Soil and Water Conservation Engineering
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Lecture – 40
Drop Inlet Spillway (Contd.)

Hello good afternoon, now we are going to cover the 2nd part of the Drop Inlet Spillway design.

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Now, where the how the spillway design takes place? So, this is the part I of the spillway design.

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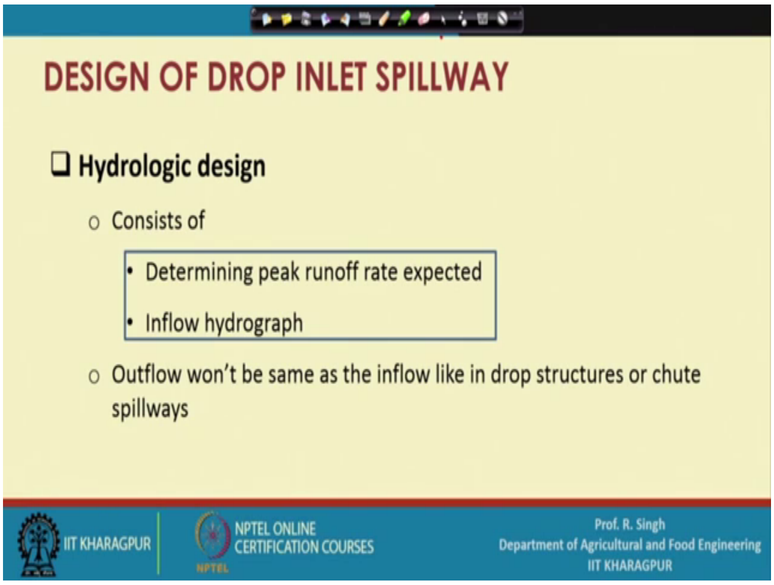

So, the drop inlet spillway design has all three component; the hydrologic design hydraulic design and the structural design. So, we mainly focus on the hydrologic and a hydraulic part. So, first we are going to discuss about the hydrologic design and that will be followed by hydraulic part. So, now, hydrologic design what we do here it consists of determining peak runoff rate, that is expected peak runoff rate we design there.

And then, the second one inflow hydrograph so, outflows would not be same as the inflow like in drop structure or the chute spillway structure. So, that is why we have to design both the expected runoff the peak runoff and the inflow hydrograph.

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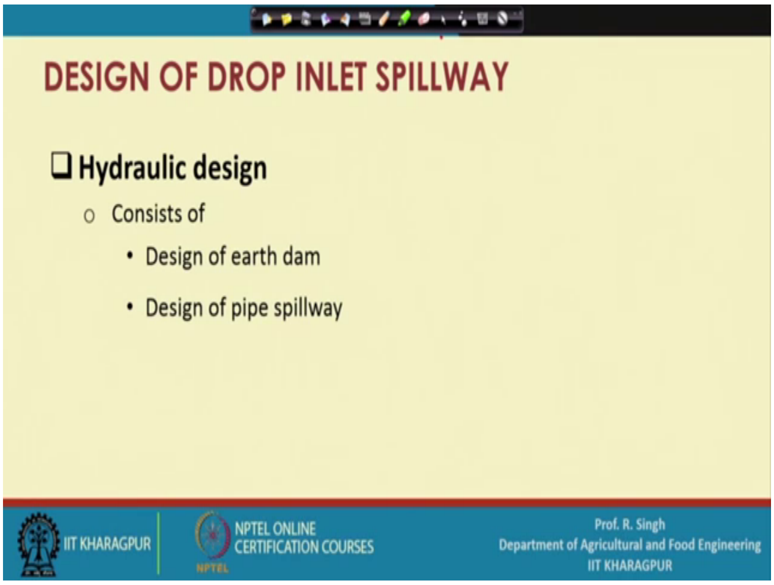

Now, coming to hydraulic design, hydraulic design consists of design of the earthen dam and design of pipe spillway. So, making a base of these two design our next steps will go forward.

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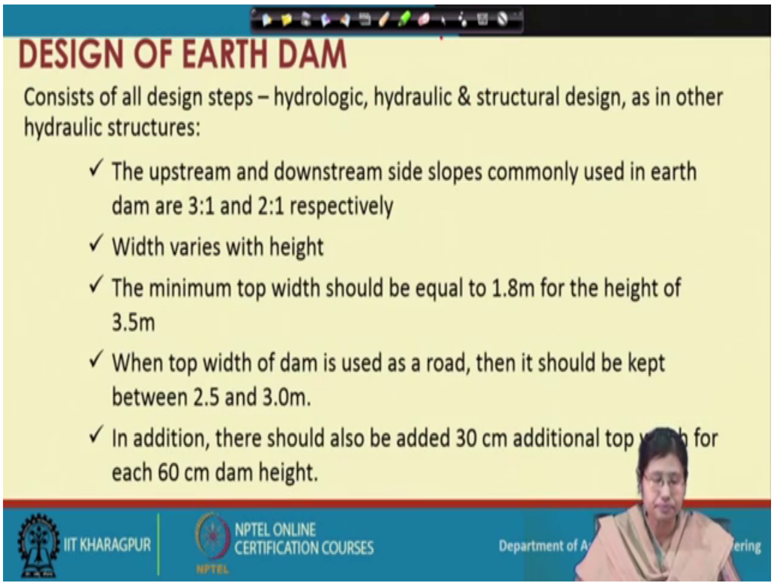

So, now coming to the design of earthen dam, it consists of all design steps that is hydrologic design, hydraulic and structural design and any kind of hydraulic structure. Now, coming to how we can make a design of the earthen dam. So, the upstream and downstream side slope is commonly used in earth dam at a 3 is to 1 or 2 is to 1 slope.

And with in general varies with the height, the minimum top width should be equal to 1.8 metre for a around a height of 3.5 metre, when the top width of the dam is used as a road, then it should be kept between 2.5 to 3 metre. In addition, there should also be added 30 centimetre additional top width for each 60 centimetre dam height.

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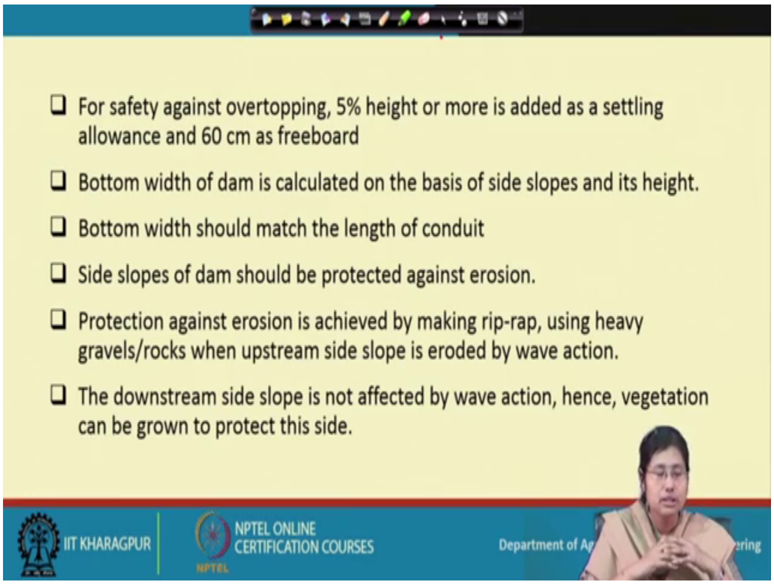

Now, to come back the safety against overtopping 5 percent more height should be added as a settling allowance and which it should kept as 60 centimetre as a free board. And the bottom width of the dam is calculated on the basis of slide side slopes and it is height.

The bottom width should match the length of the conduit and the side slope of the dam should be protected against erosion. So, protection against erosion is achieved by making a rip rap or using heavy gravel or rocks, when upstream side slope is eroded by wave action from the downstream water. The downstream side slope is not in generally affected by wave action; hence the visitation can be grown to protect this side.

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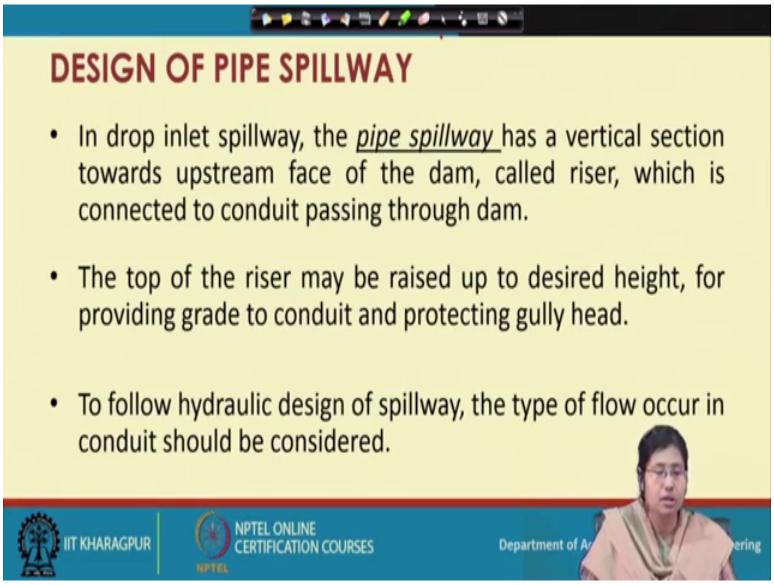

Now, coming to design of the pipe spillway in drop inlet spillway a pipe spillway has a vertical section towards the upstream face of the dam. So, this vertical section is called as a riser and this is connected to conduit passing through dam. The top of the riser maybe raised up to a desired height for providing grade to conduit and protecting gully head. Now to follow hydraulic design of the spillway the type of flow occur in the conduit should also be considered.

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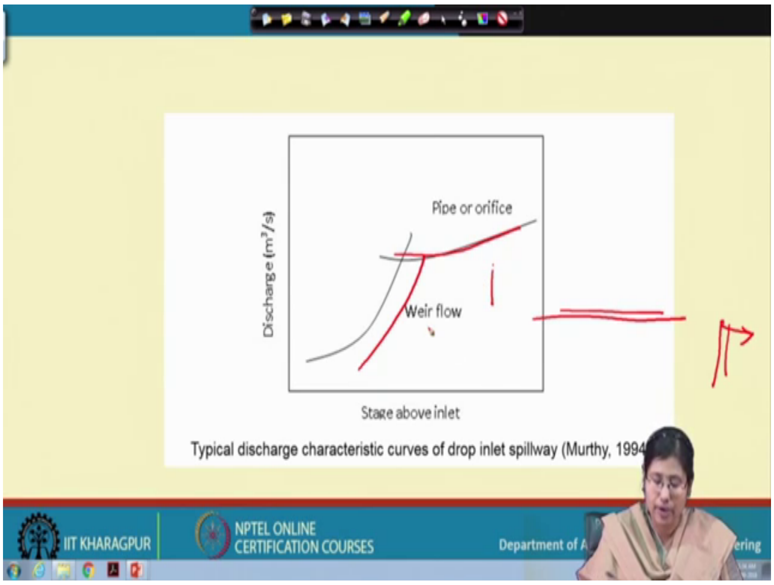

So, now this is you can see a typical discharge characteristic curve of drop inlet spillway so, here the first part is come where flow prevails and the second flow the pipe or orifice flow prevails. So, this is the weir flow and here, an intersection point is located in between two.

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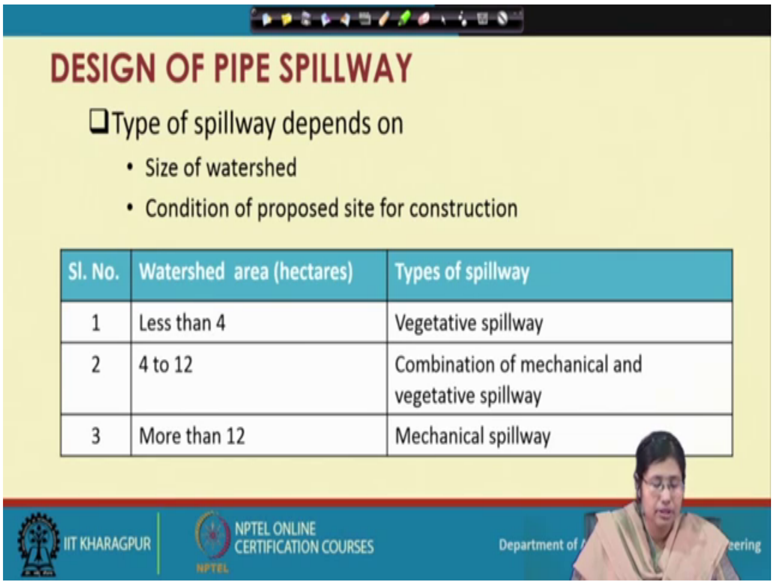

Now, design of the pipe spillway here, the type of spillway depends on the size of the watershed and condition of proposed site for construction. Now, the water it the type of spillway depends upon the water shed area the how large is the watershed. So, if the it is the watershed area is less than 4 hectares the generally vegetative spillways are provided, in case of small spillway structure.

But, in case of medium watershed like here, it is listed between 4 to 12 hectares combination of mechanical and vegetative spillway is to be provided. And where the spillway structure is a little bit larger that is between more than 12 hectares mechanical spillway structure is to be provided to withstand the load of huge capacity of water.

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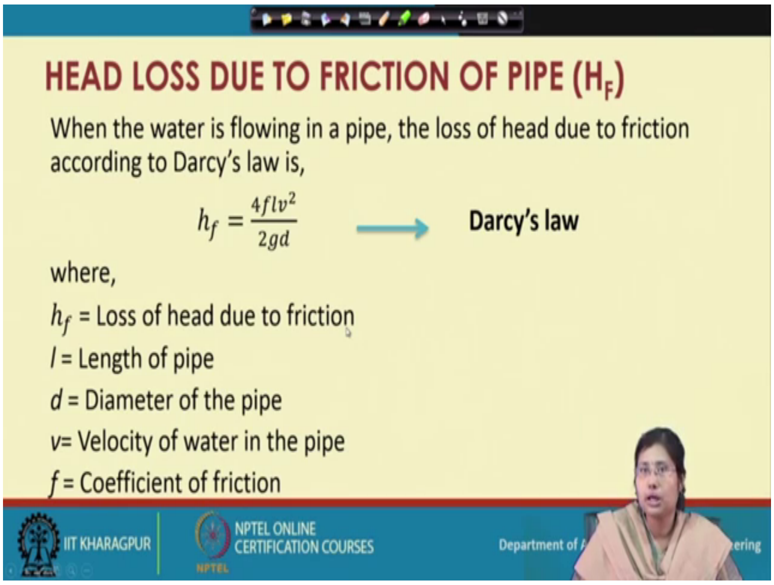

Now, coming to a hydraulic design, so, here we have to consider the friction loss in the pipe and other kind of losses. So, this is in general it is taken from the flow through conduit or the pipe flow. So, as you know the when the water is flowing through the pipe it is in general governed by the Darcy's law.

And a loss of head due to friction is computed can be using Darcy's law. So, this is the head loss due to friction so, 4 f l v square divided by 2 g d, where h f is the head loss due to friction, l is the length of the pipe, d is the diameter, v is the velocity of the flow and f is the coefficient of friction.

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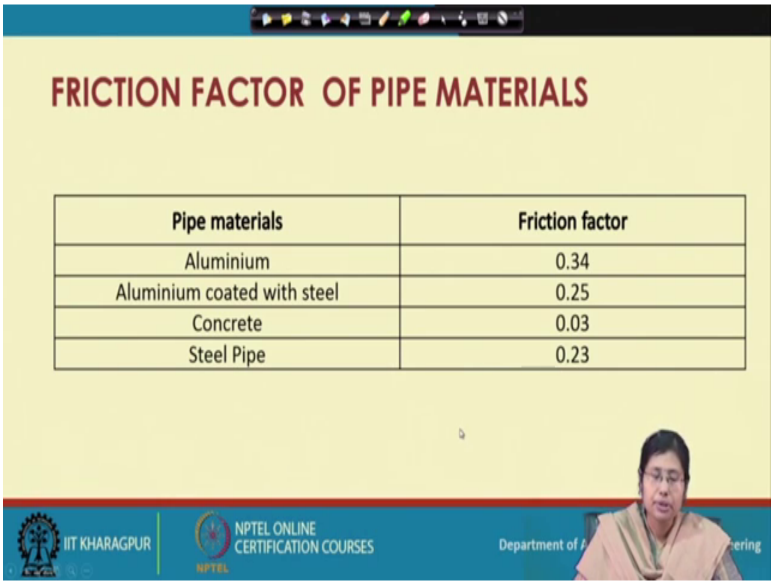

Now, coming to the friction factor for different pipe structures so, different factor is already tabulated. So, for the pipe material if it is aluminium material the friction factor is 0.34, when aluminium is coated with still it is 0.25 and for the concrete structure it is 0.03 and a steel pipe it is again 0.23. So, as you can see from this table for the concrete structure the friction factor is quite a less; however, for metal or the aluminium structure the steel pipe structure the friction factor is quite high.

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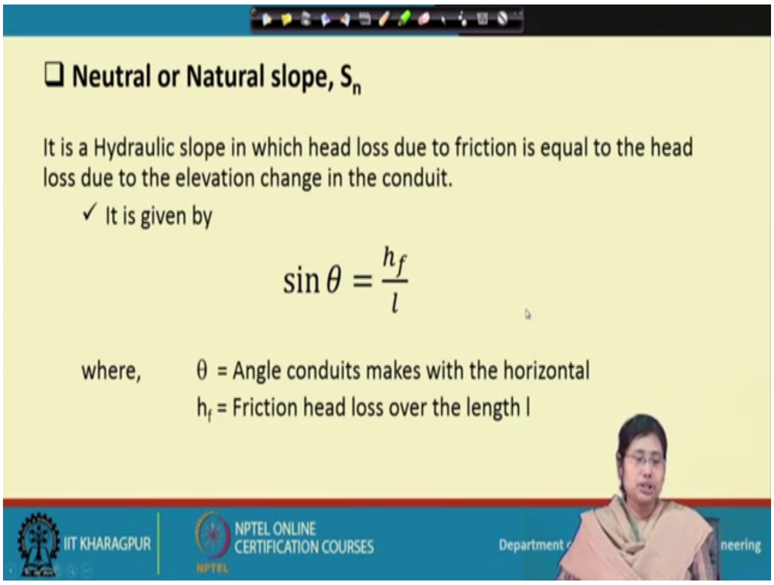

Now, coming to the neutral or the natural slope, it is a hydraulic slope in which head loss due to friction is equal to the head loss due to the elevation change in the conduit. So, it is given by cos sin of the angle that conduits makes with the horizontal. So, here so it is a function of friction head loss over the length l. So, sin theta is the function of h f divided by l.

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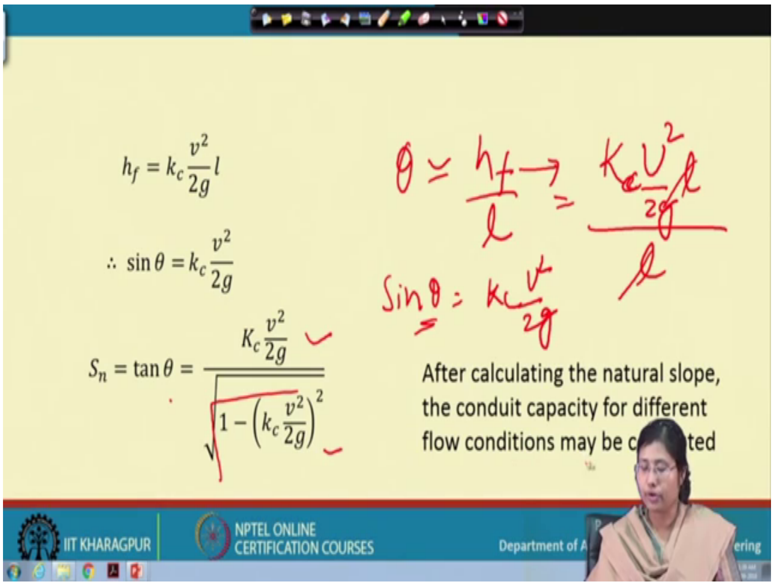

Now, as you know the coefficient of contraction so, when the pipe flow prevails so, h f is k c, where k c is the coefficient of contraction v square by upon 2 g l is the length of the pipe. So, now, the sin theta can be a function of so, this one k c where l l get is cancelled so, here the sin theta is h f by l.

So, now the equation for h f is k c v square by 2 g. So, where c k c is the coefficient of contraction, when the pipe flow prevails l divided by l. So, here so, l l get is cancelled so, sin theta is nothing, but k c v square upon 2 g. Since, theta is very small, we can also say that S n is a function of the tan theta and K c and then 1 minus k c v square by 2 g. So, this equation we can derive from this. So, after calculating the natural slope the conduit capacity for different flow conditions can be computed.

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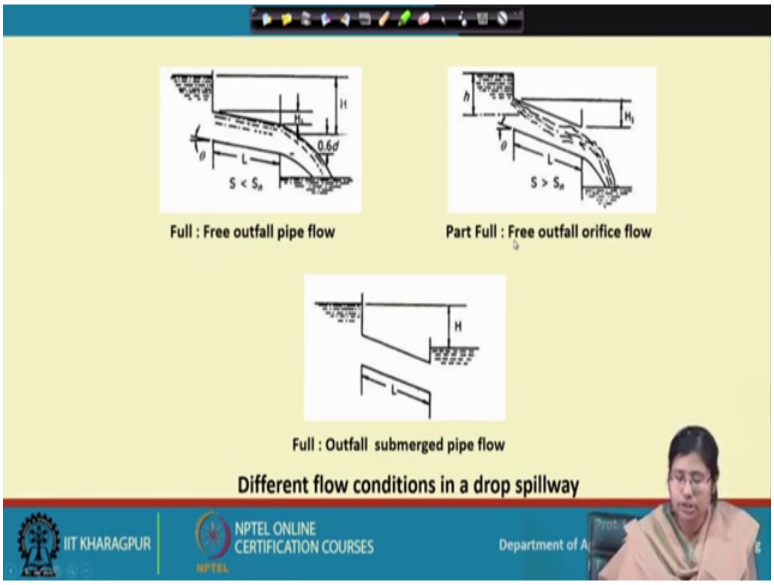

So, here so three different conditions are plotted so, here when S n is when the natural slope is less than the slope of the channel so, the free outflow or the pipe flow prevails. When the opposite is true so, when the slope is greater than the natural slope partly full free outfall orifice flow condition prevails and when this slopes are equal. So, full outfall submerged by flow condition prevails.

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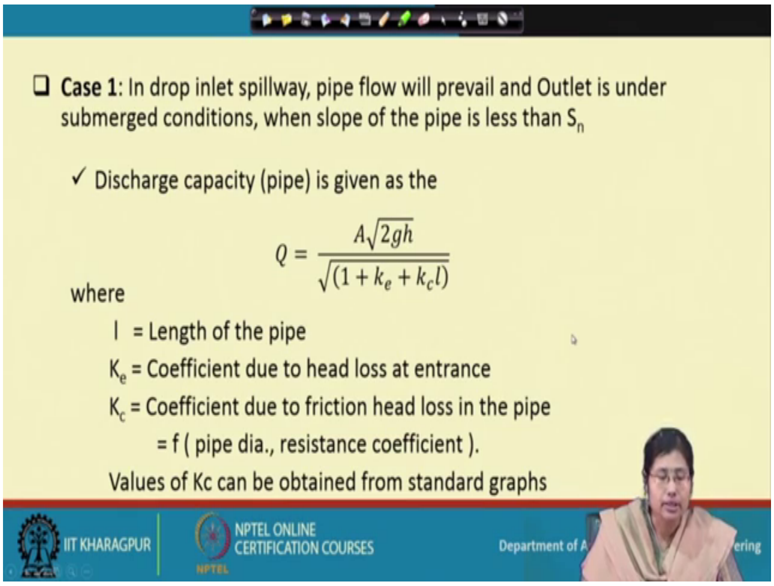

Now, coming to case 1, in drop inlet spillway, pipe flow will prevail and outlet is under submerged condition, when the slope of the pipe is less than S n. So, the discharge capacity in that case is given by this equation, where it is a function of area and h and couple of coefficients.

So, where l is the length of the pipe K e is the coefficient due to head loss at the entrance and K c is a coefficient due to frictional head loss in the pipe, where it is a function of pipe diameter and the resistance coefficient values of K c can be determined from standard graphs or tables.

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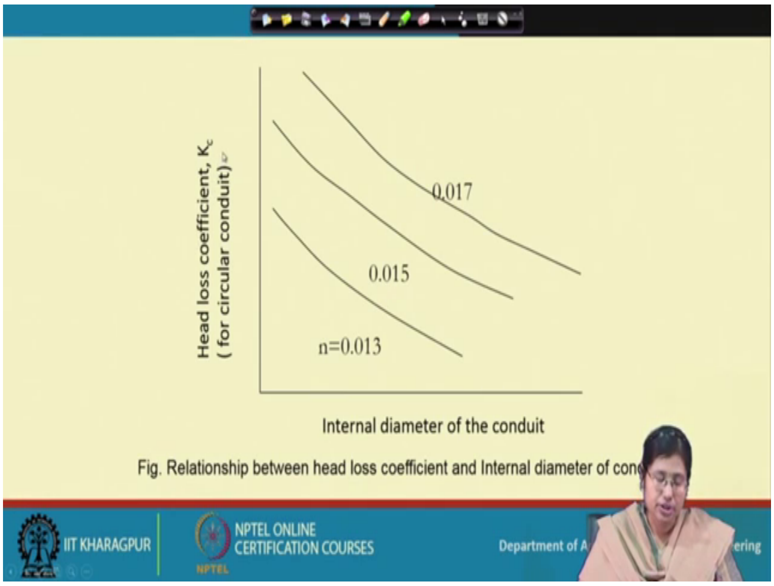

So, this is the coefficient of head loss for circular conduit, where this is a function of internal diameter of the conduit and at different end of the Manning’s roughness coefficient. So, this is the relationship between head loss coefficient and internal diameter of the conduit.

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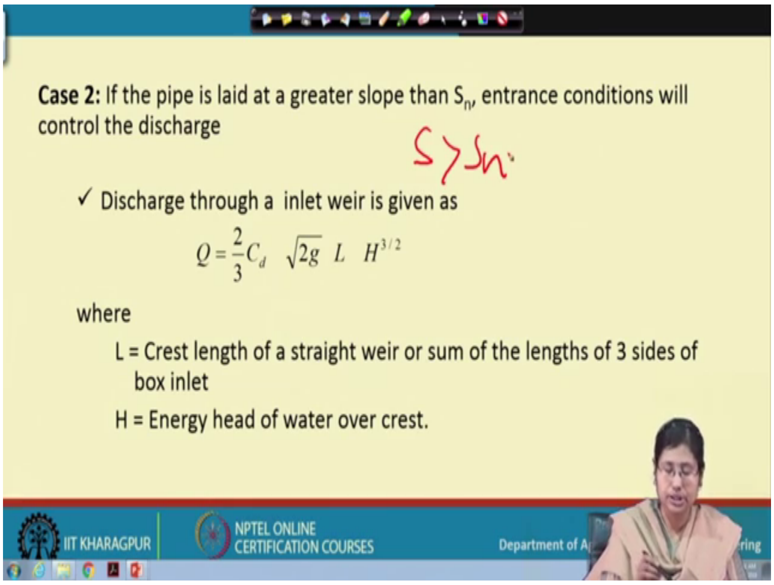

Case 2, if the pipe is laid at a greater slope than S n, so, this is the case to condition, where S is greater than S n. So, the entrance condition will control the discharge in this case. And in this case the discharge through inlet weir is given by the equation of weir the flow through the equation weir. So, where a C d is the coefficient of discharge, L is the crest length of a straight weir, or the sum of length of 3 sides of the box inlet and H is nothing but energy head of water over the crest.

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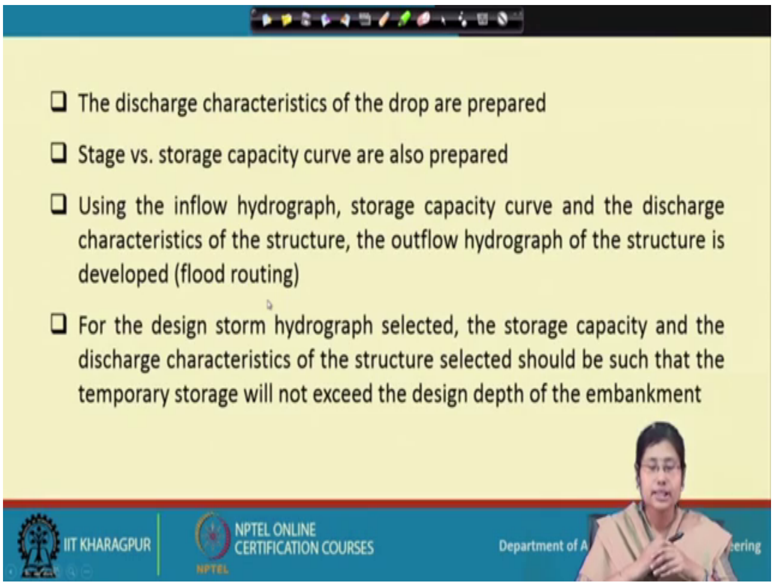

The discharge characteristics of the drop are then prepared and the stage versus storage capacity curves also prepared in this case. So, using the inflow hydrograph storage capacity curve and the discharge characteristics of the structure the outflow hydrograph of the structure is then developed this is a the flood routing steps. And the lastly for the designs storm hydrograph is selected the storage capacity and the discharge characteristics of the structure is then selected should be in such a way, that temporary storage will not exceed the design depth of the embankment.

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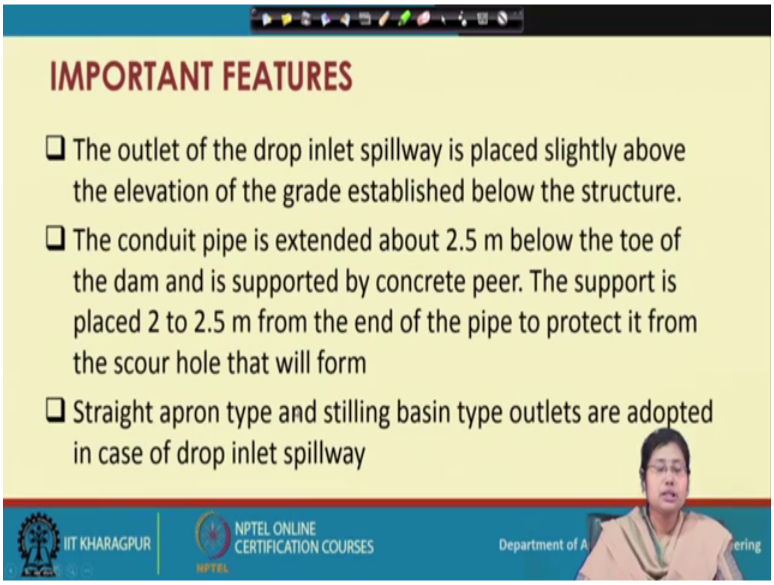

So, some of the coming to some of the important features, the outlet of the drops inlet spillway is placed slightly above the elevation of the grade established below the structure. Second the conduit pipe is extended above 2.5 metre below the toe of the dam and is supported by concrete peer. The support is placed around at a 2 to 2.5 metre from the end of the pipe, to protect it from the scour hole that will form. The straight apron type and the stilling basing type outlets are in general adopted for in the case of drop inlet spillway.

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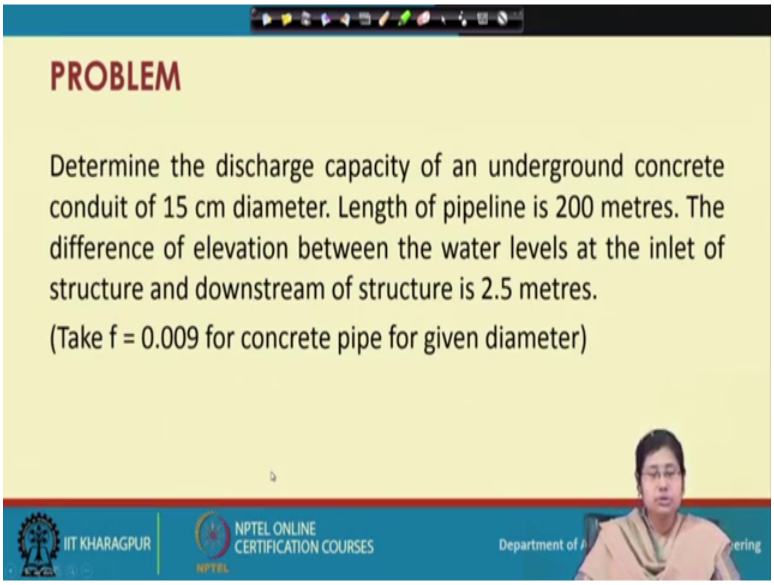

Now, we are going to solve a small problem based of the design steps, I have taken. So, determine the discharge capacity of an underground concrete conduit of 15 centimetre diameter the length of the pipeline is kept as 200 metres and the difference of elevation between the water level at the inlet of the structure and downstream of the structure is 2.5 metre. So, this information the last information will be used for calculating the slope of the structure and take f 0.009 for concrete pipe for a given diameter.

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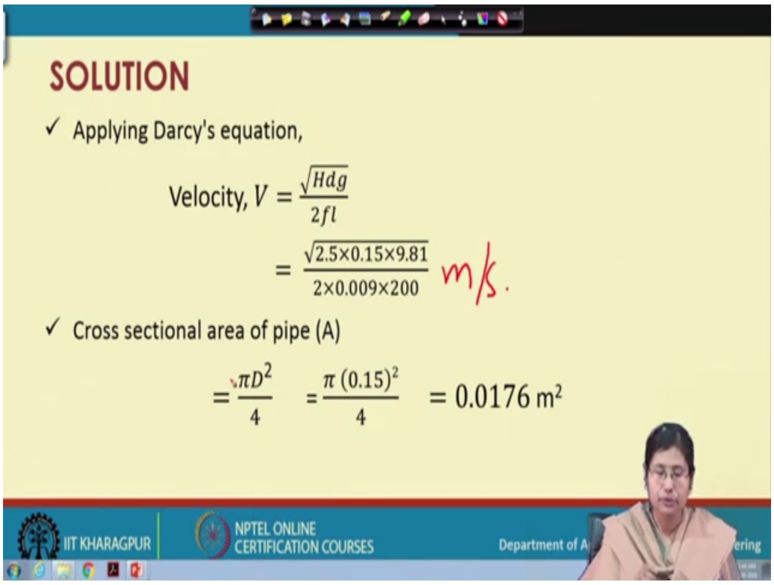

So, here we first calculate the velocity of flow using the formula. So, this formula is already covered in the beginning the velocity of the flow through the pipe. So, this is the Darcy's formula as you can see here so, using that we first calculate the velocity of flow in unit of metre per second. Now, once we know the velocity of flow we calculate the cross sectional area of the pipe. So, since the pipe is assumed as circular the cross sectional area will be a function of diameter of this pipe and pi D square by 4.

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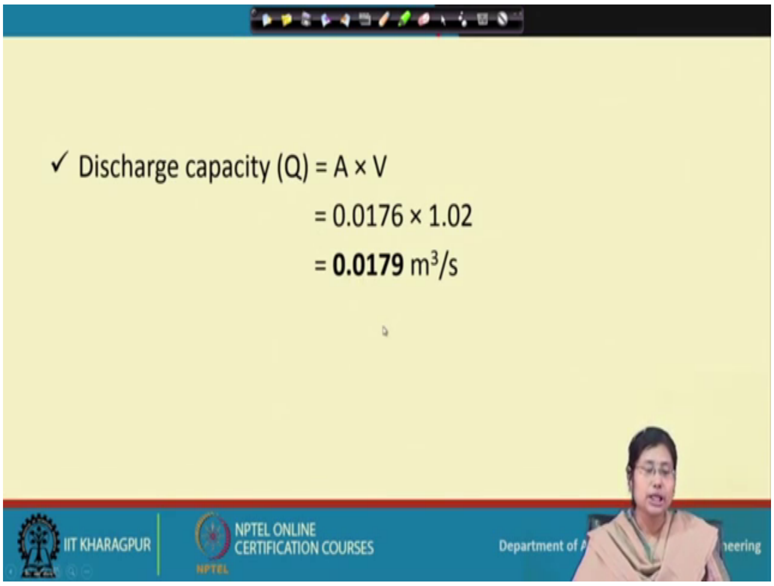

So, here comes the cross sectional area. And now, the discharge capacity is nothing but a function of the cross sectional area and the velocity which is then we multiplied here and getting the discharge capacity of the pipe that is it.

Thank you.