Water Management
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Lecture 36
Sprinkler Irrigation System (Continued)

In last class we were discussing the various layout patterns of the main lines and the laterals which depend on the topography which you are having in a specific area and we had seen some of the layout patterns how they can vary with respect to the availability of the source and with respect to the terrain which is prevalent in that particular area. We had discussed specifically those terrains which are quite regular terrains they are not highly irregular.

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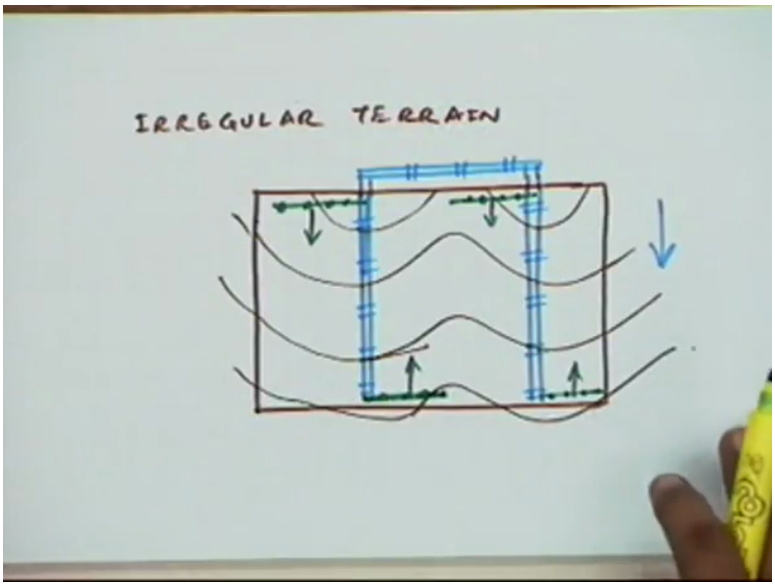

Let us have a look at what will happen when you have a irregular terrain. In that case when you have irregular terrain what can be the possible layout patterns again these are some of the possible layout patterns there can be many other which can be used and it will be a function of many many factors it also depends on the choice of the operator or the designer he can have 2 or 3 options out of which you can choose 1.

Let us have a look at one such possible irregular terrain let us take this terrain which has more undulations if we say that these are the these are the controverts which in general might find that means they are two ridges which are quite prevalent here. In this case as we have in this particular case the slope is in this direction this is the general slope that means these are the controverts of higher elevation, these are the controverts of relatively lower elevation.

As we had earlier mentioned that we will preferably have the main line on the ridge now if we situate the main line on the ridge and this main line again the source the two main lines which you have laid all these are the main line sections this is the nomenclature which I am using for depicting the main line as we have done earlier also. On these main lines if you have laid the main line in such a fashion to operate the laterals the laterals can be operated in this manner that you have these two laterals this moving in this direction and this one moving in this direction there can be another lateral another set of laterals one here, another here this is moving in this direction and this moving in this direction this can be one possible way by which you can operate these laterals, this is the layout which can be used.

Now in all these cases you can see you can visualize the laterals are on the minimum slope, the main lines are on the maximum slope and the laterals are taking advantage of the fact that there can be some some gain in pressure because of the natural slope which is becoming available to it. So it is compensating the losses to certain extent and then you are also trying to systematically move the laterals so that you can cover the whole area in a reasonably good time that is entirely that is another part of the design when you have to look at in overall sense how many laterals you will require to cover the whole area within the irrigation interval.

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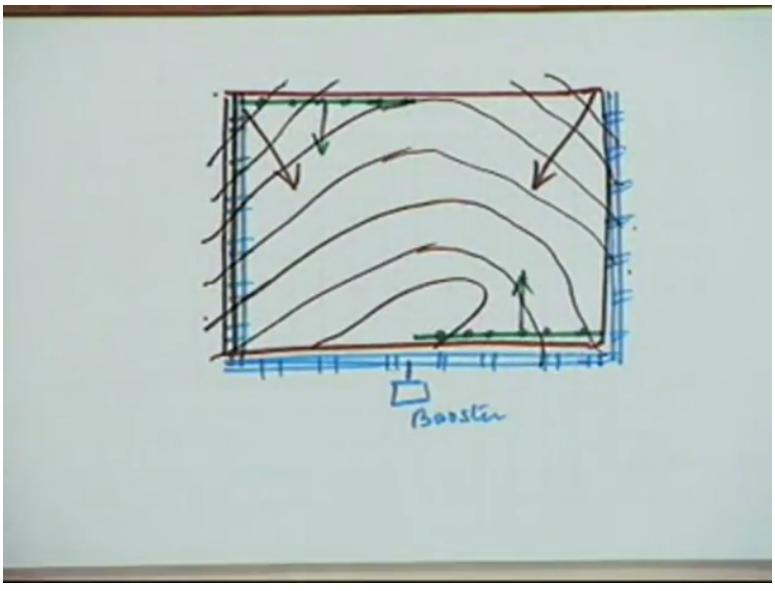

Similarly let us have a another situation of irregular terrain, in this case you had quite a symmetric terrain let us take a case where you have a terrain which again you have the these are the these are the controverts which are again the slope is in this direction these are the controverts of higher elevation and the slope is a downslope with respect to these controverts.

In this particular situation you again if you look at the situation that in this case the slope is in this direction the general slope and as far as this part of the field is concerned the second part or the right hand part or portion of the field is concerned the slope is in this direction.

So preferably you will like to have the main line laid on one side I use the same colour sequence for laying the main line, this is another main line which is laid down. Now from here I can have the lateral which is having the sprinkler heads and that can be moved in this direction. Now the advantage is that in this particular case your main line is laid on one side and you are still taking advantage of the fact that there is some downslope there is some pressure recovery which is possible in if your lateral is laid down in this particular manner or is in this on this side.

Whereas when you come to the other part now this is the main line which is you are getting the water from the main line suppose if you are getting the water from this end, you have moved here there is no problem because this is the lower elevation when you move from this to this side again the problem is not much because you are the increase in elevation is not very drastic because this is the same controvert, this is the next controvert and this is lower than this one.

So you are almost going from higher elevation to a lower elevation and then again the elevation starts rising but when you try to take care of this area you might have to lay a main line which now will be going from this end to the upslope this is the place, this is the point where you will have problem you will have to have either a pressure which is very excessive to take care of this pressure requirement you will have to have a pressure which is very excessive here or you should go in for a booster here, you can have a booster pump here and then that booster pump will provide the additional pressure which is required in this particular line.

As far as the lateral is concerned you can have the lateral which is taking care of the other half of the field and this lateral you can move up this is one way of covering this area in which you can instead of having a very high pressure in this section of the line because in that case as we have discussed earlier if you have very excessive pressures they might be detrimental as far as the pressure in these laterals are concerned. So either you will have to use some device by which you can control the pressure the pressure regulators have to be used or you can go in for a booster which is a much better option than providing excessive

pressure and then bringing them down through the pressure regulators because providing the pressure regulators increases the cost.

Now with that we we have taken into consideration the various possible layouts but that is not exhausted all the possibilities there are many more which can still used they can different then what we have discussed so far.

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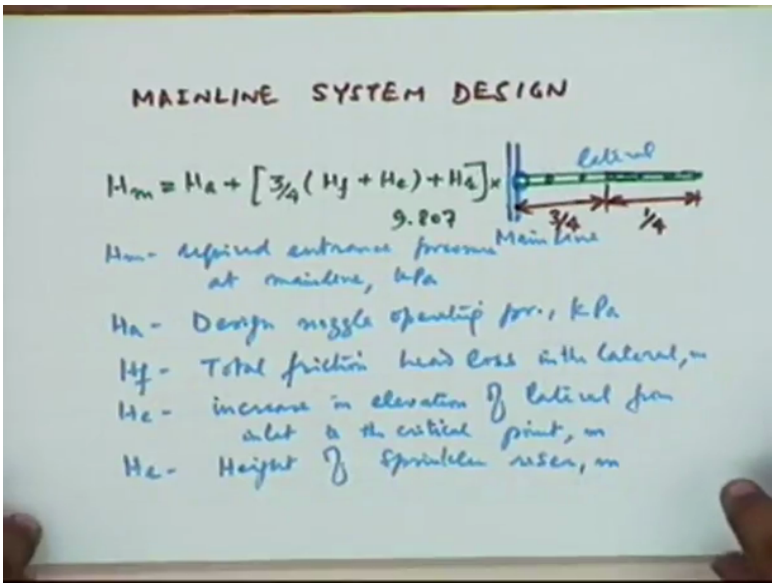

Let us now try to go on to the the main line main line design, we have seen that the lateral in the case of the lateral we can what we need is we need to know how much will be the loss then we can choose the lateral with respect to the pressure requirement of each individual sprinkler and we have seen all those those various requirements. Now when we talk of a main line again the main line cannot be designed in isolation the main line has to be designed with respect to the lateral pressures. What is the pressure requirements of the laterals because ultimately the main line why you are providing the main line to provide the water at a desirable pressure to the laterals.

So if we if you say that this is the main line this is the main line and this is the lateral we are interested in when we look at the main line what is the pressure requirement at the junction of the main line and the lateral that is what we are basically interested in. So if we designate that pressure as H m where H m where H m is the required entrance pressure at main line in Kilo Pascal this H m can be expressed as H a plus 3 by 4 of H f plus H e plus H r into a factor converted into into the Kilo Pascals and the various other items which we have expressed H m in H a is the design nozzle operating pressure again in Kilo Pascal, H f H f is the total

friction head loss which we have earlier computed in the lateral we have seen the various expressions by which we can find out the head loss in the lateral where we had used that factor F and this is expressed in meters, H e is the head loss due to the increase in elevation of lateral from inlet to the critical point or the critical sprinkler you can say in meters and H r is the height of sprinkler riser in meters.

Now in this particular case you might wonder that why we have used this factor of 3 by 4, what happens is that if I take this is the total length of the lateral you have the sprinkler heads which are spaced on this lateral. In normal practice when we do not have the these sprinklers if there is a pipe you can always say that the head loss and the total length of the pipe will be half in the first half of the pipe and in the remaining half of the pipe will be another half of the head loss will take place.

Whereas in this case since the discharge is varying, since the pressure is varying throughout the section of throughout the length of the lateral the head loss it has been seen that if you take this total length in the first half of the length of the lateral 3/4th of the head loss will take place in the first half and only 1/4th of the head loss will be taking place in the the next the subsequent half of the pipe.

So to when we are designing the H m when we are designing the the main line for the pressure we are making assumption that we are we are interested in designing for the average value the pressure the average pressure which is considered is somewhere in the midway portion of the lateral. So when we take the total lateral we are only interested that H a which is applicable H a is the average pressure in the total length of the lateral and that is why we take this 3 by 4 as the portion of the head loss because that is what occurs in the first half of the length of the lateral, okay.

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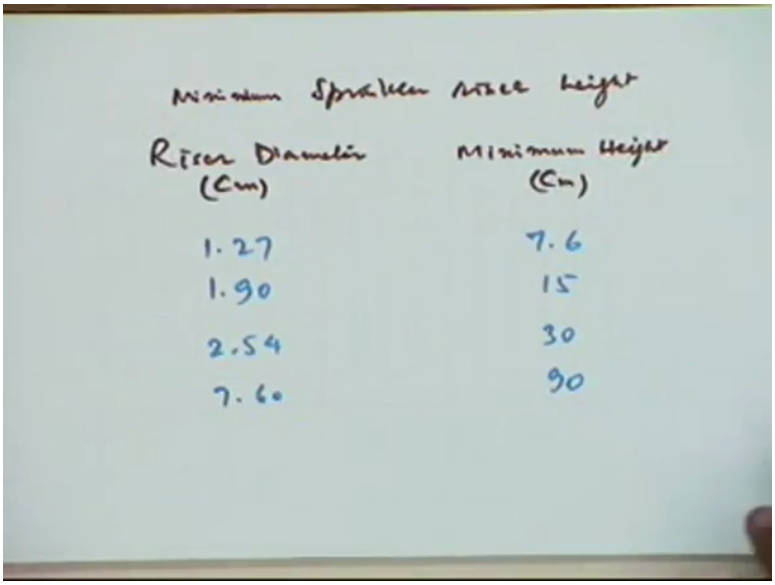

Now height of the sprinkler riser there is minimum sprinkler riser height which is recommended which is the function which depends on the size of the pipe the riser pipe diameter which is used the minimum sprinkler riser height is a function of the riser pipe diameter which is given in centimetres and the minimum height is given also in centimetres. If the riser pipe diameter is 1.27 centimetres the minimum height of the riser pipe should be 7.6 centimetres. Similarly the other recommended values which are given for the range of (()) (21:15) which are normally used. So these are the various values which are recommended values for the the riser pipe height with respect to the diameter of the riser pipe used.

Then besides finding out what is the H m requirement which is the pressure requirement H at various individual points of the main line on the main line again is the same thing the main line is also behaving in a similar manner as the lateral is behaving. In the case of main line also you might be finding that if you are operating more laterals it will have a similar situation that it is having discharge which is reducing as you go further into the along the length of the main line. But even if that is not true one thing is certain that when you are designing the main line you have to look at the criticality of the each individual point where you are tapping the main line by using a lateral.

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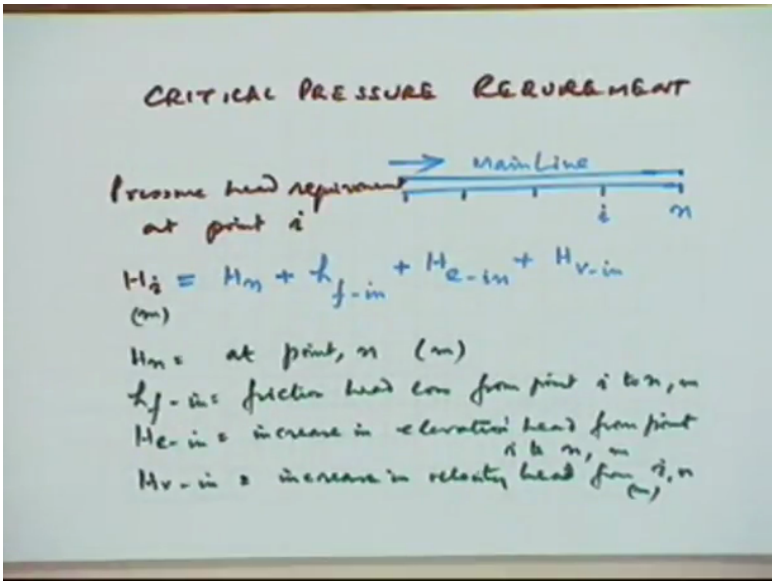

The critical pressure requirement is very important to be looked at in a main line let us say this is the main line you might be tapping this main line at various locations and if this is the flow direction in the main line. Let us assume that this is the last portion the last the end of the main line. Now when I want to look at what is the critical pressure in the main line the best way is to start with the extreme point because here we know what is the pressure requirement H m is known H m has been found out from the pressure requirement of the individual sprinklers with respect to the other factors which are prevalent in a particular lateral.

So if I if I know what is the pressure requirement here you can find out if you move to this section of the main line what will be the additional pressure requirement because it has overcome some more friction of the main line pipe is one possible loss which has occurred in this particular zone and there can be some elevation loss or gain, there can be some velocity head which is prevalent all those things if I say that this is n and this I call it i to find out what is the pressure requirement at point i the pressure head requirement if I call it H i this is this can be put equal to H n which is the pressure requirement at point n plus h f i n plus H e i n plus H v i n what are these terms?

H i we say we have already mentioned that this is the pressure head requirement at point i and this is expressed in meters, H n is the pressure head required at point n so it is the pressure head requirement at point n again expressed in meters, h f i n is the friction head loss there will be some friction head loss between the section from i to n expressed in meters and H e i

n is also is the increase in elevation head from point i to n in meters. Similarly the H v i n also is the increase in velocity head from i to point n expressed in meters.

Now these are the possible variations and once you find out what is the value of the pressure head at i you can keep on doing this on each individual point along the main line and the pressure which is the maximum that will give you the most critical pressure which should be used or which should be looked at which must be taken into account when you choose a main line.

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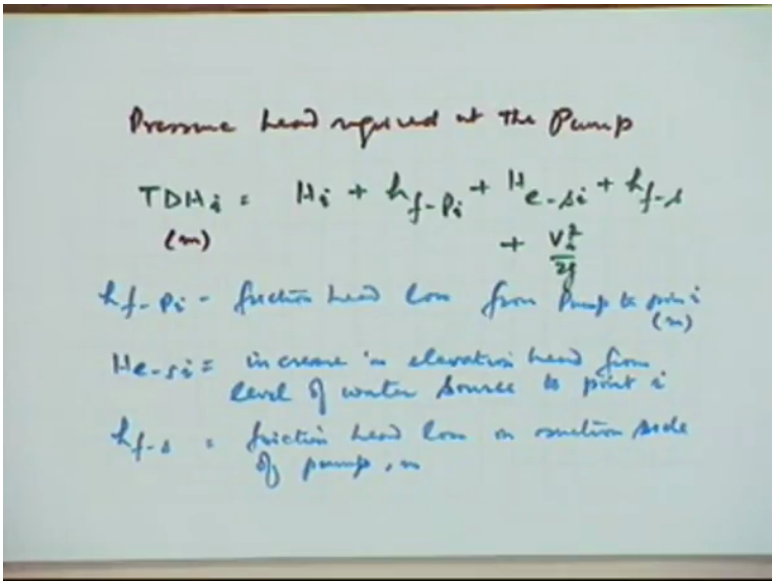

Besides that you will also be interested in what is the pressure head requirement at the pump, what pump should be selected. So the pressure head required at the pump can also be you can also evaluate with respect to the most critical point in the main line and that also is when theoretically I think is better to always find out for each individual point what is the total dynamic head which is required with respect to that point on the main line.

If you can do that then you will be much safer because there can be many situations where because of the increase or decrease in the elevation you might find that the criticality of a particular point can vary. A point which you field should be critical, it might not be critical because of the fact that the way the main line is laid on the field in actual practice. So the total dynamic head requirement must be calculated for each individual point of the on the main line and you are finding out the total dynamic head of any individual point you can use this expression which takes care of the various head losses prevalent as we have seen in the previous case.

These are the various items or the terms which must be considered when you are looking at the total dynamic head required at point i this is the total dynamic head required at point i in the main line expressed in meters and the H i we already know what we have already mentioned the H i is the pressure at that particular location plus h f dash p i is the friction between the friction head loss is the friction head loss from pump to point i expressed in meters again.

And the other items are also similar this is the elevation in increase in elevation head from (())(31:55) to the point i or the level of the water source H e s i is the increase in elevation head from level of water source to point i and this h f s is the friction head loss on suction side of the pump in meters.

Now this total dynamic head should be computed for each individual point on the main line and that head which is of that total dynamic head which is the maximum that we selected for the selection of the pump at that time you can also make a decision whether to have a booster pump somewhere in the lateral portion if the pump size is becoming too much that will create a problem of having very excessive pressures in other points of the main line.

So you have to look at which option to be selected, do you want to select a pump which can (())(33:54) to the problem (())(33:55) to the requirements of all the individual points but then you have to look at how much is the fluctuation if the fluctuation is very high you might decide to use a booster pump instead and avoid using any control devices on the laterals.

Now with this we will we have completed the detailed design of the sprinkler irrigation system we have covered almost all the segments of at least one specific type of system where we are not is not a when there are many other types of sprinkler irrigation systems which we have discussed but we have not gone into the details of the designs because of the (())(34:49) of time available with us we have taken only the conventional sprinkler irrigation system which is normally in most of the places is becoming more and more popular and we have discussed almost all the the various aspects of for design, how we go about the design and which are the various components which have to be looked at what are the other details which are important to be considered and with that we close this chapter, any questions? Okay then.