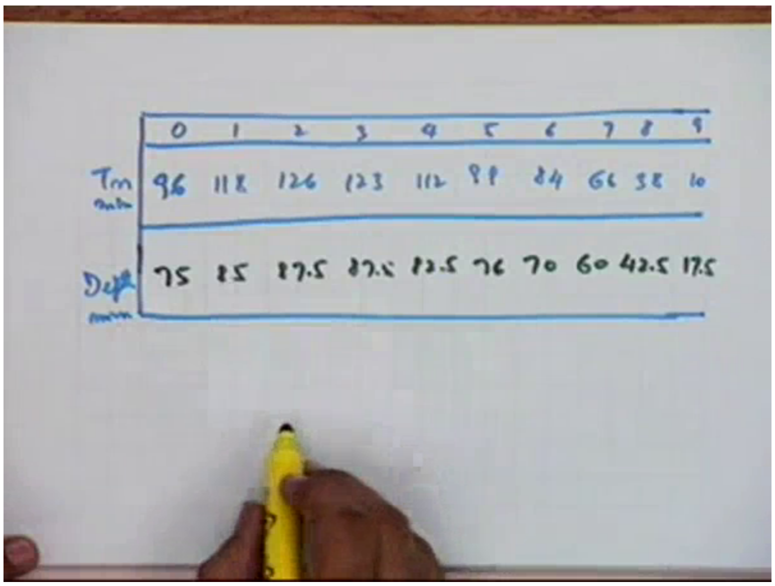

Now using suppose this data which has been observed you use this data to find out how much is the the depth infiltrated depth, let's have a look that we know these are the various if we see that we have stations 0 1 2 4 5 these are the various stations. And we have recorded that what is the the net time for which the water is available at these stations. And we have said that we have got this is in minutes 96 minutes 118 126 123 112 minutes. Now using their average soil characteristic which we have using those infiltrometer test, we have found out the soil characteristics in terms of that equation Y is equal to A T to the power B plus C. And using that equation we can find out what is the depth of infiltration in millimetres. Now the depth of infiltration which we find for the corresponding locations in the present case this is the, these are the actual values which you derive by using that infiltration curve characteristics that this this much is the depth that can be infilted depending on the time which you have observed at this location using the actual data.

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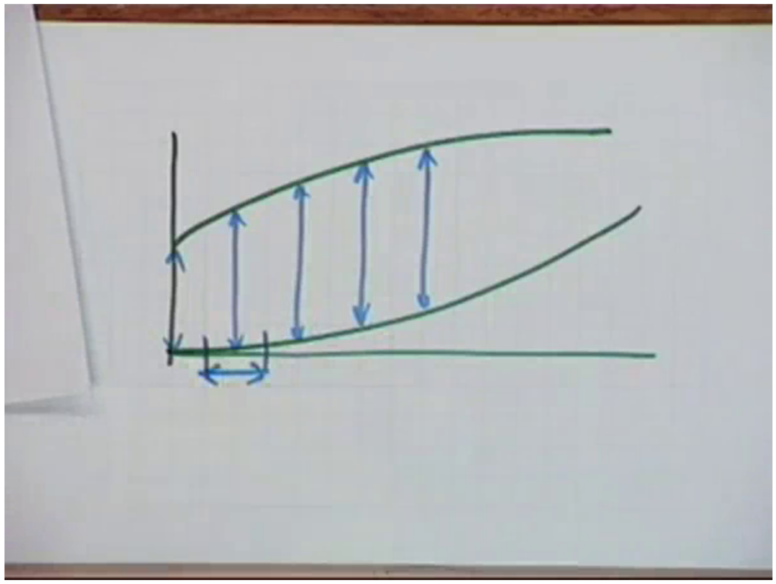

Now here if I try to take average depth because in each of these cases when we have various stations we have said that this is our the advance and recession curve at each one location we're find out how much is the the infiltration time and at each of these locations we're having a value which is only a single value. So if we assume that this part is representative of this, this segment you can always a average of the previous and this one and that is what is being represented by this segment.

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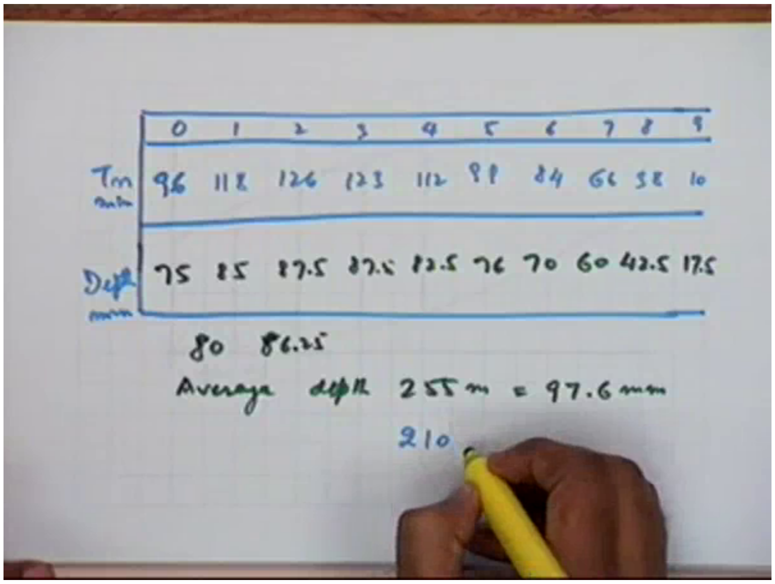

So that way you can you can take the average and those average is you can note down at this location, now this is, this is just trying to reduce the the impact of discretization you are taking the individual values. So if you take the averages you will get some average value for all these different segments which are 20 meters each and then you can take the overall average, the average depth of the total length which is 255 meters turns out to 97.6 millimeters. Using this data the average, if you take the average depth, these are the actual depths or for for example in this particular case you will find that between this and this the average will be 80, between this and it will be 86.25 and so on. So if this 80 is representing the first 30 meters then you can find out that for the total segment of of the total length of 255 meters the average works out to be 97.6 millimeters.

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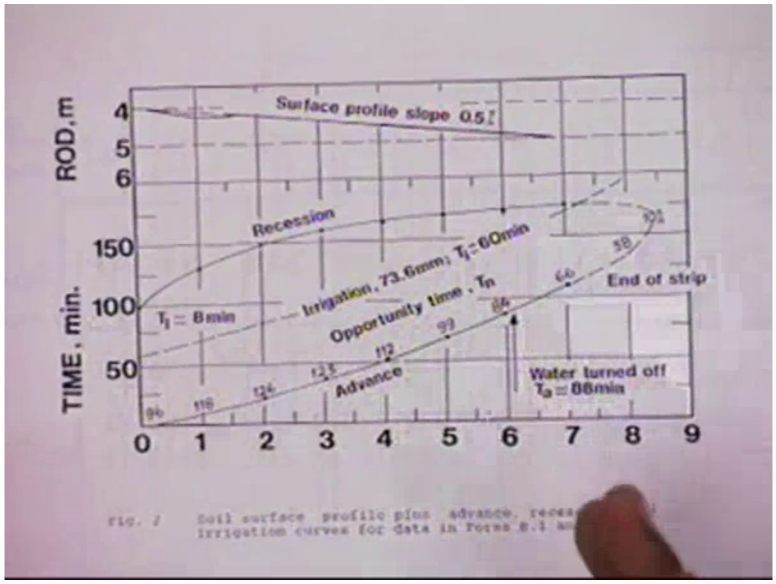

And if you take, we are also trying to look at another if you see here we are trying to find out that if the length would have been 210 meters only then what will be the, because in this segment you can see is quite obvious that the distribution will be really very poor because the time of infiltration is very low. So if you go beyond beyond this segment up to here you still have that these two curves are not trying to converge. The opportunity time is still quite reasonable. We will have to check that, because we might ultimately find that even this length is not sufficient you might have to choose a length which is another 30 meters on this side. So that is where you can make various options.

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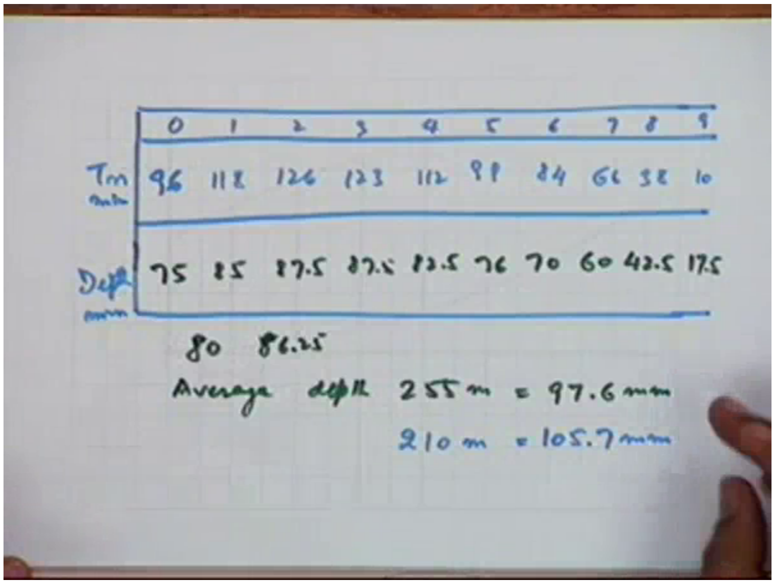

And let's try to make a option that if we select 210 meters of border length, what would be the the average depth which will get using this the the soil typical soil characteristic curve, which we have assumed or which we have selected from those 4 samples. You will get a depth of 105.7 millimeters. So these two depths are the ones which you're getting from the the data which you have observed. Now at this junction it will be quite worthwhile to check how these depths, because this depth is totally constraint this depth which you have which you're finding out is totally constraint which the fact that whether the soil properties of the soil characteristic curve which you have obtained is reasonable or not.

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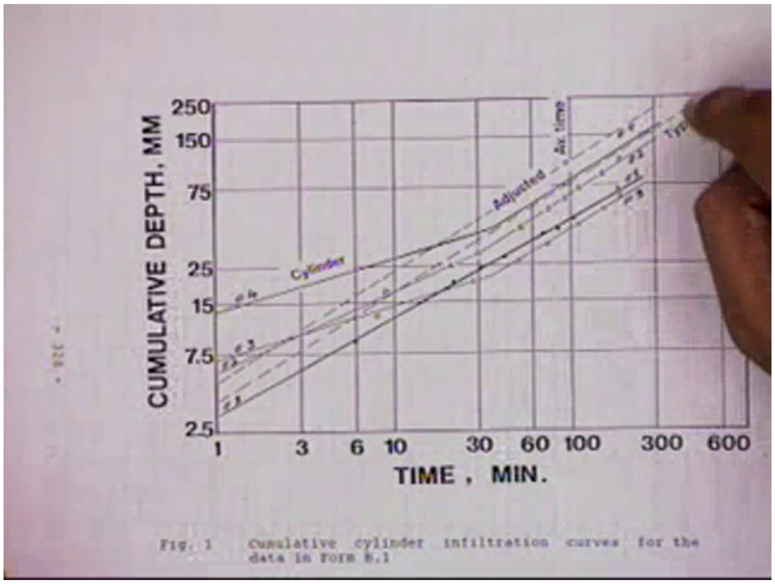

Fig. 1 Cumulative cylinder infiltration curves for the data in Form 8.1

Where the range was so much if you again have a look on this the range is too big. So you have to you have to justify you have to have a in-depth study of that characteristics whether the selected characteristics are reasonably representative of the area or not.

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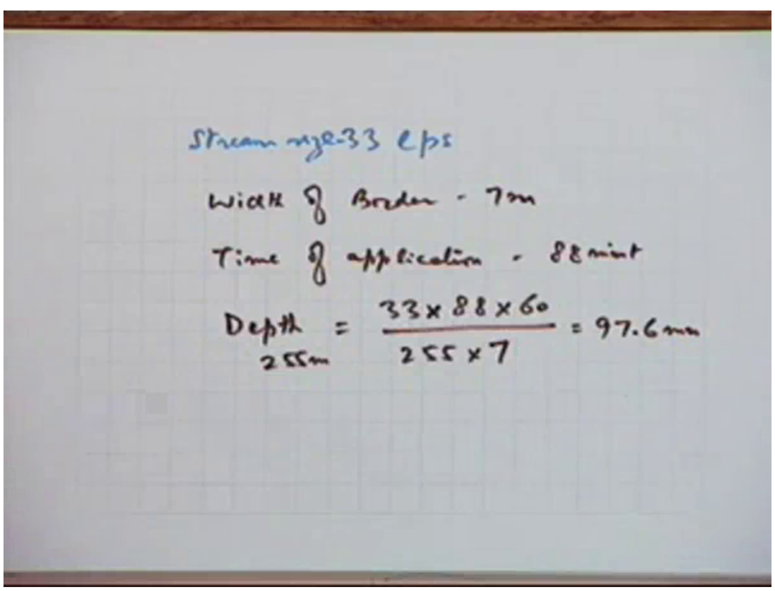

So to do that we make a analysis depending on how much volume has been sent to the strip how much volume we true to do some analysis on the the basis of the supply of water. We know that we have stream size which is 33 litres per second okay. We also know that the weighted width of the border is 7 meters. And we also know the time of application so the width is known. The time of application is known. This is 88 minutes. Using this if you want to find out what is the volume and convert that volume into equivalent depth that depth will be the depth if you use 255 meters length, because it will be function of what length you're using. So if you use 255 meters length, this volume will work out to be 33 litres per second and these are 88 minute seconds divided by the area. And this will work out to be 97.6 millimetres.

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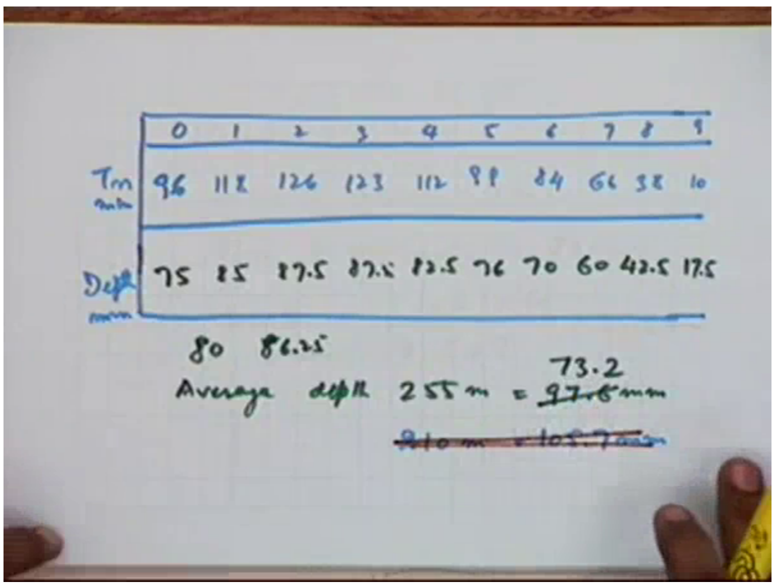

There has been a slight mistake which has been made here and giving to this information this is not my fault. This is not 97.6 millimetres this is the value which is less is 73.2 millimetres and this is also accordingly. This is the value which will be the value which is after the adjustment has been made. So it's observed here at this junction that because it cannot be, if you look at these values it cannot be 97.6 the average value. This average value has to be lower, and looking at these values also is 60 42 17 and there are some higher values so the average is around 73.2 okay.

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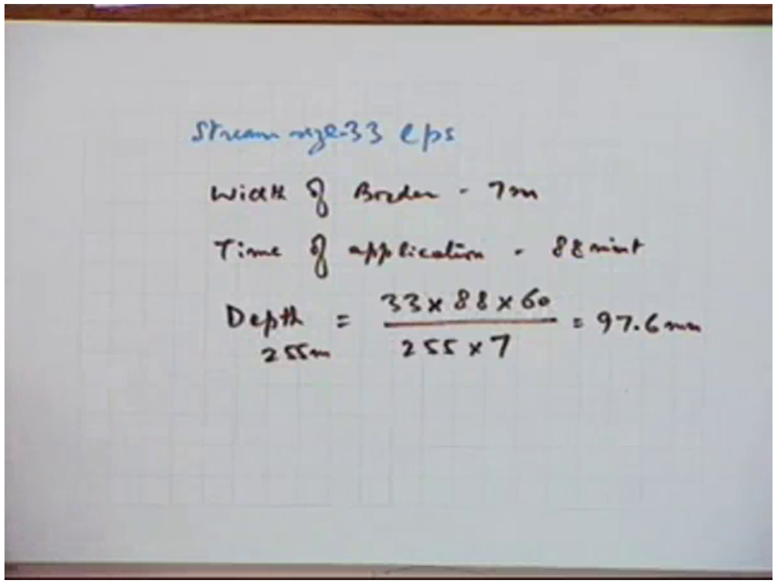

Now this depth which works out to be 97.6 is if you try to visualize what is this depth? This is the average depth depending on the fact that you have depending on how much water has been sent to the strip, how much volume of water has been to the strip. So you're infiltration characteristics curve is giving you under simulation. The this this signifies that the infiltration characteristics curve which we are using is giving a under simulation and that needs adjustment. How you adjust that because even if you look at there will be there will be some surface turn off there will be some other losses also.

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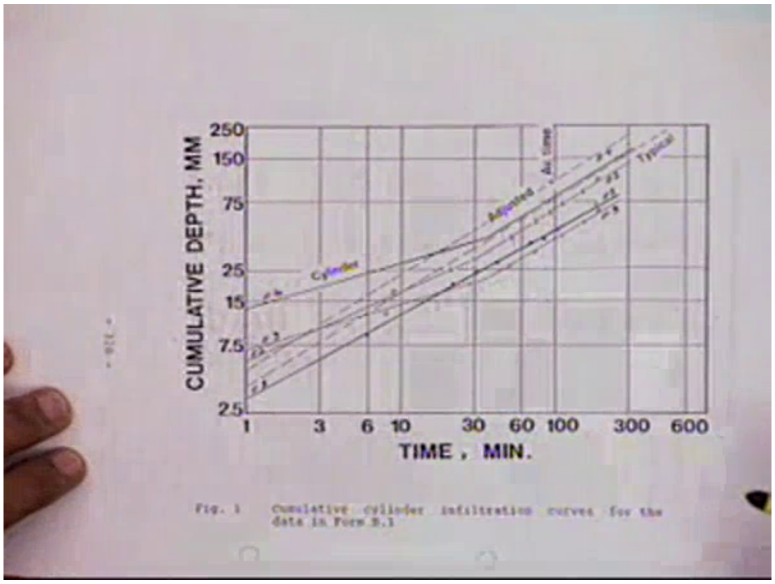

This 97.6 is corresponding to line here because the minimum which you want to send if you find out what is the where is that gone.

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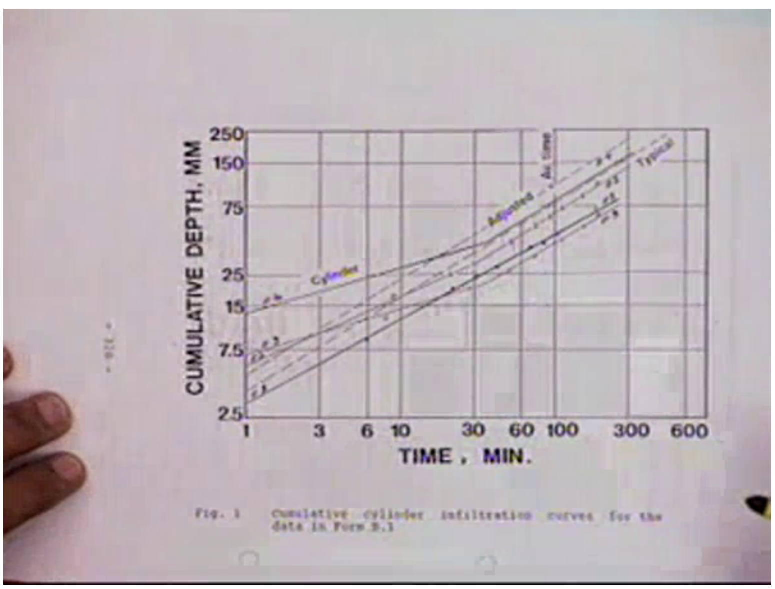

Hmm if you look at it this particular place the average time if you look at the typical curve which we have selected, this is the lower curve which has been selected. And at that curve you're getting a value of 73.2 which is the average depth. At 73.2 what is the time the corresponding time is around   it works out to be around 96 minutes. So if I take a value the average depth which is 73.2.

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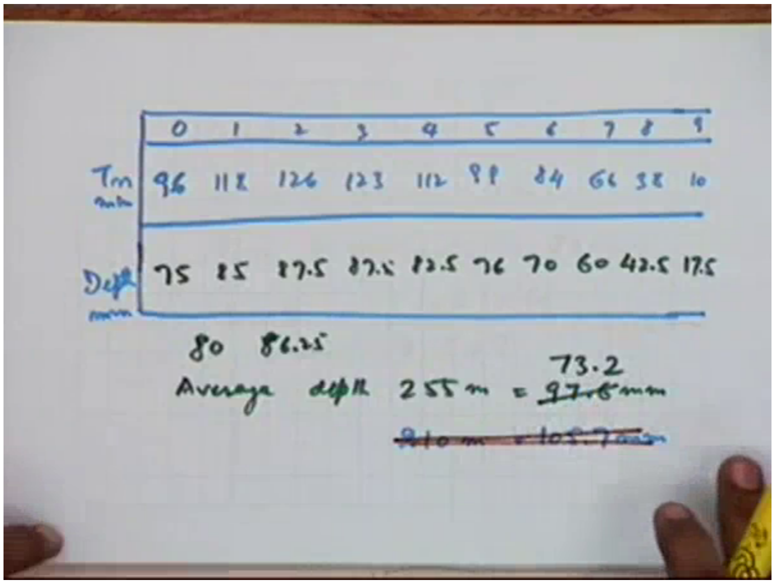

Which I have found out from here that this is the average depth which I was getting.

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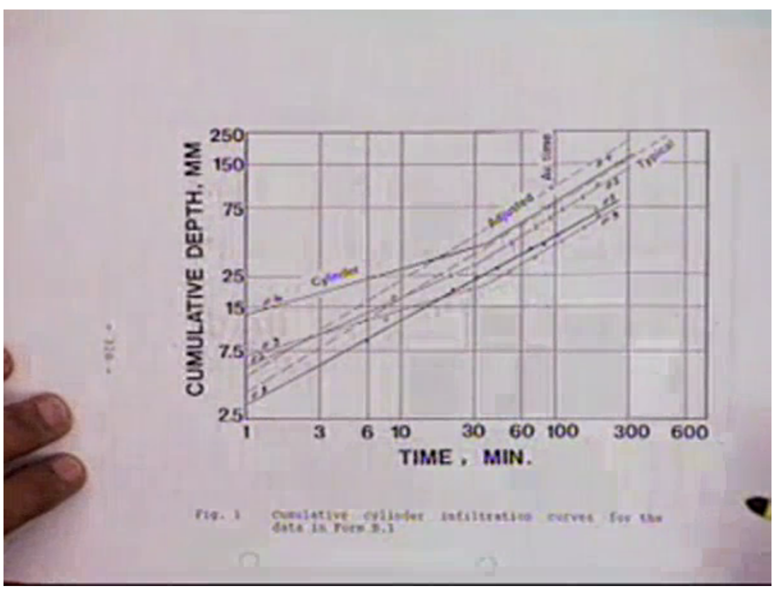

If I use this typical curve which I have found out on the basis of the average data or the on the basis of the actual data I have found out the average curve and I am not sure whether that average curve is still representative of the total area or not. To to verify that I went to the volume basis I found that that volume will create how much depth on the average. So in this situation if I find out that 73.2 depth how much time it takes to get nearly 73.2 depth is around 96 minutes.

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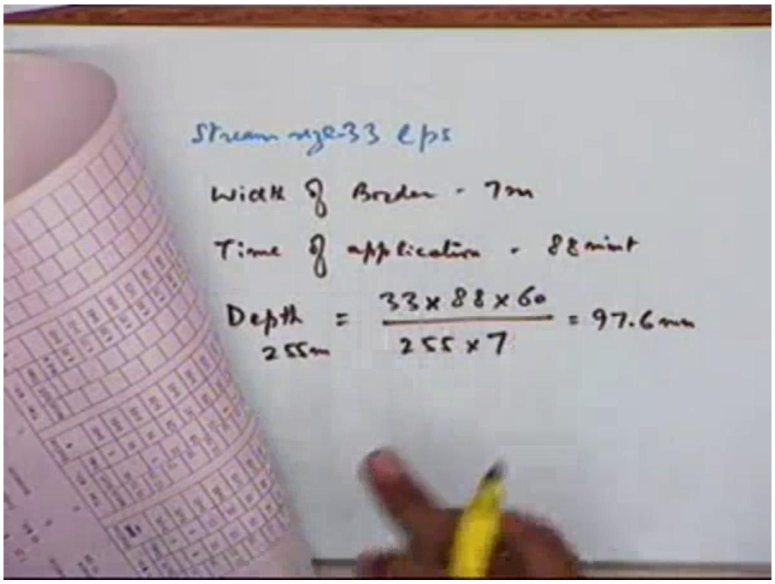

For 96 minutes in that 96 minutes I should get a depth with respect to the volume or with respect to the stream size which has been selected.

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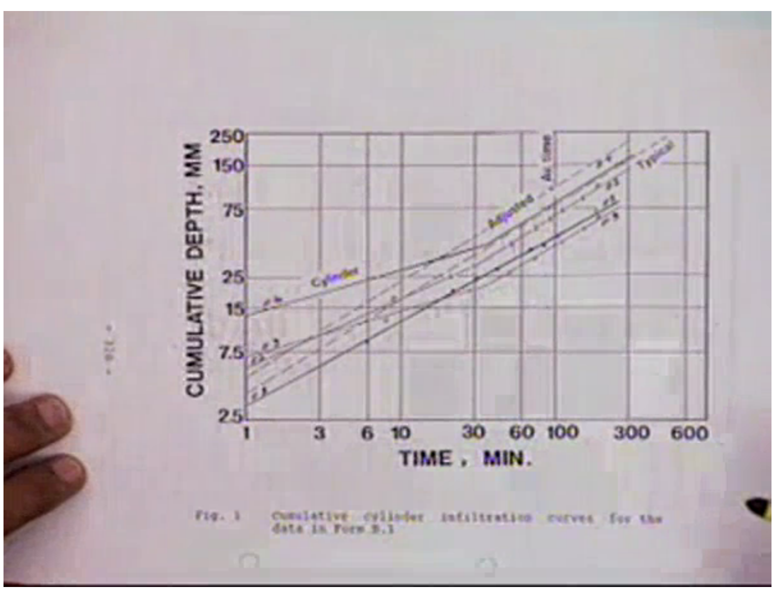

I should have got a depth of 97.6 centimetres. So I I take this point to a level which gives me a cumulative depth for the same time which is equivalent to around 97.6 millimetres. So I shift this curve up and then I draw a line parallel to the previous typical curve. That is how I make the adjustment I have kept the same slope but I have changed I have shifted I have adjusted that the the infiltration rate in such a manner that for the same time I get a value at least which is equal to the value which I spread using that average stream size and that minimum that average value of depth I should get from that infiltration curve, it should be the representative curve. Having got this adjusted curve.

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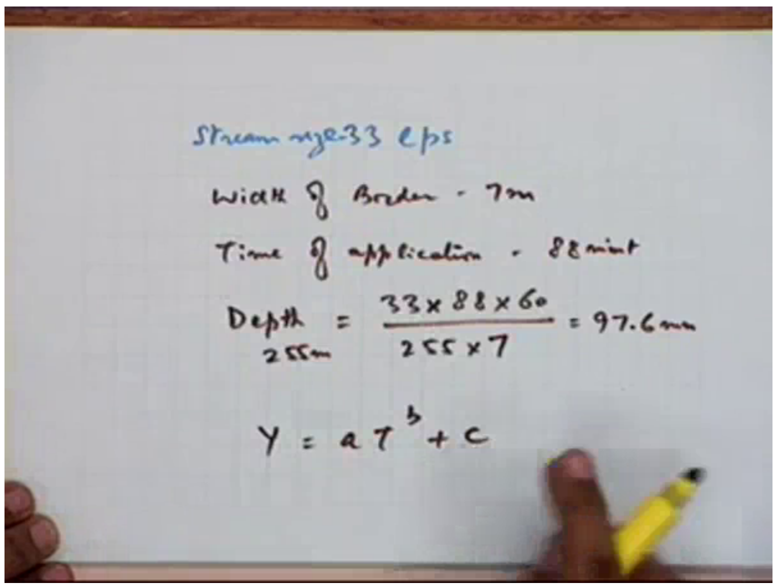

Now I I try to verify that and I find out how much is the or in other words I get new curve which give me a analysing this, this particular adjusted curve I get a new set of values which I analyse for A, B and C.

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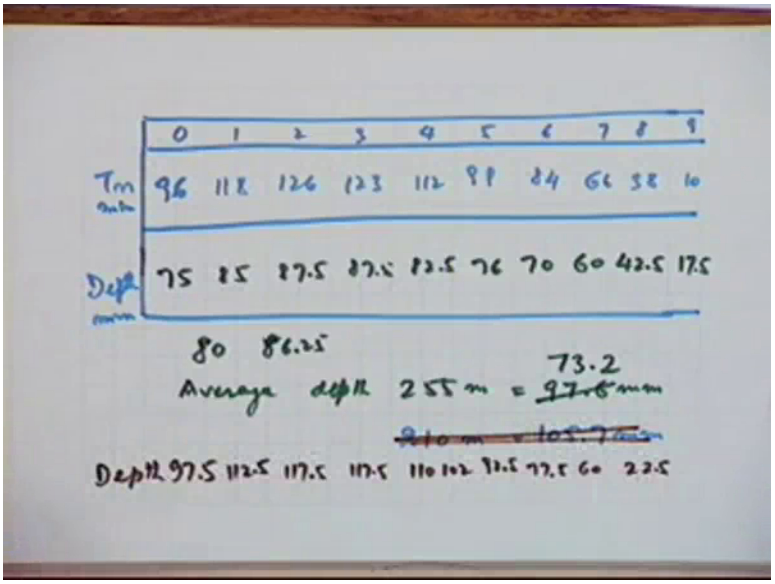

And use that curve in-turn to find out how much is the how much will be the the depth for these infiltration opportunity times okay. So that is what I will do here and I find out what is the change depth, I will write at this level the change level in this particular case is 95. 97.5 at this station it will be 112.5 instead of 85 and then I will have 117.5, 110 millimetres, 102 millimetres and 92.5, 77.5 and so on. So these values are the adjusted values or the revised values with respect to the new characteristics and this I analyse again to find out what is the average depth now.

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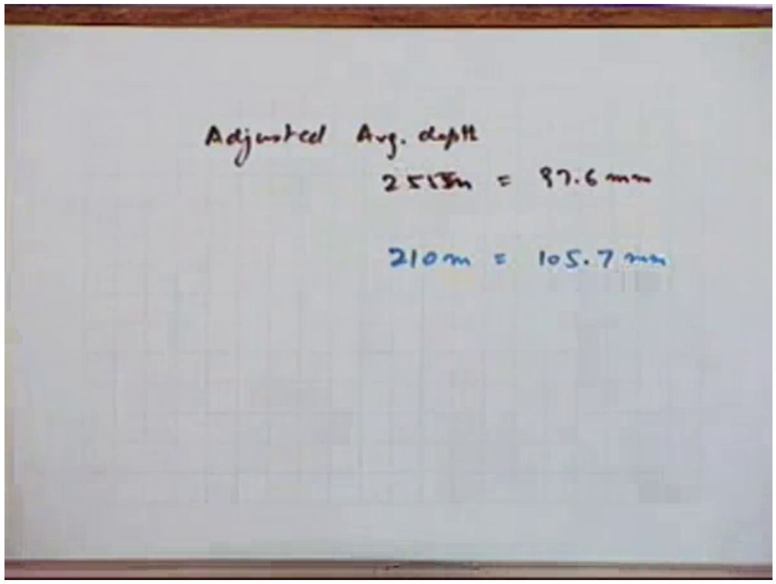

The adjusted average depth if I take the total length of 255 metres works out to be 97.6 millimetres okay. Which is the same now, which is the same as what I have found from the criteria of the stream size by analysing the volume which has been put on to the total length. At the same time if I decide to reduce the length because we know that last segment is poorly (()) (44:24) of the the infiltration opportunity time is very low in that, so if I decide to take only 210 meters of the length. This quantity works out to be 105.7 millimeters. Now this is important because we have seen that how the whole competition changes so either you have to have lot of those infiltration test mate and the and take average which will be representative or the total but still it will be much better if you verify those characteristic because these characteristics are varying so much in the the location of the test or even otherwise the soil characteristics are so much variable that when you're doing the point test infiltrometer test is a point test. In-fact you're using a very small area of the total area which might not be represented and there can be some other inaccuracies also because when you're using the infiltrometer test we have seen that even if you have the double cylinder the double that two cylinders you are using but still there can be some little dispersion.

So it can give some values which are not always the representative values so having that you can use the actual test to find out what are the the general characteristics. What shape it takes what slope it takes that slope be representative slope because the slope will change when you go from one type of soil to another type of soil, that is what is reflecting the rate of change of infiltration.

And once you have done that you must at least verify, how much is the variation or whether that that infiltration characteristics which you have arrived at is it really representative or not. And that is how we do it, that's what we have just (())(46:40)

Having done this then the next part is to find out the the various efficiencies and that is what we have that main aim of this doing this total analysis was to arrive at, to check various efficiencies whether those efficiencies are reasonable or what are the upper limit of those efficiencies all those things, you have to you're interested in.

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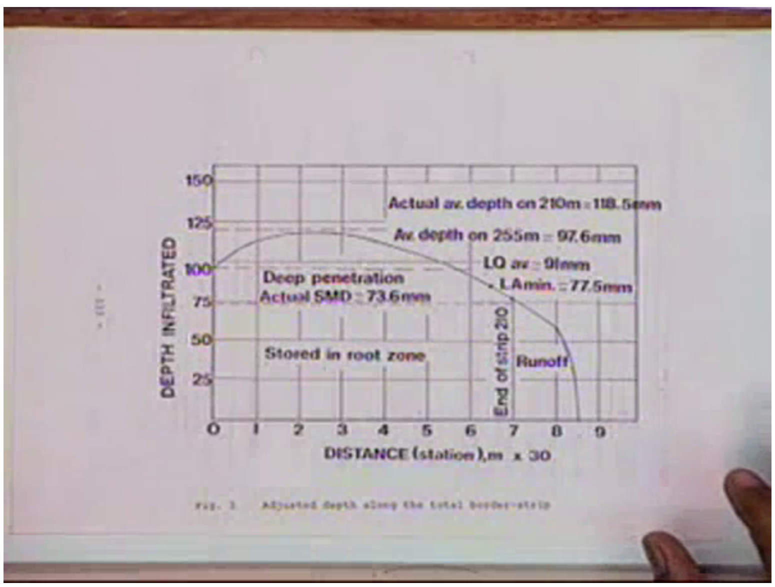

To do that this is the another depiction of the same data, but drawn in a different manner. Now here the same thing has been redrawn by taking the this as the the starting point for every individual value at each section, how much is the the total infelted water. Now we had found found out that that in the first case there is 96 97.5 millimeters and so on. So this gives you a depiction that how much is the total water which has been infelted at different stations. And this is the level the actual soil moisture deficit level was in this particular case we had mentioned in the beginning that 73.6 millimeters is the deficit which is prevailing in the field. So that means you need it basically if this much water if you take the total length then you needed up to this level you needed the water. So all this amount is the water which is stored in the root zone. Any amount which is above this level is the water which has gone into the deep percolation which has gone beyond the the root zone depth. And if you decide that you will end the strip at 210 meters then this will become (())(49:09) component.

Now this will be there will be some still still some water which will be available and which will go as run-off. While finding out the the efficiencies there are different ways by which you can evaluate those efficiency. One is that you can use these areas directly, these areas are depicting the volumes. So if you do that you can find out the efficiency using that or you can use only the depth you can you can find the the suitability of these different way or procedures and they are they are not giving much different results the results obtained are almost similar. So if we we try look at what are the various values of these efficiencies I will if we note down the areas.

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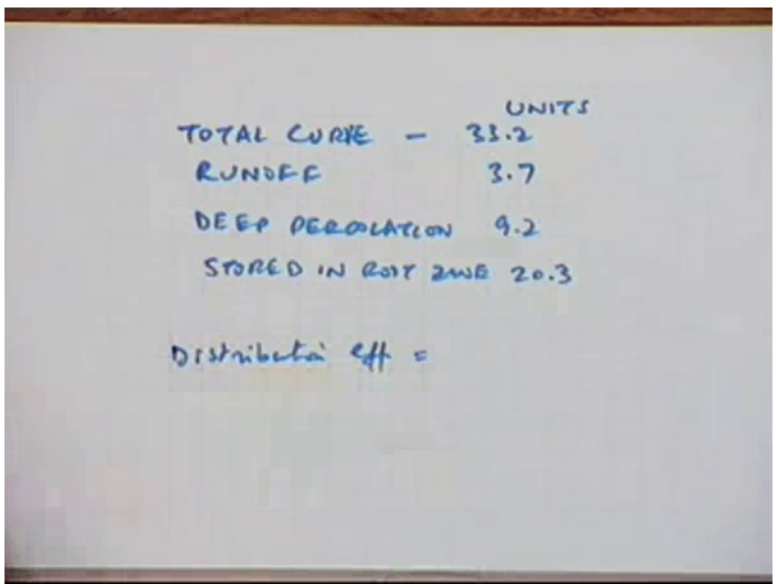

The areas which are observed the total curve under the total curve the area is 33.2 units okay. Either you can have a mesh or you can use a transparent graph anything you can do is or a graph paper can be used to find out the unit areas and the unit can be any unit is a material. The run-off is observed to be 3.7 units. And deep percolation is 9.2. The amount stored in root zone is 20.3 units okay. Now using this you can you can find out the various efficiencies which we have already discussed earlier. For example if you want to find out the distribution efficiency, distribution efficiency in this case now let me also mention that another .

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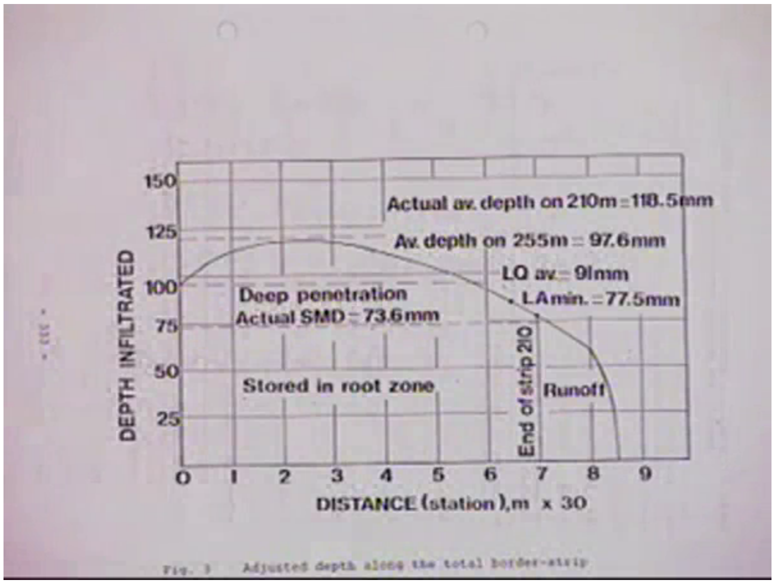

If we look at this value 77.5 millimeters this value is the the minimum depth which has been observed up to this particular level. The minimum depth which has been noted down which is required.

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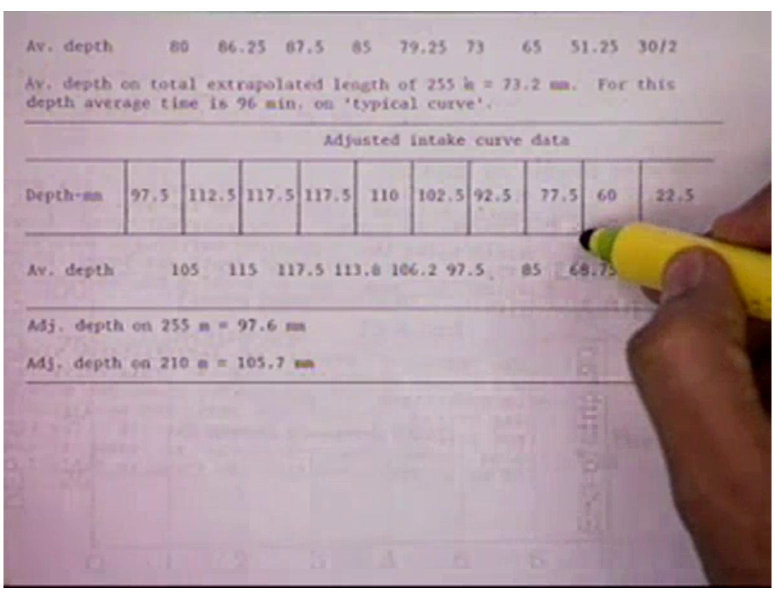

For example in this case this is 77.5 millimeters is the depth required up to 210 if you take the length of the border up to 210 meters only. And 77.5 is the minimum of the total. At every location the minimum depth which his required is 77.5.

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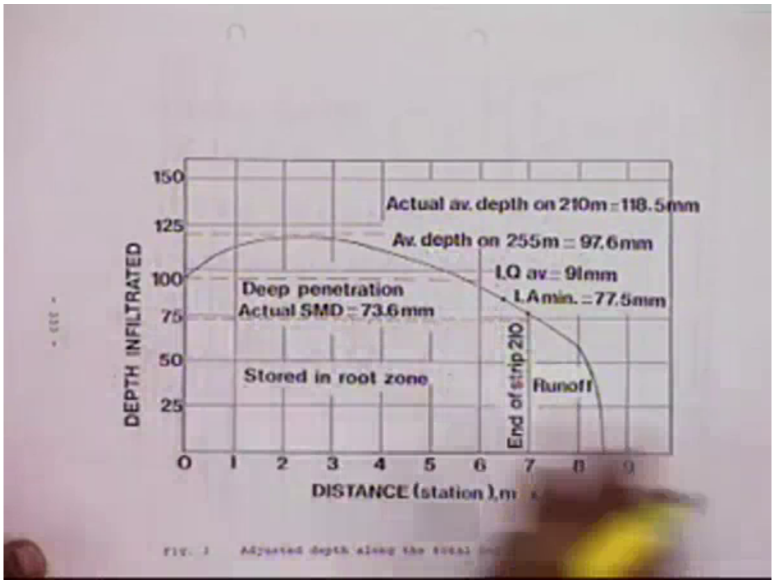

So with respect that depth if we have to achieve that then you will have to provide some water which is under the stored in it's root zone will be more if you would have got more deficit okay. So in other words you can also say that the potential value of the the efficiency the application efficiency could have been slightly different if you didn’t decide to irrigate the field at this soil moisture deficit level if you would have allowed the irrigate the soil deficit to increase to 77.5 millimeters depth then it was possible to have, because in any case you're getting this much water throughout this length so it was possible to achieve a higher efficiency.

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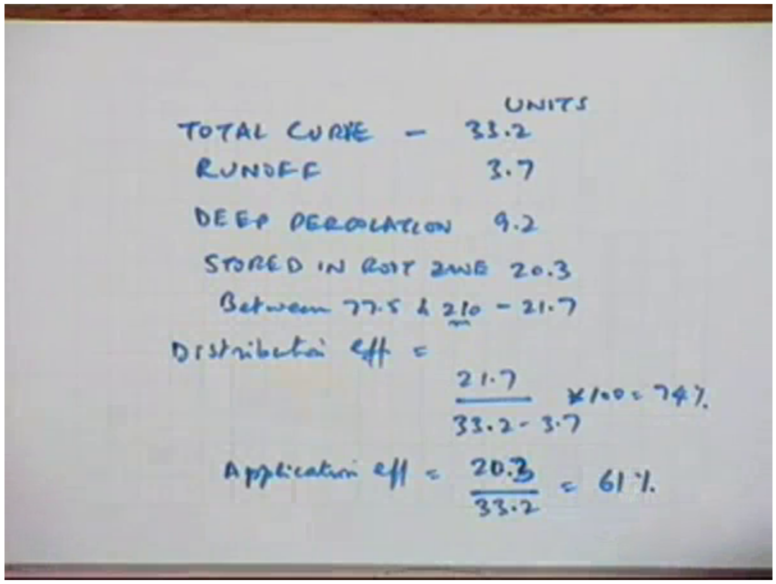

And the area up to this level of 77.5 millimeters is that area is between 77.5 and up to the 210 meters level this area is 21.7. So this give you a a value which is achievable value and in that situation the distribution efficiency would have been 21.7 is the depth which is applied depth and the if you take care of the surface run-off you're left with this is the depth which is required. This is the depth which is applied 33.2 minus 3.7 which has gone as the run-off. So if you multiply it by 100 this is 74 percent. So the distribution efficiency can be worked out from here. Similarly the application efficiency on the basis of the actual actual case the actual SMD the actual Soil Moisture Deficit this is basically 20.3 and how much you have the water you have applied. This works out to be 61 percent only.

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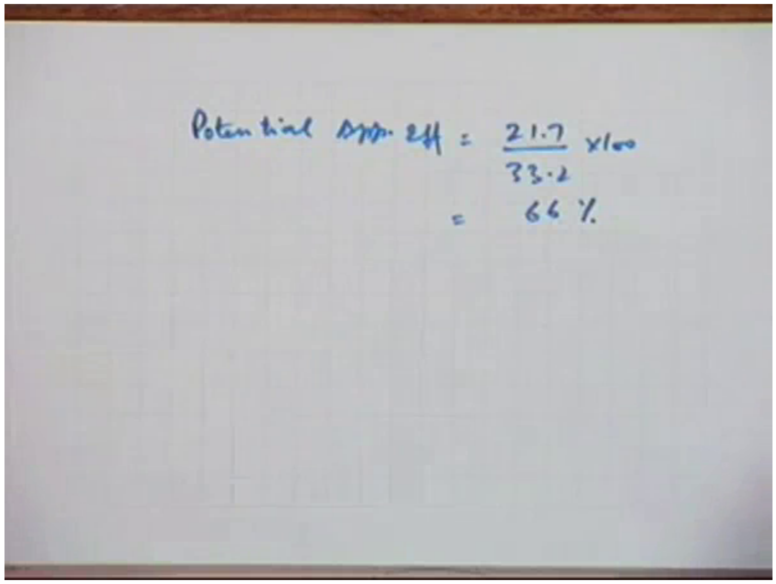

Whereas the potential value of the application efficiency could have been this could have been higher this could have been 66 percent. Had you waited for some more time and had you let the soil moisture deficit go to that level. So that is where the management allowed deficit comes into picture that if you if you can manage your irrigations in such a manner that you let the deficit which is reasonable deficit reach a level which is the optimum level you will find that the efficiencies can be much better.

Similarly you can find out the other efficiencies which are which we have already looked at and we also know the procedure how we can make use of those efficiencies. This is only one aspect which we have seen similarly in this particular case now this with respect to the stream size which 33 liters per second. If you use a different stream size you will find that all these quantities will change. So in the evaluation procedure your aim is to come out with those combination of parameters which gives you the optimum efficiencies and that is only possible if you analyze more number of these strips with variation in these parameters and it's more of a trial and all procedure when you're doing and evaluation okay. With that we will close this chapter on Water Irrigation System if you have any question you can ask.