Advanced Hydraulics
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Module - 5
Channel Transitions
Lecture - 3
Channel Transition Part 3

Welcome back to our lecture series on advanced hydraulics. We are in the fifth module on channel transitions or flow through non prismatic channel sections. This is the third lecture on this particular module.

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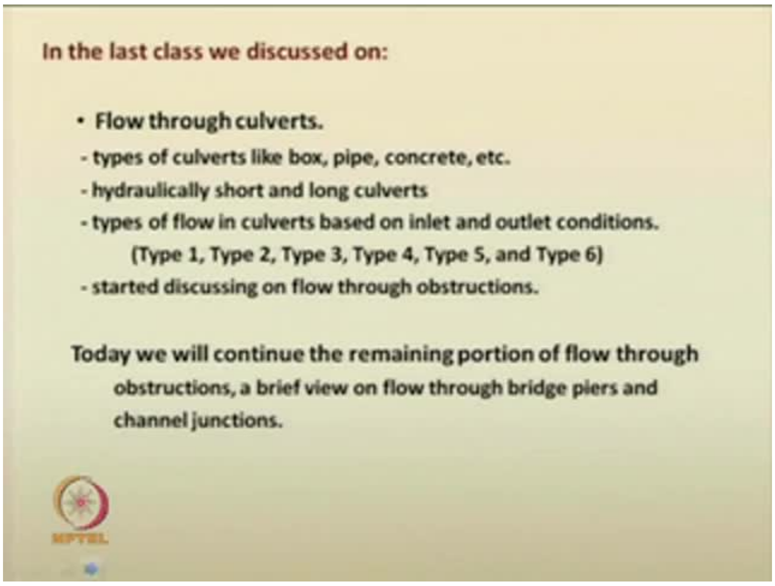

We would like to wind up this module by today itself. In the last class, we discussed on a flow through culverts. The types of culverts like box culverts, pipes culverts, concrete culverts and all they we have briefed in a passing by statements and all. We also discussed on what is meant by hydraulically short and hydraulically long culverts, the types of flow in culverts based on the inlet and outlet conditions and various parameters, we have suggested that there are type 1 flows in culverts, type 2 flows, type 3 flows, type 4, type 5 and type 6, so we had discussed them elaborately also.

We started discussing on flow through obstructions, there are various obstructions like bridge piers, columns, various things can be found in water channel and all. So, you can suggest means an obstruction means where minimum two, due to that obstruction two pathways are there for the flow of water. So, it is that is the difference between the obstruction and a construction, if you recall them. Now, today we will continue the remaining portion of the flow through obstructions. That is bridge piers channel junctions and some of the other aspects etcetera, fine. So, channel transition part three.

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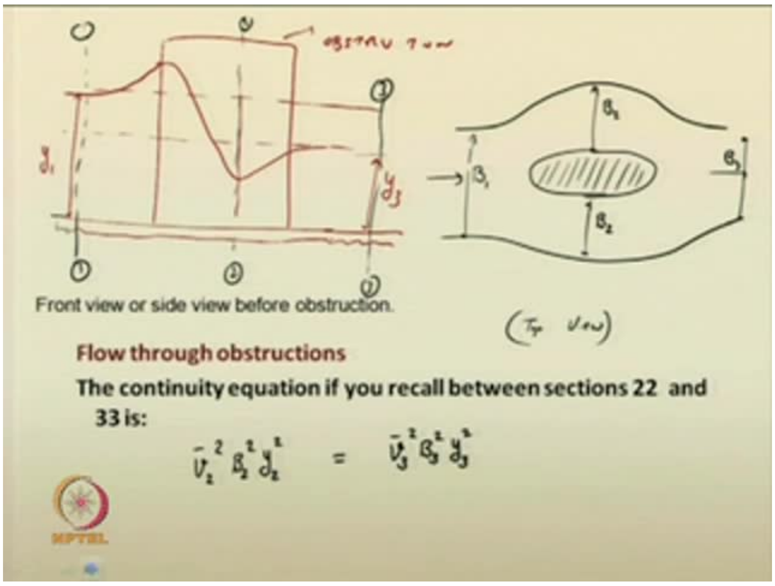

So, recall the obstruction, if you recall them. This was the front view, if you see the top view, say there is a obstruction in the channel. If you recall them this is the top view or plan of the channel. So, this is your obstruction in the channel, water is flowing in this channel in this direction. Let us assume that here the channel width is B, B 1, then subsequently we suggested at this location this is B 2 and at the downstream the width was considered as B 3.

If you recall that and a section vertical section of the same obstruction flow through obstruction was depicted in the last class also, in a similar form. So, we can device three sections, sections 1 1, sections 2 2, section 3 3. So, consider this section 2 2 and section 3 3, we are of course, dealing with steady state conditions. That is flow is in steady state, although there is an obstruction, the flow pattern is steady it is not changing with respect to time.

And recall the continuity equation so between these two sections, section 2 2 and section 3 3, we had derived the continuity equation as such right that is the v 2 squared b 2 squared y 2 squared is equal to v 3 squared b 3 squared y 3 squared. So, we had stopped at this location, that is we had derived up to this portion and then stopped it. So, today let us continue the same aspect we have to incorporate the energy equations also between the sections and try to analyse how the flow through obstruction can or how we can analyse flow through obstructions?

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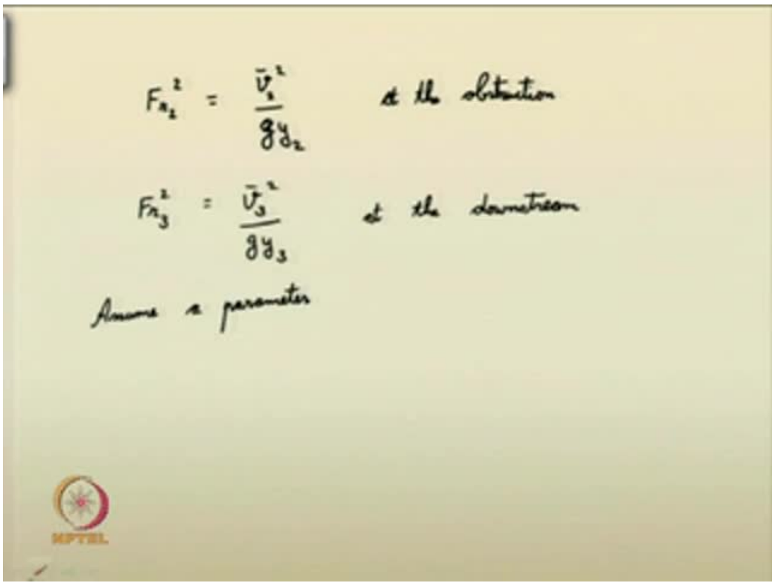

Let us at the obstruction the Froude number can be derived like this right or given like this v 2. Say all of them are rectangular means sections, so we can give the froude number, the square of the Froude number as v 2 squared by g y 2. Similarly, at the obstruction . Similarly downstream Froude number can be given by v 3 squared g y three at the downstream. So, you can now use this Froude number criteria, also assume a parameter now say we are dealing with obstruction. So, you have B 1 width of the rectangular channel at the upstream b 2, sorry here it is B 2 by 2, B 2 by 2.

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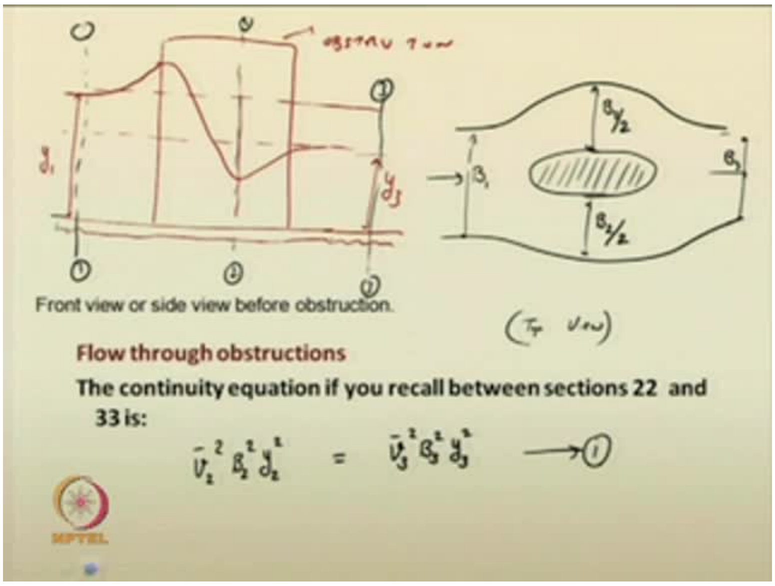

I am extremely sorry on that, so please note that. So, and the rectangular channel width at the downstream it is b 3. So, you have now v 2 squared b 2 squared y 2 squared is equal to v 3 squared b 3 squared y 3 squared due to this steady state conditions. All you can use the continuity equation in the as given here say, I can write it equation one.

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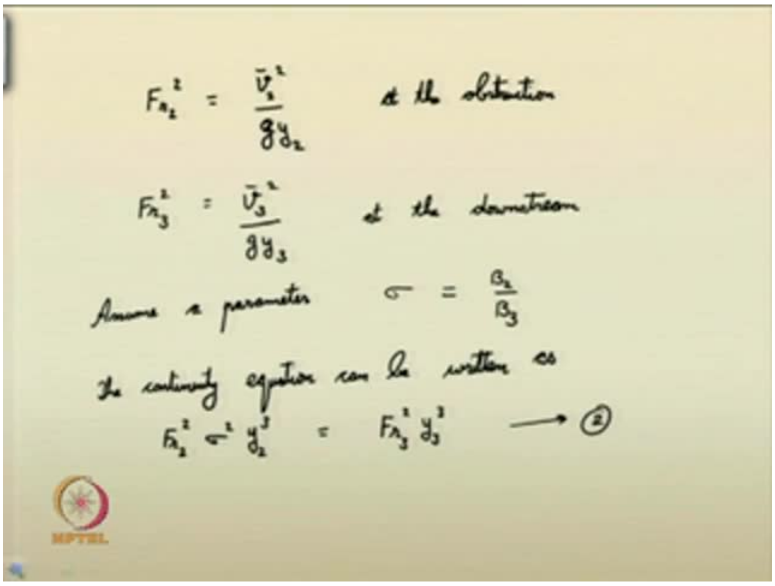

Now, apply the Froude numbers Froude numbers in that continuity equation, also you can assume a parameter say sigma I am just assuming a parameter sigma which is nothing but ratio of B 2 and B 3. So, it is B 2 by B B 3 definitely. As you can see, B 2 may be less than B 3, but in there are some there may be some cases where B 2 the means the combined width B 2 by 2 plus B 2 by 2 here. They may be greater than B 3, but that is that does not matter.

Now, let us assume this as a parameter, so using these parameters now the continuity equation can be written, a continuity equation can be written as F r 2 squared sigma squared y 2 cube this is nothing but equal to F r 3 squared y 3 cube. So, just give it as equation number two. Now, you can consider the energy equation between the two sections, just recall the two sections. Say here section 2 2 and section 3 3, section 2 2 at the obstruction, obstruction and section 3 3 downstream of the obstruction. Definitely you know that, the energy as it flows from upstream to downstream energy will get reduced, right?

That is the natural law, so it gets means there will be some energy loss you cannot that is you cannot gain energy. Means there will be some loss in energy since some of the cases we have neglected loss of energy, in this case however if there are any loss and all, you know that the energy at section 2, section 3 3 can never be greater than energy at section 2 2, right? Therefore, energy at section 3 3 can be represented in terms of a percentage, means percentage of energy at section 3 3 based on the conservation of energy law we can use that.

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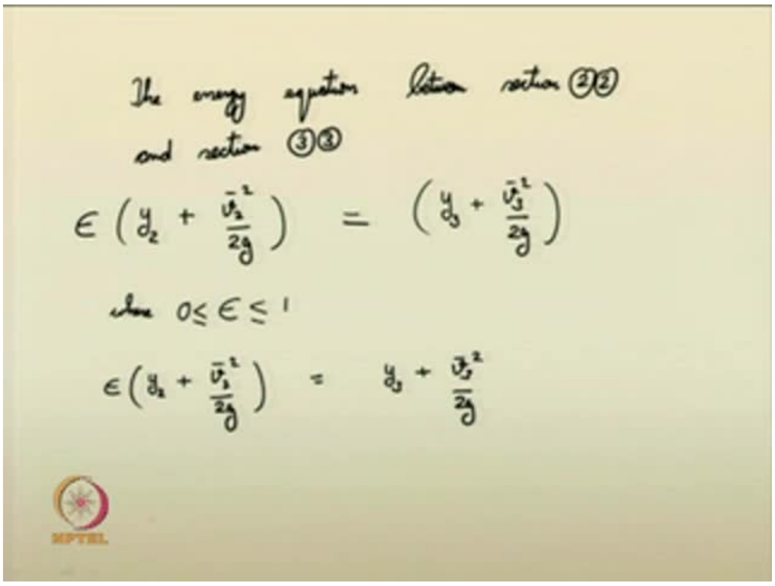

So, I can now write the using the energy equation, I can write it now. In the following form energy equation between section 2 2 and section 3 3. This is nothing but say energy at section 2 2 is y 2 plus v 2 squared by 2 g. We are neglecting the datum head assuming that the datum is same for both the sections. Energy at, I have not yet equated. Energy at section 3 3 is nothing but y 3 plus v 3 squared by 2 g. So, this downstream energy we can consider it as a percentage of the upstream energy, right?

Therefore, I am writing it in this particular form, I am using a a fraction term epsilon such a way that the downstream energy is a fraction of the upstream energy. So, this it is obeying the same principles. I am writing here, where epsilon you can say 0 less than or equal to epsilon less than or equal to 1. Like that you can suggest now, if I write it in now in the following form you can now further simplify, using the continuity equations and all continuity equations as you have developed in terms of the Froude number and all.

You can incorporate it here, we will see that epsilon I can now just simplify the entire quantities epsilon into y 2 plus v 2 squared by 2 g is equal to y 3 plus v 3 squared by 2 g, that is nothing, it is nothing but again you can proceed it epsilon times y 2 plus v 2 squared into y 2 by 2 g y 2.

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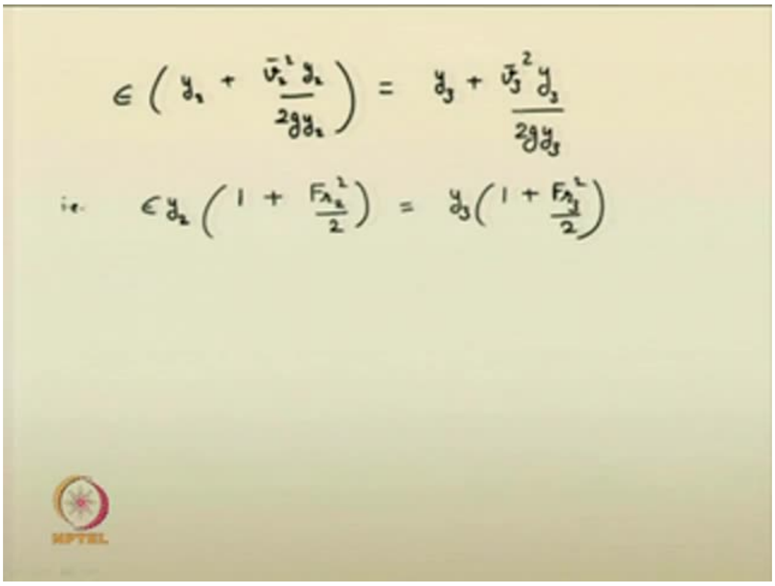

Why did I write it like this? That is I can in the next step, I can take y 2 out of this brackets, that is the reason and you know v 2 squared it is by 2 g is nothing but your

Froude numbers quantity, right? So, that way we can reduce the equation further. So, the reason behind in reducing is that we can eliminate v 3 squared y 3 by we can eliminate y 3 and y 2 all from the expression.

If we can get the expression in terms of Froude numbers and all it will be a much much better aspect while designing. All you can directly go with the Froude number aspects and all. So, that is epsilon into y 2 1 plus v 2 squared by 2 g y 2 is nothing but half of Froude number square a square of the Froude number. So, this is y 3 into 1 plus f 3 squared by 2, recall in the previous step that is this particular portion. Okay?

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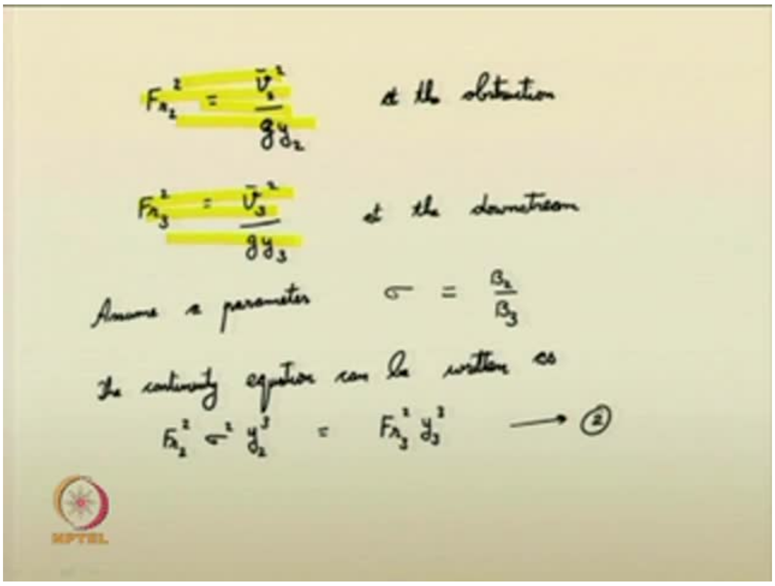

So, the same thing we have incorporated it there. So, I am just modifying the quantities now you can find it as a ratio.

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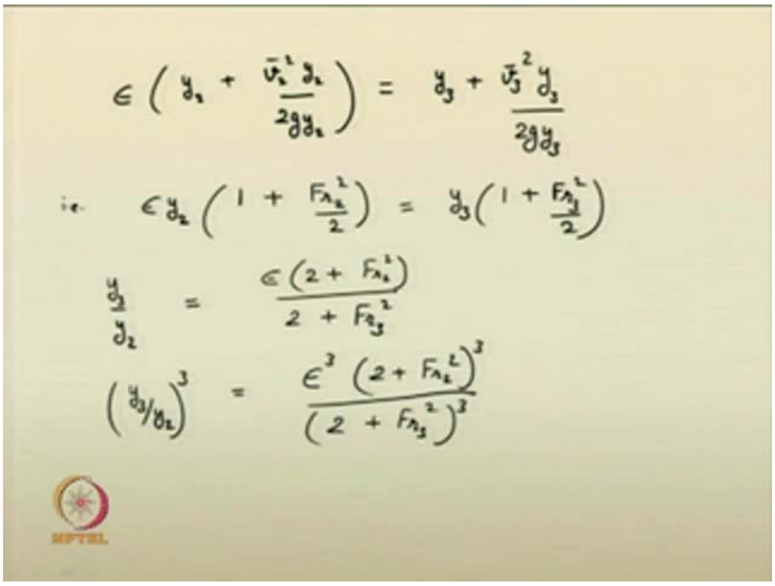

Now, say y 3 by y 2, here it is nothing but equal to epsilon times 1 plus F r 2 squared by 2 or if you want you can cancel 2 from the denominator. That way what I can do is I can multiply the quantities here by 2 times F r 2 squared by 2 plus F r 3 square like this. Also I can write now y 3 by y 2. What is that ratio? You can just make a cube and see amazing for the benefit y 3 by y 2 cube is nothing but epsilon cube 2 plus F r 2 squared whole cube by 2 plus F r 3 squared whole cube. So, what are you getting from here, from this particular relationship?

F r 2 squared from this continuity equation, what are we, what I am getting now? So, F r 2 squared or y 2 by y 3 y 3 by y 2 whole cube is nothing but F r 2 square by F r 3 square into sigma square. That quantity I can substitute now in that next portion. Here I will just substitute it in that form, I can write the quantity now as F r 2 squared by F r 3 squared into sigma squared is equal to epsilon cube 2 plus F r 2 squared whole cube by twice F r 3 whole squared whole cube or you will get a better expression.

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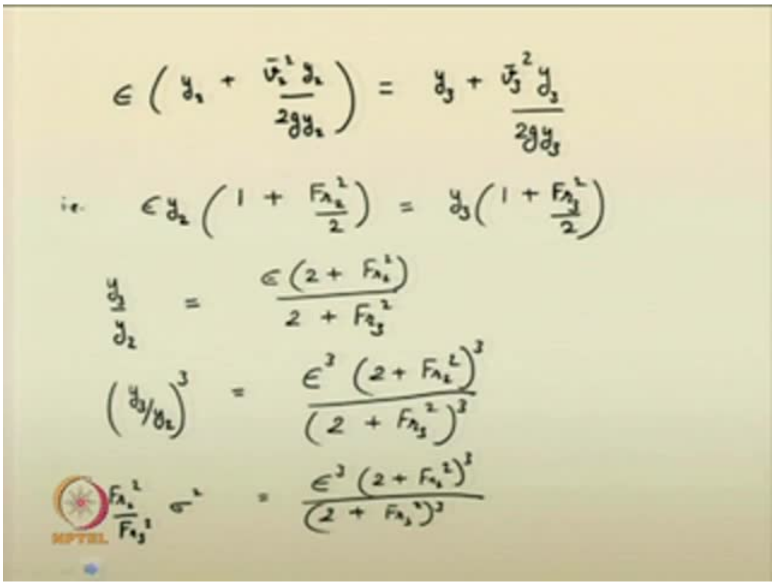

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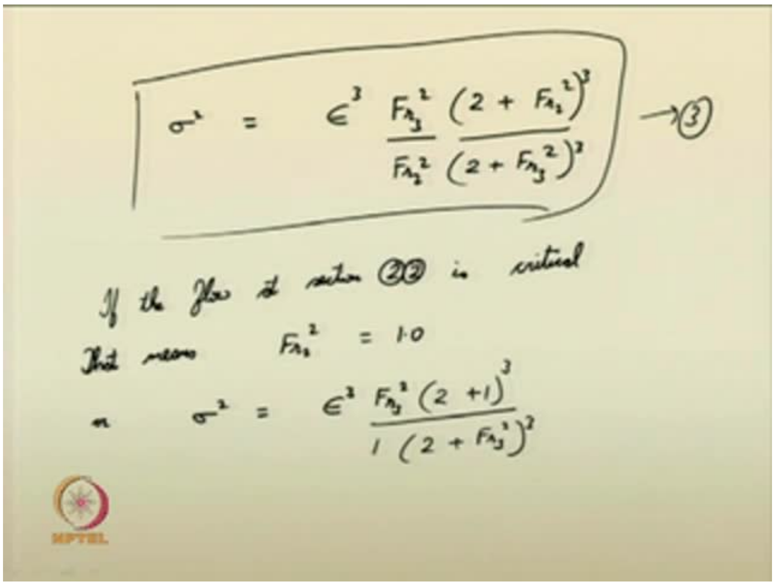

Now, for sigma squared because that is the parameter, that we have devised or assumed for this particular analyses, right? So, sigma squared is equal to epsilon cube F r 3 squared by F r 2 squared 2 plus F r 2 squared whole cube by 2 plus F r 3 squared whole cube, where F r 3, F r 2, F r 1 and all they are Froude numbers at their respective sections. So, from this relationship what we can suggest now?

Say, let me give this as equation three. So, equation three is now can be used when the design analyses and all for obstructions, that is you will get a picture, what should be the ratio of B 2 by B 3. That is what sigma squared is suggesting, right? So, if the flow at section 2 2, that is the obstruction, if the flow at section 2 2 is critical, so we are assuming that subcritical flow is coming into the obstruction here.

The flow here it is subcritical, from in the upstream section it is subcritical and we do not know in the obstruction. What is the type of flow, and at the downstream condition also, what is the type of flow? So, let us assume that the incoming flow is subcritical. So, that way what we can suggest is if the flow at section 2 2 is critical, that means your F r 2 squared is equal to 1 or sigma squared becomes epsilon cube F r 3 squared. This is nothing but 2 plus 1 whole cube by 1 into 2 plus F r 3 squared whole cube, but we have means for the flow at the obstruction section to be critical.

You require a certain type means that the width has during the width ratio that is B 2 by B 3, that square of that ratio will be corresponding means will be obtained based on the downstream Froude number. So, what is that froude number that gives the critical, that gives critical flow at the obstruction side? What is that froude number?

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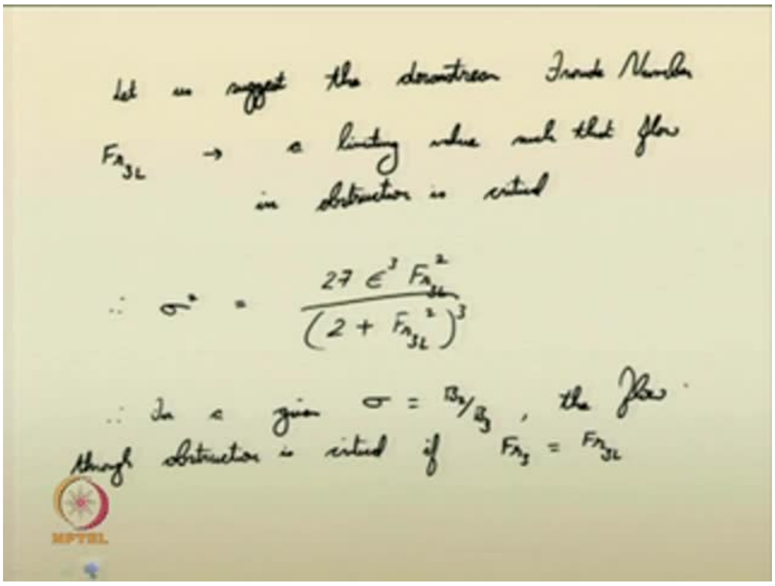

So, let us now suggest that, let us suggest the downstream flow Froude number. Let us suggest the downstream flow Froude number F r 3 l a limiting value, such that flow in such that the flow in obstruction is critical. So, not all the Froude number values in the downstream section causes critical flow at the obstruction, only a certain Froude number will cause critical conditions at the obstruction. So, let us consider that particular value of the Froude number in the downstream section as a limiting value.

Therefore we will get this particular relationship, it should be written in the following form only, not in the earlier form in the limiting condition. That is 27 epsilon cube F r 3 l squared by twice F r 3 l squared whole cube. So, this is the critical sorry, limiting condition that allows critical flow at the obstruction. Therefore, for therefore, for for a given sigma is equal to say B 2 by 3 the flow through obstruction is critical if the downstream Froude number is equal to this limiting Froude number, fine? That is quite obvious, right?

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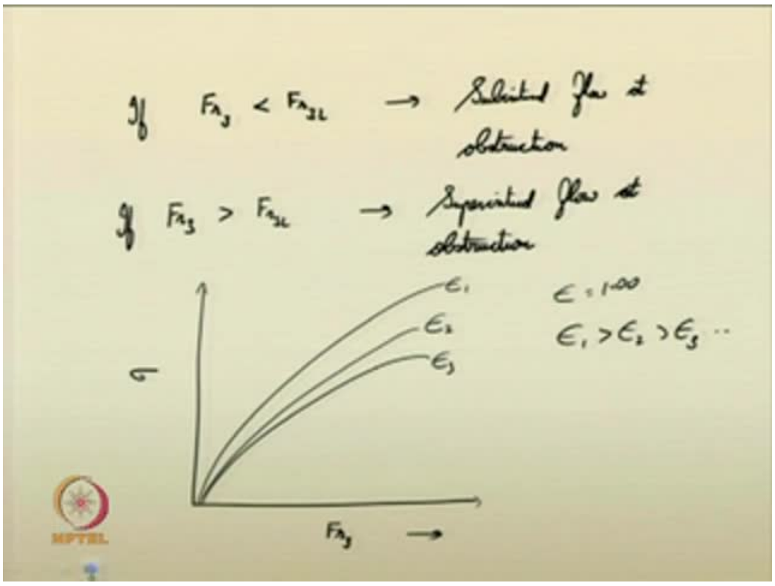

So, if F r 3 is less than F r 3 l that limiting this thing, what happens? So, the flow through the obstruction is subcritical subcritical flow at obstruction. If F r 3 it is greater than F r 3 l it will be having that is the flow at obstruction is supercritical flow supercritical flow at obstruction. So, like that you can suggest criteria, now now based on this one can easily draw say the downstream Froude number versus the width ratio sigma B 2 by B 3, right? So, it can be drawn for various cases say like this one particular graph is there another graph like this.

Definitely this is say for different values of epsilon, epsilon 2, epsilon 3. Epsilon epsilon starts from 1 epsilon 1, greater than 1 epsilon 2, greater than epsilon 3, like that it you can go for various cases like that. You can plot it, plot and these charts can used for design purposes further. So, that way one can design obstructions and all next what we would like to discuss is on flow between bridge piers flow.

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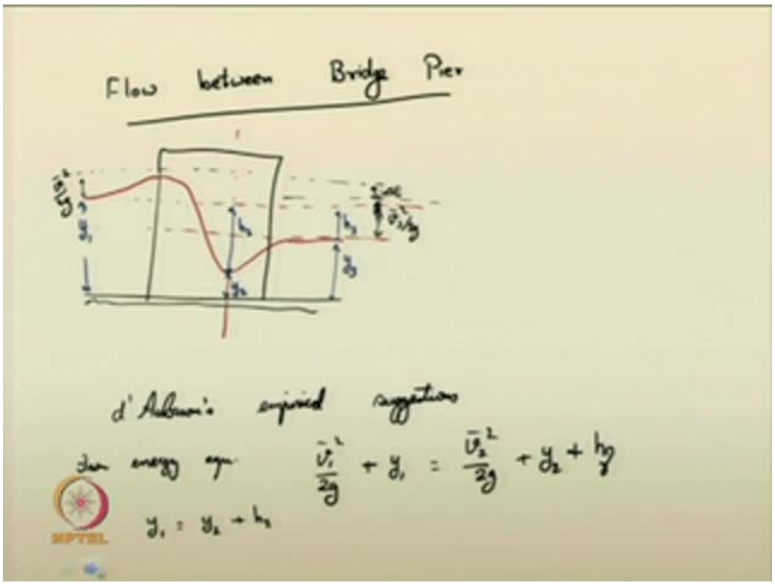

So, a bridge pier is also an obstruction, it is also means the same theory related to obstruction. You have to employ it here in addition to that you have to suggest certain some more aspects there. That is the reason, we can briefly study them. So, we are you are not going to study in detail these aspects. Especially this particular chapter we are just briefly covering them, so recall the same thing in the obstruction you have used the following diagram.

There is an obstruction, then the water flow say if the this is the height of the normal flow upstream. Then it suggested that it may increase, then it may decrease and it may reach like this. This was the flow profile suggested, right? So, in this particular case we would like to suggest the following parameters. Now, say let us assume that the difference in height here. This is y 1, you recall them this is y 2 and this is y 3. So, this height difference. let us assume it as h 2 and this difference in height. Let us assume this as h 3, so in the obstruction.

So, some of the means some of them have scientists, have done experimental studies and all they have. For example, D'aubusson as referred from the Ven te Chow’s books on open channel hydraulic. So, he has done several experiments and came up with empirical suggestions. So, the empirical suggestions are developed from the energy equation and all. For example, from energy equation, develop the empirical form say between two sections. Section 1 1 and section 2 2. Let us consider, so v 1 squared by 2 g plus y 1, that should be equal to...

So, you know the, this is the energy line fine, this is v 1 squared by 2 g and this will be definitely we have to see, how much energy loss is there del e, that has to be accounted? Based on that we will suggest say some line here v 3 squared by 2 g and this is the energy loss del e, fine? So, v 1 squared by y 1 is equal to say between section 1 1 and section 2 2. It could be v 2 squared by 2 g plus y 2 plus h f, right? You also know that y 1 is nothing but y 2 plus h 2.

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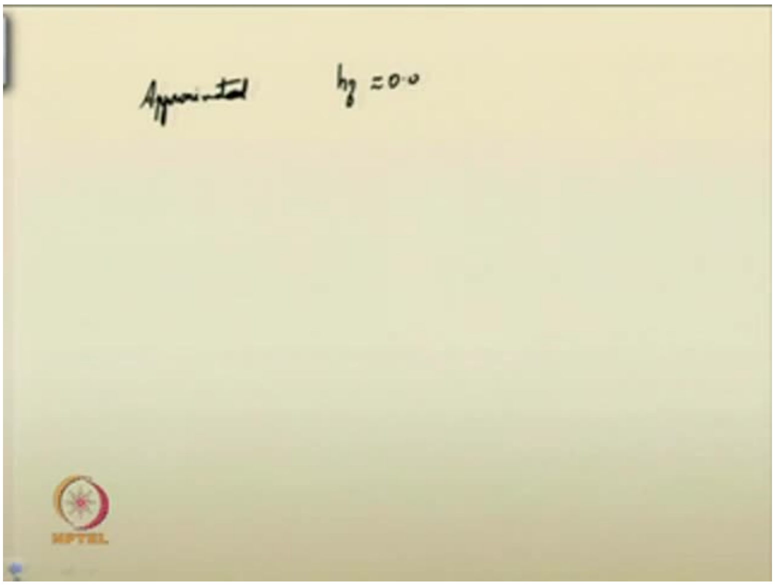

So, if we approximates, so it is D'aubusson's method, what he suggested that he approximated that is there is no frictional loss. That is what he suggested approximated h f approximately equal to 0.

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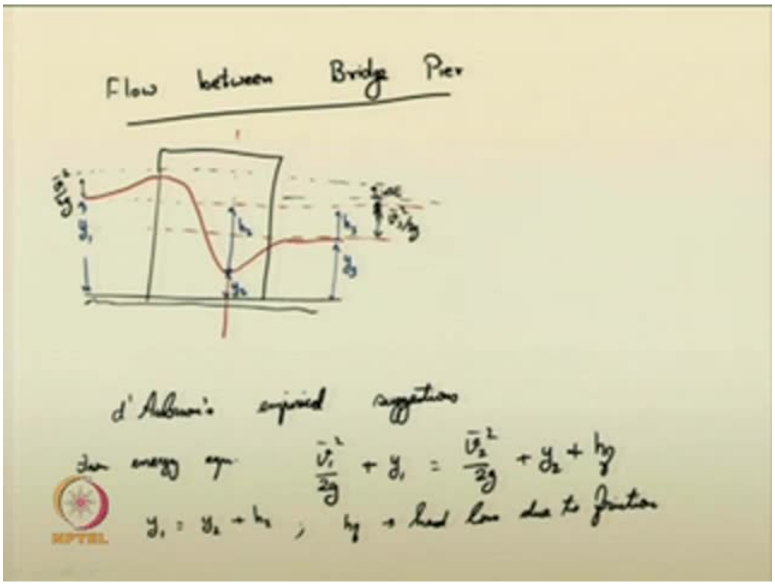

Recall the previous equation, so that is h f is head loss due to friction. So, the same thing if h f is equal to 0 and all he came up with a suggestion that the velocity at section 2 2 be given as q by k a b 2 into y 2, where k a is coefficient of contraction, it is coefficient of contraction.

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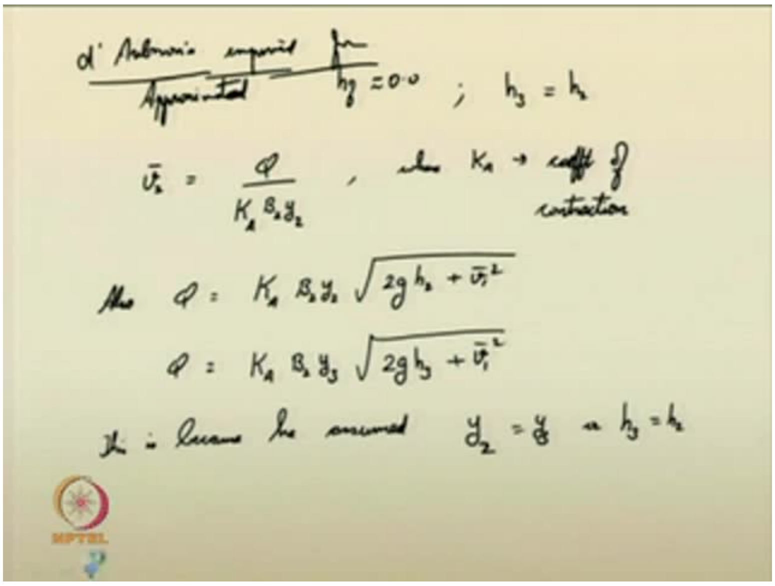

So, he came up with one this particular suggestion. Also he suggested the discharge q is nothing but from the k a into B 2 y 2 root of 2 g h 2 plus v 1 squared. Also suggested that this distance this height h 3 that was a original pier. Means the original pier description we have h 3 h 2 as distinct values, right? But in Aubusson’s Aubusson’s case, D’aubusson’s empirical form, he approximated friction loss as 0, he came up with these things, also he suggested h 3 is equal to same as h 2. So, that is y 2 and recall here y 2 and y 3 will be same, in his case.

So, for such conditions and all he came up with the following discharge relationship, q is also q is equal to k a B 2 y 3 because y 2 and y 3 are same root of 2 g h 3 plus v 1 square, right? So, it is because basically, this is because he assumed y 2 is equal to y 3 or h 3 is equal to h 2, that is the reason why you can write it in the following form discharge at both the sections they they means this in this form it can be written.

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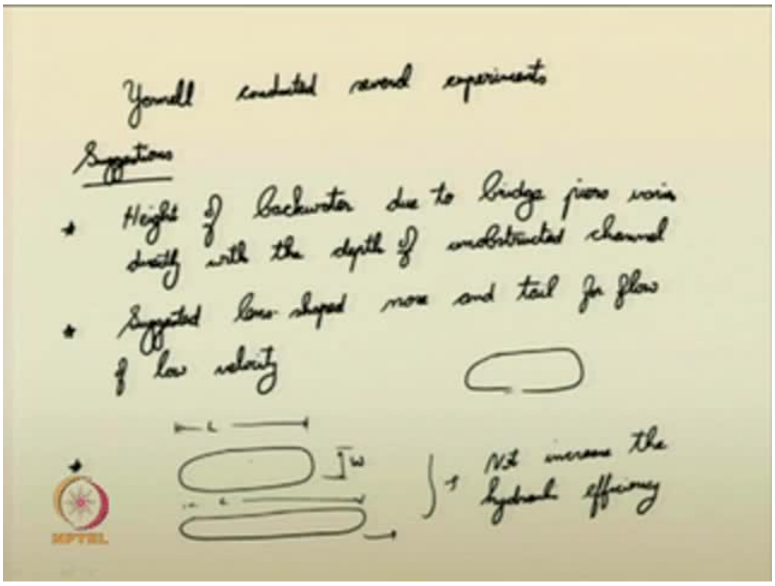

Another scientist Yarnell, this also referred from Ven te Chow’s book on Open channel Hydraulics. So, Yarnell conducted several experiments. He conducted several experiments, then he came up with certain suggestions. Some of the suggestions from his experiments are you can just give it as a point by point. Height of backwater, height of backwater due to bridge pier, height of backwater due to bridge piers varies directly with depth of the unobstructed channel.

So, that is the height of the backwater due to bridge pier varies directly with the depth of unobstructed channel. I hope this is self explanatory, right? Height of backwater due to which, piers varies directly with the depth of unobstructed channel. So, it is the downstream condition that suggests what should be the type of backwater in the upstream locations and all he suggested lens shaped nose and tail lens shaped nose. Tail for flow for flow of low velocity for low velocity flow, the bridge piers and all should be having some lens shaped concave.

Like that he suggested another interesting aspect, he found was that by increasing the length of the pier, it is with with respect to its width by increasing that it is not going to further increase the hydraulic efficiency of the channel flow. So, that way, there is no meaning in increasing the length of the pier, the length of the pier. Means say here in this particular case, this is the length of the pier and this is the width.

There is no point in further increasing it this much for the same thing, for the same width it is not going to increase. It is not going to increase the hydraulic efficiency, so there is no meaning in going for such aspect. Next point, interesting point we can suggest is that here, even if you reduce the width means further increase the width that also it is not going to affect that much. So, that way you can infer many of the aspects, yes he suggested some.

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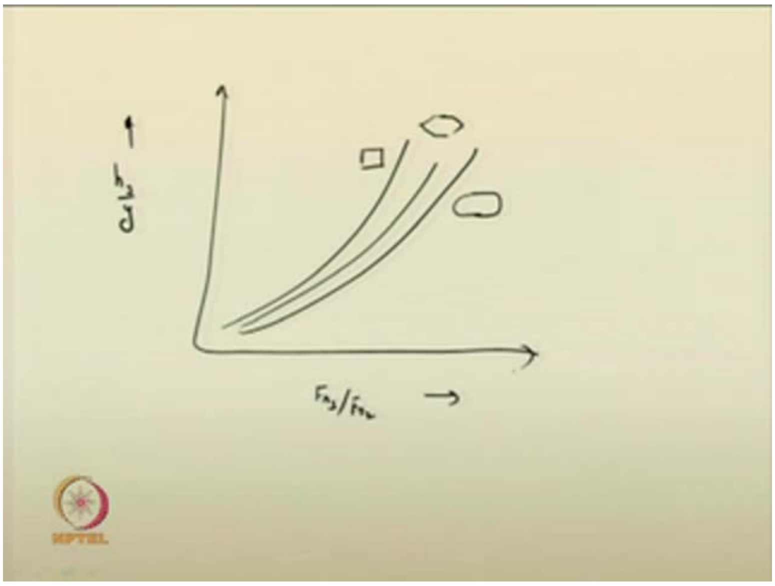

Graphical solutions also for some cases say Froude number ratios with respect to h 3 by y ratios. So, you know what is h 3 and came up with certain charts say this may be for sharp nosed he suggested smooth nosed conditions and all say this is sharp cornered pier whereas, you have a smooth pier. You you may also have some intermittent curve where the cross section can be something the pier cross section can be something like this. So, many things he as observed, they can be used in the design purposes. Next, we can briefly cover is underflow gates.

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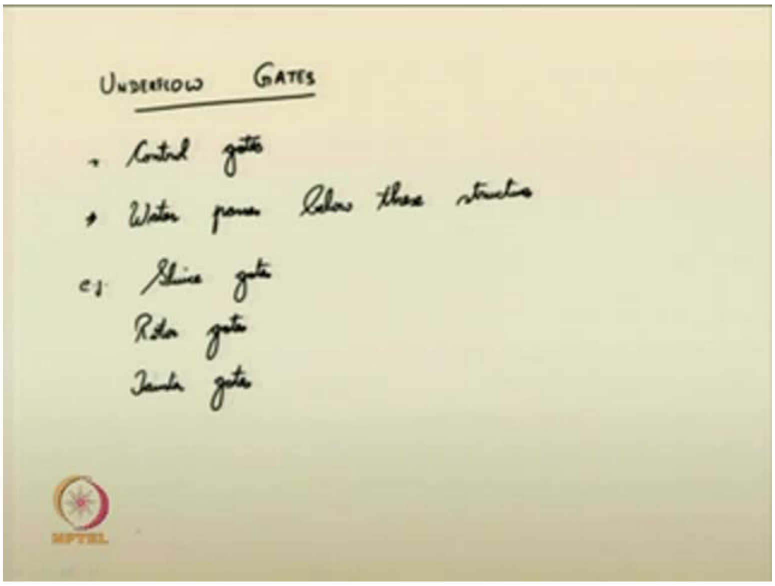

So, you have already studied sluice gate or we have mentioned in some many of our lectures about sluice gate. Although we have not exclusively studied them, right? So, sluice gate. So, they are called control gates, right? Sluice gates or underflow gates are control gates, they are used to allow flow below the structures. So, these are structures say sluice gate is a structure. Other things, they are structures that allow flow below it. So, water passes below the structure that, you can note them. Some of the examples are sluice gates or rota gates, tainter gates, there are many control gates that allow underflow through them. Some of the diagrammatic things which we can suggest is, say a sluice gate looks like this.

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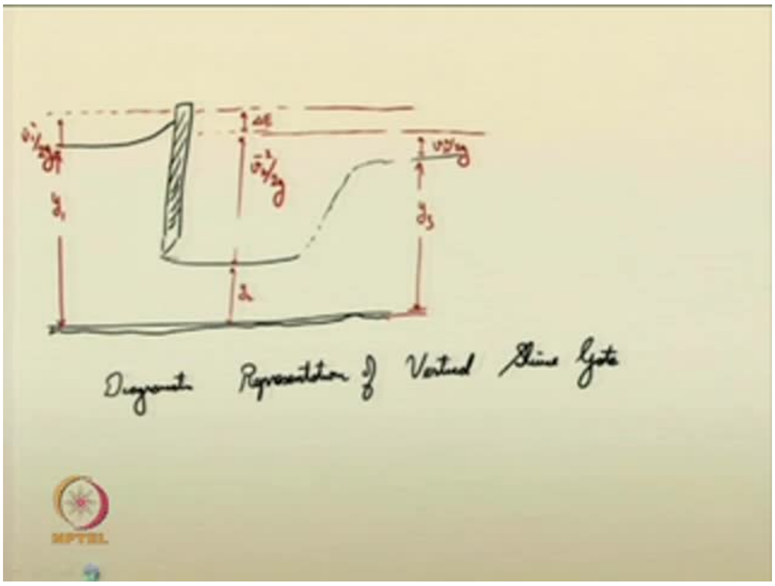

I can just give a section so this is the upstream portion and in the downstream. This is the channel bed water gushes like this. So, it may form hydraulic jump, we are not sure so this is the upstream. I can just give it in a different colour, now this is the upstream depth y 1. Now, I can also draw energy line, so let us assume this v 1 squared by 2 g that is velocity head. This is say section two having depth of flow y 2 and we are drawing an energy line somewhere here.

This you are suggesting it as v 2 squared by 2 g velocity head at this section. This is the energy loss energy loss between section 1 1 and section 2 2. If a hydraulic jump is formed here, this you can take it as section three and then this is y 3 and this particular quantity we can give this as v 3 squared by 2 g. So, same phenomenon if you try to use them, this is this particular diagrammatic representation is, this is a diagrammatic representation of vertical sluice gate.

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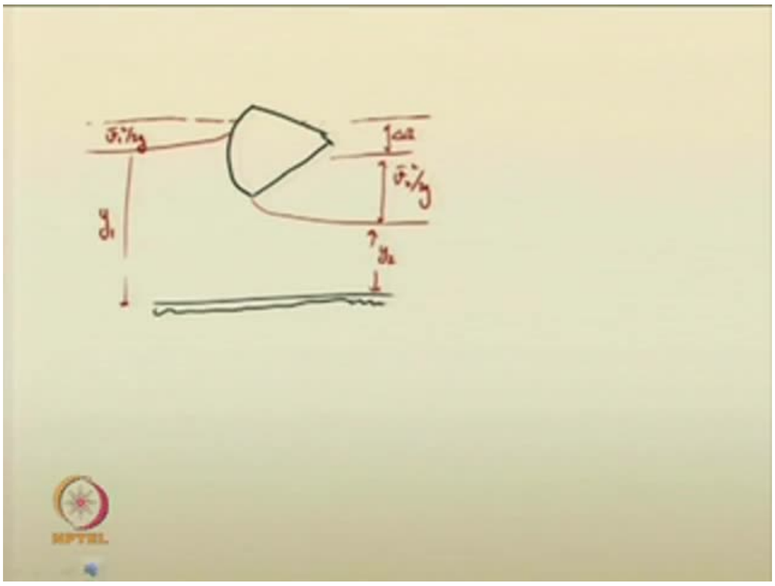

Another underflow structure we can just briefly show in a diagram form is a tainter gate. So, tainter gate it is a structure like this. This structure is it is being used like this, it is a channel bed, you may see that water in the upstream, it may it is will be like this, at this level. Then water in the downstream will gush it down like this. So, definitely there will be some sort of energy change, say if this is the energy line say some drop in energy del e, if it is there. So, this is your y 1 v 1 squared by 2 g and it is v 2 squared by 2 g and this is y 2 like this. You can think about the, so this such type of structure, it is tainter gate. It is more compared to this sluice gate, it has more span and it can, in it can be used to control large volume of waters also.

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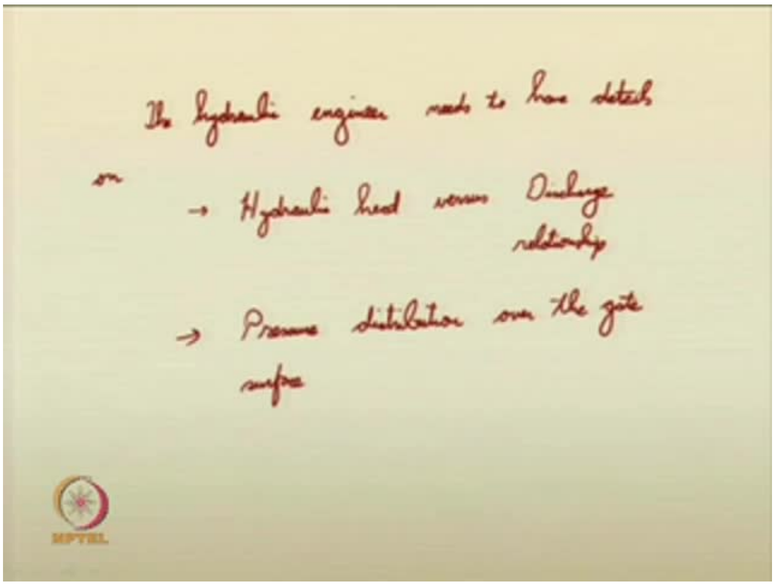

So, why such underflow structures and all while designing the hydraulic engineer needs to have, details on he needs to have details on hydraulic head versus discharge. So, hydraulic head versus discharge relationship, it is at whichever location he want to design such underflow structure he need to understand what is the hydraulic head versus discharge relationship, that can be used? Also he need to understand the pressure distribution, the pressure distribution over the gate surface.

Say over the gate surface definitely, if you see these two surfaces water, it is submerging. Means it is around this surface water is striking it in contact with this particular structure. So, there is some volume of water there at a height, it may be creating some sort of force. If you look into this also here you here also you can see that, so recall your fluid mechanics portion and all you will see some static conditions. There so these aspects need to be covered while designing underflow gates.

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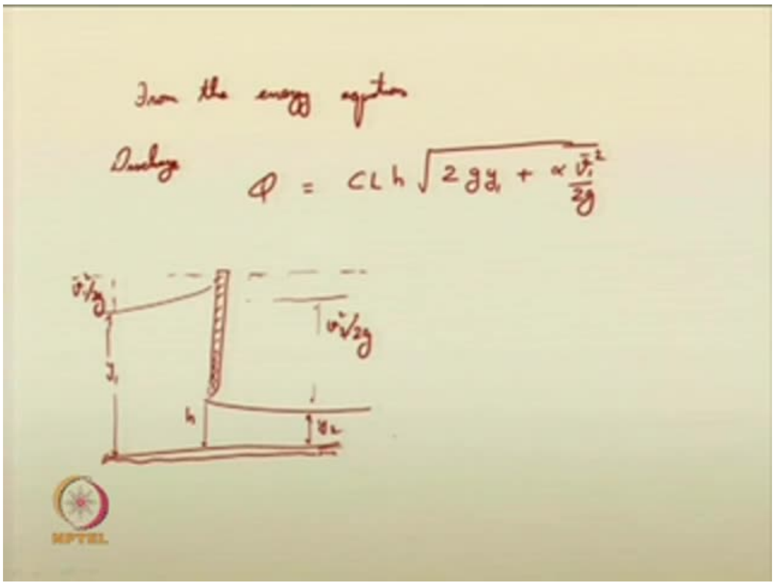

So, from the energy equations, so from the energy equations it is being understood that, discharge say for on a vertical sluice gate it can be given as c l h root of 2 g y 1 plus. If your alpha, that is the energy correction factor, if it is significant you need to incorporate. Then alpha v 1 squared by 2 g. So, you know all the parameters here or I can just again draw it for your benefit, this is your height y 2, this is say we do not know exactly. So, this is like this so this is your height y 2 this is h is the height of the opening below the sluice gate, so that need not be same as y 2.

In fact most of the time it is not like that this is the height y 1, so you can just draw the energy lines, this will be v 1 squared by 2 g, here it is v 2 squared by 2 g. So, you have the following in the sluice gate, you have the following parameters. Now, based on this the discharge is easily found. Discharge usually you want to adjust that discharge, that is the objective of the sluice gate. So, how much discharge you want to give in the downstream? They can be found it from here, next topic which we would like to quickly cover is the channel junctions.

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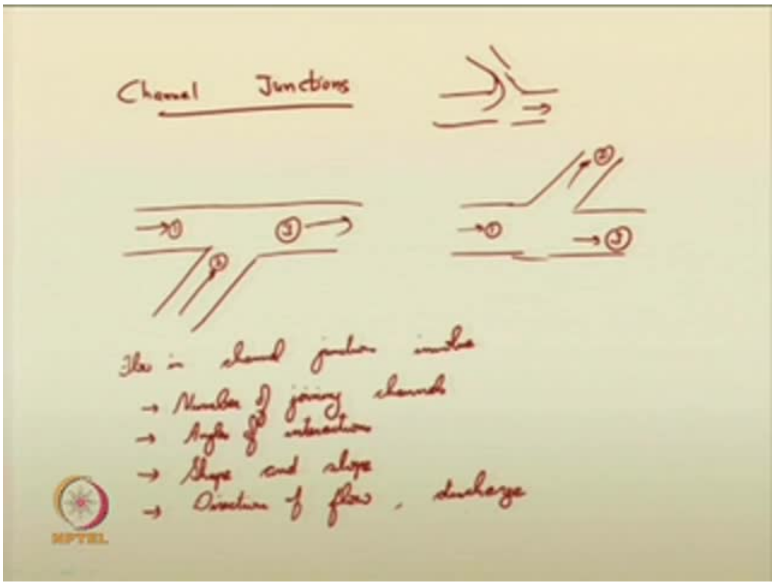

So, channel junctions, you might have seen them say one channel is coming like this, another channel is coming like this, they are merging and it is forming a third channel. So, flow is coming like this, flow is coming like this, it is going that, so if I name this channel as channel one, this as channel two, this as channel three, there are three channels coming into picture here. One and two is merged combined and forming channel three, similarly there can be reverse also that is one particular channel is there it is getting diverged into two, say this is two, this is three like that.

That can also be, that can also happen in many of the cases. In fact there are there, so we can suggest now flow in channel junctions. They are controlled by a flow in channel junctions involved number of joining channels. How many channels are forming? That junction the angles of interactions between channels, that is also quite significant. You may see that some channels, it may come like this and it may go like this also. At some of the cases, some of the portions some quantity may go like this, some of the quantity may go like that, it can happen in nature.

So, it depends on various angles of interaction, it also plays a significant role shape and slope of the channels directions. Direction of flow landscape direction of flow discharge, how much amount of discharge is there? These are also going to affect. So, we can based on these quantities, one can infer flow in channel junctions.

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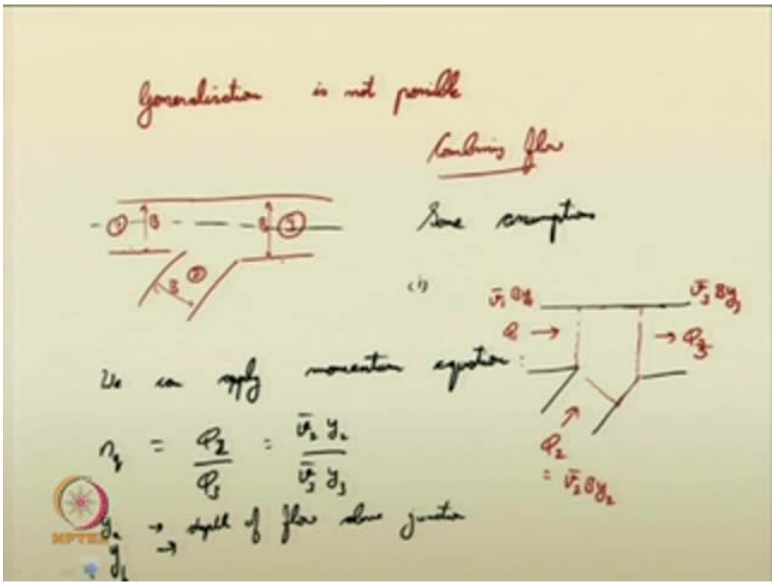

So, what we have to understand is that, generalisation of channel junction flows is not possible, generalisation is not possible. If you want to analyse it in a brief way for example, in Ven te Chow's book also it is being mentioned there, if channel one is coming like this, channel two is merging forming channel three, if such a situation is there, this is combining flow, right? This is a case of combining flow from different channels.

Suppose, let us assume that all the channels channel 1, 2, 3 they are horizontal and they are having equal width. Let us assume that they are having equal width, let us assume this one is having same; that is they are all rectangular channels. Also, some assumptions involved are some assumptions which we can incorporate in one particular type of analyses is that, flow, flow occurs from you can just note it down, flow occurs from channel one and channel two and it merges in this junction and it goes through channel three. This is one assumption means, there is no reverse flow occurring there.

We also suggest that, flow is parallel to the channel walls. So, entire this thing, it is parallel flow occurring in all the channels. That is means there is no turbulent 2 dimensional flow mixing and all this is predominantly one dimensional for each of this channel based on their channel axis and all. So, we also assume that one, that is channel one and channel three they are in same line. This is also one assumption we are neglecting the wall frictions.

Then depths, depths in channel one and channel two are equal the immediately above the junction. Say if this is junction around this junction portion above the junction depth of flow of this channel as well as the channel, channel one both are same using these assumptions. We can apply momentum equation, you can use the momentum equation, we can now suggest the following thing, I can just elaborate the thing section now or here itself.

This entire portions use the momentum between the sections given like this. So, you have in here this is q 1, this is q 2, sorry this is q 3, this is q 2 and you have that is q 1 is nothing but this is v 1. B y 1 q 3 is nothing but v 3, B y 3 q three is nothing but is equal to nothing but v 2 B y 2. Let us consider a parameter n q, such that this is equal to q 2 by q 3, so that is v 2 bar y 2 by v 3 bar y 3.

Then at the channel, this is the portion above the channel junction. So, this entire portion representing the junction, so this is above the junction. So, here both the depths are equal and here that may not be same. So, we are suggesting quantities y a depth of flow above junction and y v depth of flow below junction.

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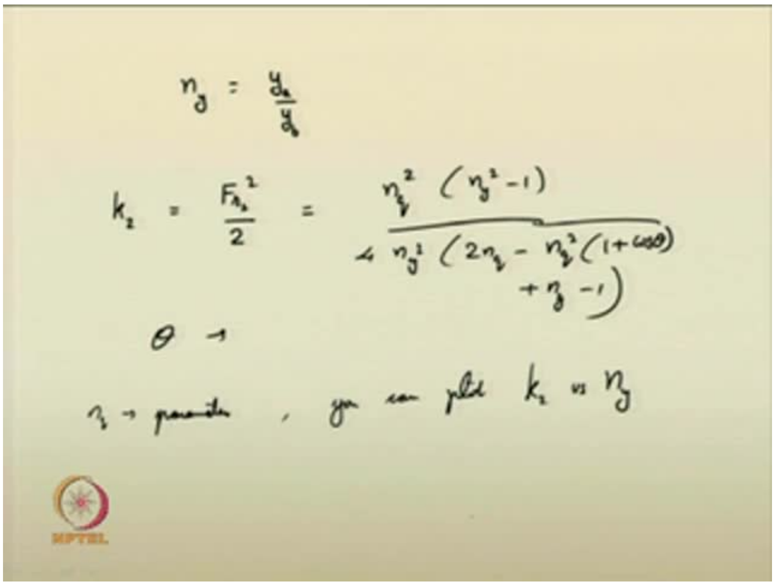

So, you can now assume a ratio n y, that which is equal to y a by y b. So, using these symbols and all from the momentum equation, it was simplified that a parameter called k 2 was devised, which is nothing but the square of the Froude number, half of the square of the Froude number at the upstream section. So, it is nothing but n q squared into n y squared minus 1 by 4 times n y squared into 2 n q minus n q squared 1 plus cos theta plus n y minus 1 like this. The denominator is there, so where theta is the angle between 2 channel.

So, this could, this is the theta value fine like that if it can be mentioned. Now, you know that n q is a parameter; now that is this n can consider it as a design parameter. Now, you can plot k 2 versus n y, so that way 1 can go with the design aspects of channel means in the channel junctions and all design aspects, like we would like to conclude. We do not want to further say for the especially for the dividing flow or the diverging flow and all that is water is getting divided from one channel in the main channel.

It is getting divided into many channels those aspects you it it has not been yet considerably studied in a theoretical form. Only the experimental analyses are involved, means available. So, we would not like to touch much into that aspect, so we will just quickly conduct one quiz on the today's lecture.

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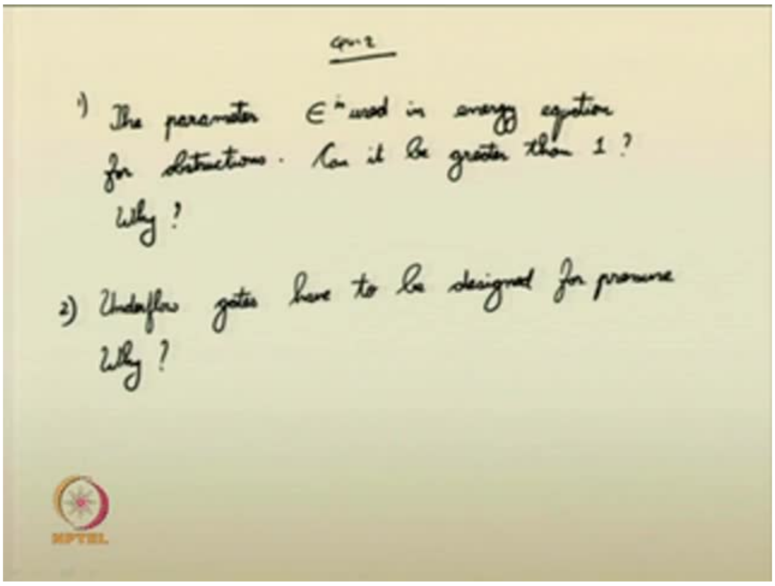

The first question in the obstruction flow through obstructions you have seen a parameter called epsilon and that was used in the energy equation. The question is can it be greater than 1, you should reason it why? If it is greater than y 1 y if it is not greater than 1, y means you have to answer them and second question under flow gates that you have studied few minutes ago, they have to be designed for some pressure force and all why.

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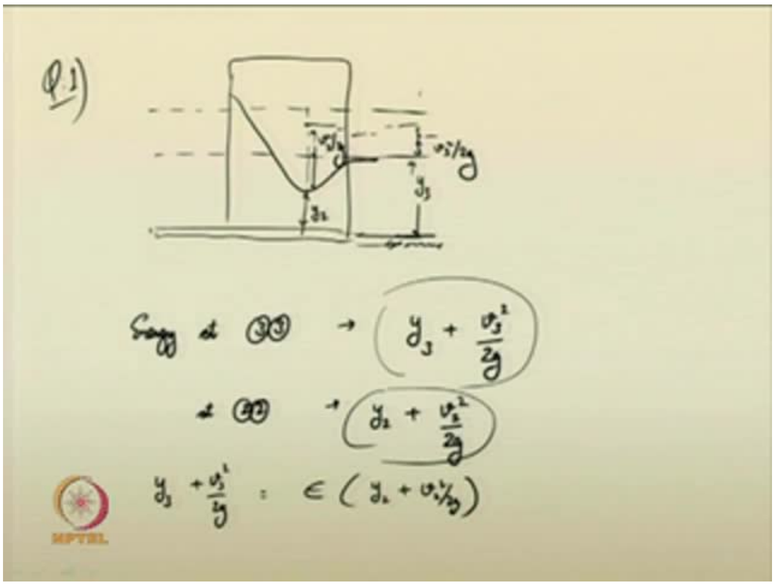

So, the solution for the first question we asked you whether the parameter epsilon can be greater than 1? So, if you recall in the obstruction, which we have done flow through obstructions and all where we suggested the conditions or a critical flow of the obstruction. So, the this is section 2 2 and this is section 3 3, you know that a energy at section 3 3 is this much, energy at section 2 2 is this much.

Flow at section 2 2 to section 3 3, if the flow has to occur definitely the energy has to be means at section 2 2. The energy has to be more the hydraulic total hydraulic head has to be more, right? So, we consider here, now this energy at section 3 3 is some fraction of energy at section 2 2. So, epsilon can never be greater than 1. So, the maximum possibility is that, there will not be any energy loss.

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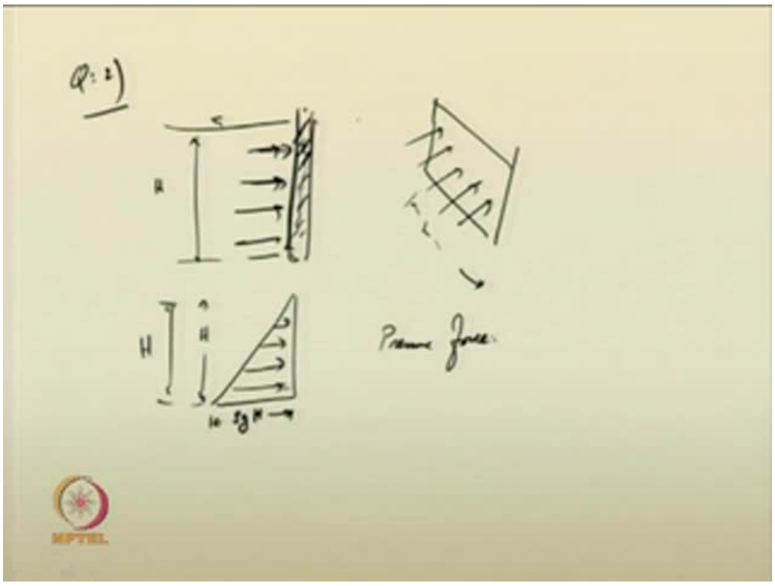

So, epsilon is equal to 1 the second question we asked is say in the vertical sluice gate and all why you require to design for pressure? Say if a vertical sluice gate is made like this, so it has on the left side water is there. So water with certain pressure it is already there, now as a vertical plane has been incorporated due to the pressure a force in perpendicular direction to this particular plane. Say if I draw it in this particular form and water, this, this is the length of the sluice gate, right? We will see that pressure force acts perpendicularly to the plane of the sluice gate.

This pressure force is caused by the depth of water this is the height h and pressure force is obtained by getting the pressure force area of this triangle. This is half rho g h, right? What we can suggest is that, this magnitude is rho g h, if this is open to atmosphere this portion the pressure is 0, this is h, so the height of the this triangle this triangular area. What it is? You know that, that triangular area will give you the pressure into area of this sluice gate, that will give you pressure force. So, your sluice gate has to be strong enough to resist that force action from water and it has to be sufficiently strong. Therefore, it has to consider the pressure.

Thank you.