Advanced Hydraulics

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Module - 3
Varied flow
Lecture - 9
Standard Step Method for Gradually varied flow computations

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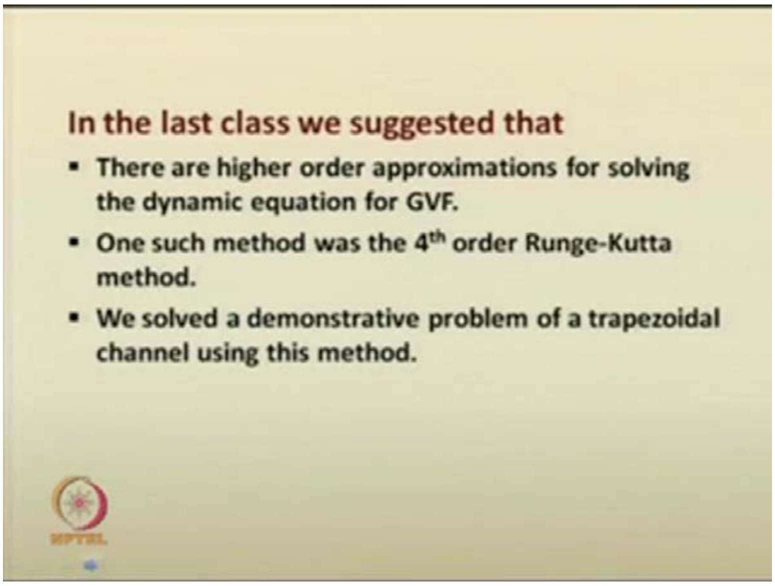

We are welcoming you back into our lecture series on advanced hydraulics. We are in the third module on varied flows. So, if you recall from the last class, we had discussed on the higher order approximations that can also be used for solving the dynamic equation for gradually varied flow. One such method that we discussed was, the fourth order Runge Kutta method. We also had solved a demonstrative problem for the trapezoidal channel section using this fourth order Runge Kutta method. So, we had done an extensive demonstration on that problem, and I hope you all have benefited much. You have understood the concept on solving that problem. If you recall the dynamic equation for gradually varied flow.

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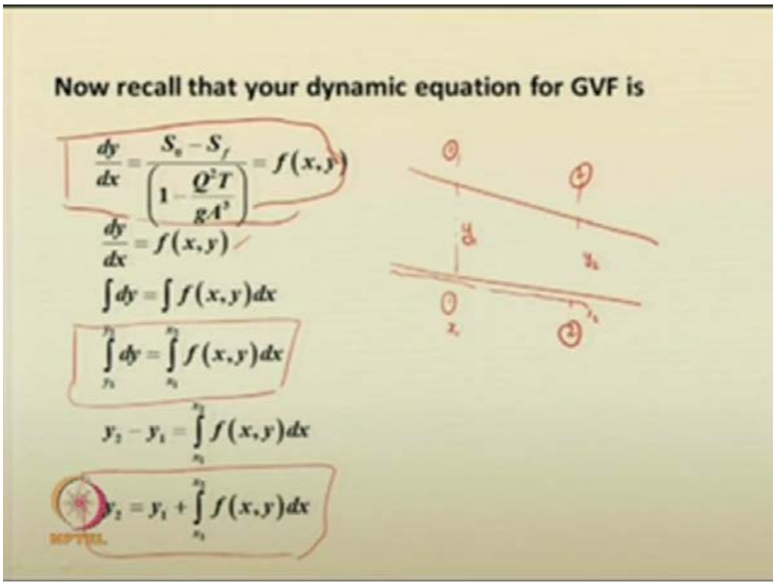

We have seen that the equation, the dynamic equation as given here it is a function of the spatial variable x and the depth of flow y, is not it. So, that is d y by d x is function of x and y. This according to your mathematical principle, you can integrate it in the following form that is integral d y is equal to integral of f of x y d x. As you are taking a channel reach, say if you are taking a channel reach between 2 sections, 1 1 and 2 2. You take 2 sections like this. Here, if the depth is y 1 this is depth 2 y depth is y 2, say this is at a location x 1, this is at a location x 2.

Then, the corresponding this integration can be provided in the following form, that can be again rearranged and the solving is done usually in this particular form. So, the various forms you have seen already, how to evaluate y 2 based on the value given at y 1. So, this is called the step process. You have seen the direct step method. You have also seen the Runge Kutta method. Today, we will see the standard step method for gradually varied flow computations.

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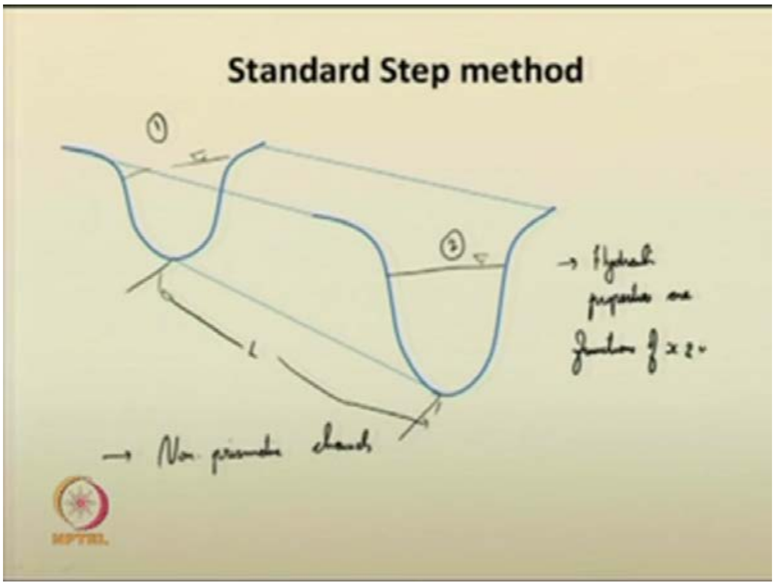

So, the standard step method, it is normally used for non prismatic channels. The standard step procedure is used for non prismatic channels, say as given here. If there are 2 non prismatic channels in a particular reach, say if this is the reach of the channel you are interested or you can give it as del x also, it does not matter. And if you want to evaluate the flow properties in this particular non prismatic channel, you use the standard step method. So, how do you evaluate them? How do you incorporate them? So, you know that say, if this is channel section 1 1 and this is channel section 2 2, let us assume that the depth of the flow here as well as the velocity of the flow here, they all depend not only on the depth of flow, the velocity of the flow, depends not only on the depth of the flow.

It is also the function of x, here, at which location of x it is? Similarly, here also this is the function of x .The flow properties are function of x especially the, if you evaluate the energy slope or the friction slope you can see those things. So, they have all the hydraulic properties are in non prismatic channel. Hydraulic properties are functions of x and y, both x and y. So, in prismatic channels, we have seen that most of the functions are properties of only the depth of flow y, but that is not the case in the non prismatic channels. So, we have to use these things. So, what they do?

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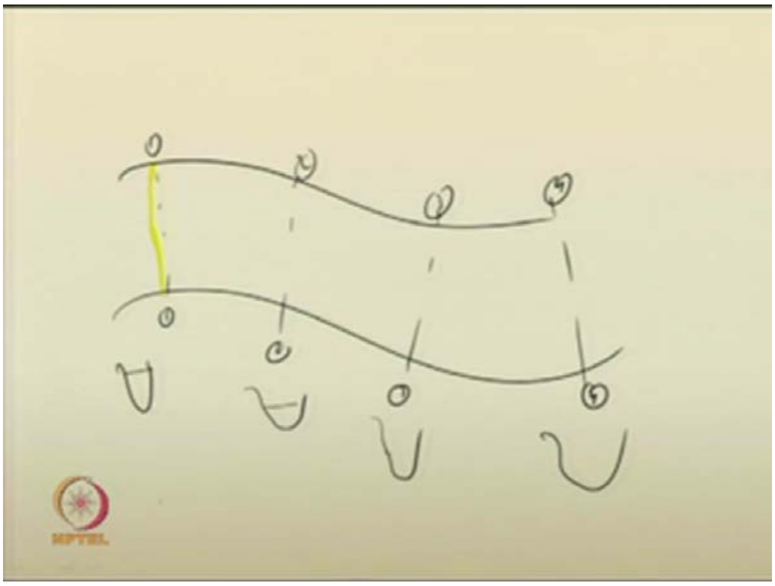

Say if you have a reach of channel, a non prismatic channel, they may conduct various field surveys at various locations. They conduct field surveys may be cross sectional survey as well as longitudinal survey along the reach as well as the cross sectional details will be captured at various locations, say this is section 1 1 this is section 2 2, this is section 3 3. Please note that this is the top view of a channel reach or non prismatic or a natural channel that is been given here.

So, you do cross sectional surveys, local field surveys are done. You measure the depth, here, you measure the depth here, properties there, what are the cross sectional properties? All those things will be recorded once you record all those things. Now, you know the distinct site locations of the channel reach between 2 channels, between 2 stations you can average the properties. So, now, suppose if all the properties are given here, now if you want to evaluate the flow depth at this location and this location like that, you can use the standard step method. Now, that is also a varied flow property. That is gradually varied flow using standard step method. You can evaluate the depth of flow.

So, as we mentioned earlier, computations are carried out from a known location say at this location, if all the properties are given to you at this location, if all the properties are given to you. Then using the step procedure, the step evaluation, we have seen earlier in the equation, say this is the step procedure. The same thing we are using the same principles we are using here. So, in this thing in the at section 2 2, to evaluate the depth of flow or even the velocity of the flow or even the discharge as you know, it will be constant. Because gradually varied flow, we have suggested that discharge is constant throughout all the sections. So, discharge will be same. All these things can be evaluated. So, u is the known property from the left hand side, you evaluate the right hand side. How do I proceed now?

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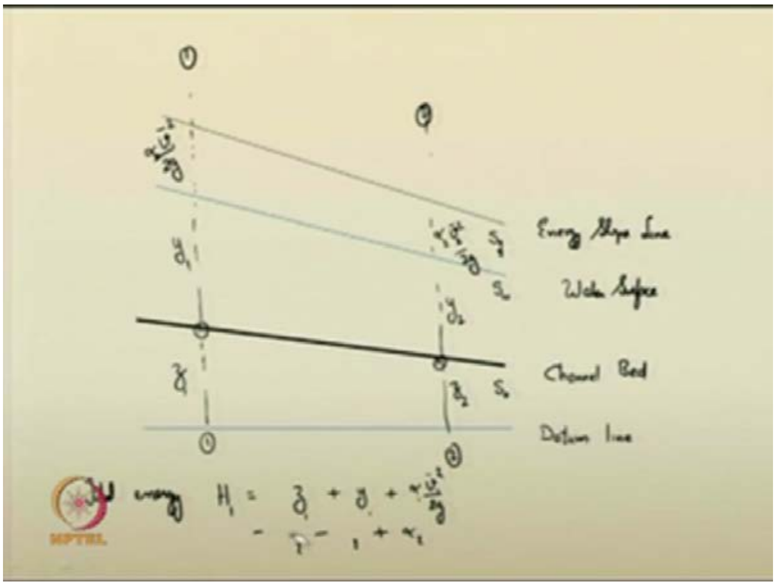

So, consider the following channel section say if I have the following parameters, say if this is your channel depth, if a at any depth z from the datum line say, let me suggest what are these line? First, let the bottom line be the datum line and this thick line, let me suggest it as the channel bed line. And the next line is the water surface line and the above one is the energy slope line. So, what are these quantities, datum channel bed and slope of the channel bed? You know it is given by the quantity S 0, water surface line is given like this and the slope of the water surface is given as S w. If you recall them, energy slope line, if it can be evaluated, the energy quantities, if it is evaluated you can easily give this quantity as it is called S e or S f, we had given these things.

Now, if at a location if a particular location if the channel bed of that location is at a elevation z from the datum line. Let the depth of flow be y at that location, and as this is a non prismatic channel, the cross sectional details are coming into much prominence here, and not only that the velocity, if you see that the velocity may not be uniform across the whole cross sections. So, you may see you will be taking average velocity and therefore, you may be incorporating energy connection factors and all. So, the velocity head at this location, it can be given as alpha V squared by 2 g. So, if you add all these quantities z plus y plus alpha V squared by 2 g, you are going to get the total energy. Total energy H at any section is equal to the datum head called z small z plus the elevation of water. Please note that y; it is elevation of water we are dealing with flow in open channels where the pressure is in hydrostatic condition. So, you have to note that.

You are not dealing with very high speed flows in such situations, where you cannot use the hydrostatic assumptions, so H is equal to z plus y plus alpha V squared by 2 g. So, this the general total energy head equation, you have already studied in this case. So, if I consider this as section 1 1, then the energy head at H 1 is equal to energy head at section 1 1 is equal to H 1 is equal to z 1 plus y 1 plus alpha 1 V 1 square like this, we can write. Similarly, another section 2 2, if I take and if that section is at an elevation z 2 from the datum line, the bed of that section is at an elevation z 2, then I can easily write H 2 is equal to z 2 y 2 and this is alpha 2 V 2 squared by 2 g. So, z 2 plus y 2, I will just give it at.

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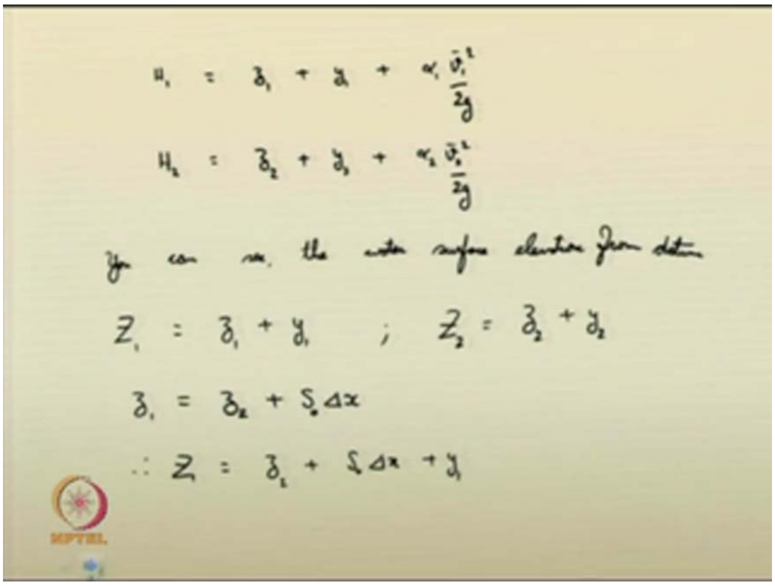

As mentioned earlier, H 1 is equal to z 1 plus y 1 plus alpha 1 V 1 square by 2 g H 2 is equal to z 2 plus y 2 plus alpha 2 V 2 squared by 2 g like this, you can give the energy equations for the 2 sections. So, what do you get if these 2 sections are separated by a distance del x? If these 2 sections are separated by a distance del x in the bed, then we can write the following form. I can find means; you can see the water surface elevation from datum. Again just make another parameter. Now, you can just make another parameter such a way that the water surface elevation, this location at this particular from the datum line. This is now called as capital Z 1. Similarly, this elevation it is called capital Z 2 like this I can just identify 2 parameters. So, your Z 1 is nothing but, small z 1 plus y 1 similarly, Z 2 is nothing but, small z 2 plus y 2.

From the following figure, can you guess certain quantities; your Z 1, your Z 1 is nothing but Z 2 plus the channel bed slope is given, channel bed slope it is already given to you that bed slope into this particular distance that will give you the difference between Z 1 and Z 2. So, I can write z 1 as z 2 plus S 0 into del x you can easily write them. Therefore, your capital Z 1 is nothing but z 2 plus S 0 del x plus y 1. These are nothing but just manipulation or rearranging of the terms. There is no arithmetic things involved here. So, as we see here in this figure, your energy line your energy it is getting decreased at section 1 1, whatever total energy was there H 1 it is getting reduced to H 2 at section 2 2. So, what is the energy loss? What could be your energy loss, what could be the energy?

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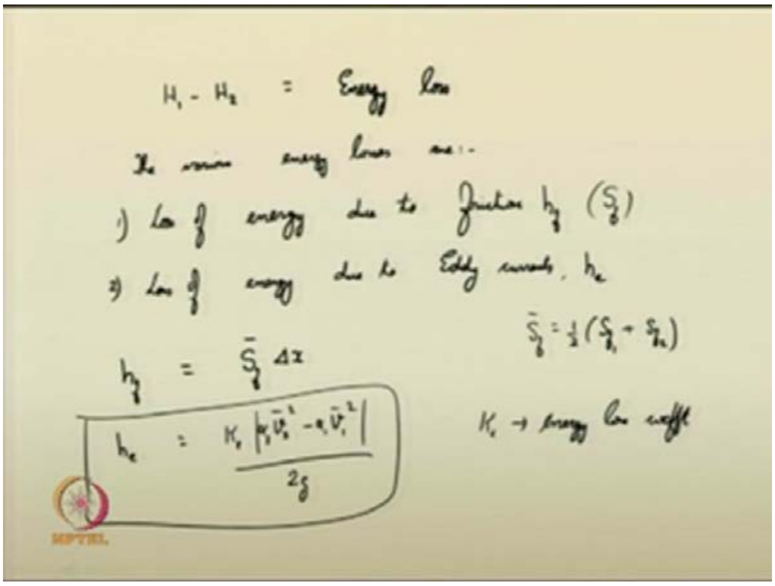

H1 minus H 2 will give you the energy loss. The various energy losses are loss of energy due to friction. That is, you know friction slope is S f based. On that you can evaluate loss of energy due to friction. And loss of energy due to eddy currents as these are non prismatic channels, there will be considerable eddy currents also so those things also causes loss in energy. So, and a loss of energy due to friction I can give this particular term as h f and this particular term as h e; h f, the friction loss it can be given as the friction slope into del x. So, we are going to take the average friction slope. So, between 2 sections say in this case, if this is section 1 1 and this is section 2 2, so what is the friction slope here? S f 1 this is here it is S f 2. Based on these 2 sections, so S f, you are going to take the average friction slope S f bar. That is given as S f bar is equal to half of S f 1 plus S f 2. So, you are going to take S f bar and you are going to multiply it with distance del x to give you the loss due to friction.

Your eddy loss, your eddy loss can be given by h e is equal to some coefficient. That is say some coefficient K l into the change in velocity. Please note that the change in velocity that is causing them, so of course, I have to use the energy correction factors also by 2 g. So, the eddy loss is given by K l is a energy loss coefficient eddy due to eddy currents and all. So, and eddies are parameter K l that can be experimentally found out. So, we are not going to going in detail about this particular parameter. So, it can be given by this following relationship; the eddy loss which is, so please note that here we are going to take the magnitude in difference between the velocity.

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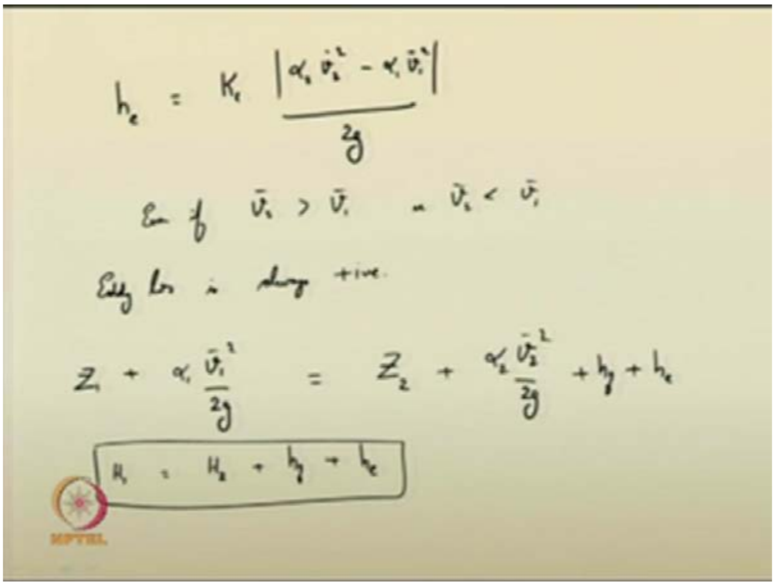

So, even as I mentioned K l alpha 2 V 2 square minus alpha 1 V 1 square by 2 g, this is given as a. So, this is the modulus of this difference. So, even if V 2 greater than V 1 or

V 2 less than V 1, your eddy loss is positive. So, there will be always eddy loss from the flow direction from the upstream to downstream. Whichever flow direction is, there cased on that the eddy loss will be always positive means, it will be a loss of energy. You will not gain any energy due to those phenomenons. So, eddy loss is always positive that you have to note it. So, it is the magnitude of the difference that you are going to take.

So, what does this relation suggest? you can see that Z1 plus alpha 1 V 1 squared by 2 g is nothing but equal to Z 2 plus alpha 2 V 2 squared by 2 g plus friction loss plus eddy loss like this, I can easily write it. So, you know what is Z 1? What is Z 2? Ultimately what does this bring? This gives you the principle H 1 is equal to H 2 plus friction loss plus eddy loss, this is the fundamental principles which you have studied even in your undergraduate level. So these things we have again come back into these things. So, these relationships we use the governing principle which we will be going to use for the standard step method. So, how you are going to use them? So, what is the first term?

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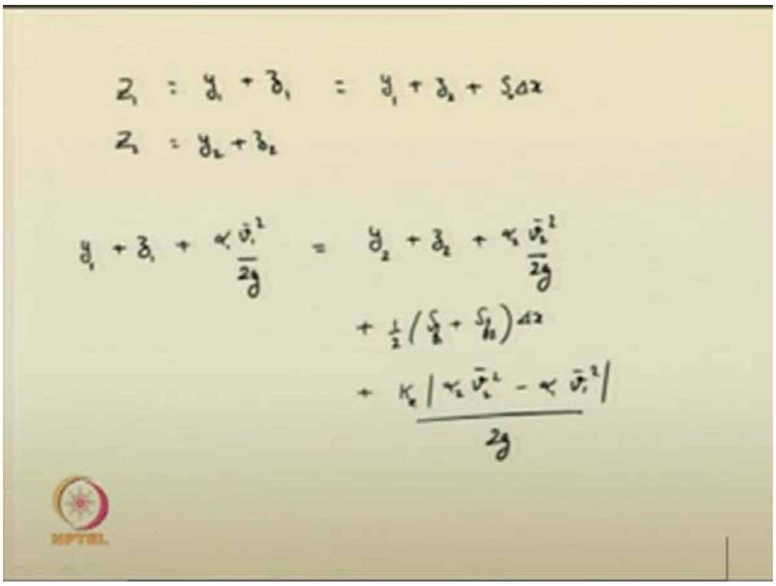

So, Z, Z 1 as we have mentioned it is y 1 plus small z 1. So, you substitute all those quantities Z 2 is equal to y 2 plus z 2. Here Z 1 if you recall them this I can write it as y 2 plus z sorry y 1 plus z 2 plus S 0 into del x like this also you can write it. Substitute all these quantities I can write for the 2 sections now y 1 plus z 1 plus alpha V 1 squared by 2 g this is nothing but y 2 plus z 2 plus alpha 2 V 2 squared by 2 g. Then the friction loss half into S f 1 plus S f 2 into del x plus eddy loss, a please note that based on the quantities I can write it plus I can just simply write it plus K e alpha 2 V 2 squared minus alpha 1 V 1 squared by 2 g. This is the relationship you are going to get then just rearrange the terms.

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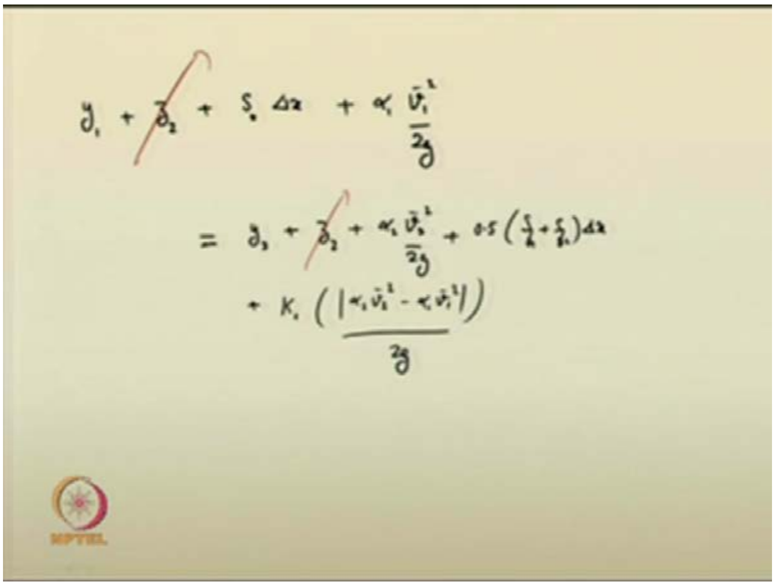

You will see that y 1 plus z 2 plus S 0 into del x plus alpha 1 V 1 squared by 2 g is equal to y 2 plus z 2 plus alpha 2 V 2 squared by 2 g plus 0.5 into S f 1 plus S f 2 into del x plus the coefficient K l into mode of alpha 2 V 2 alpha 1 V 1 squared by 2 g. So, these 2 terms gets cancelled off and as I need not further elaborate I can now easily.

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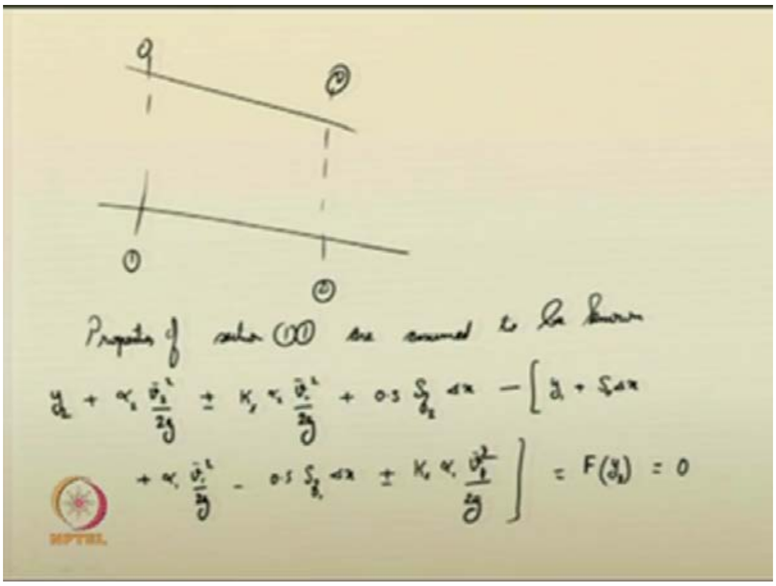

So, as you are aware that as you proceed according to the channel section. This is channel section 1 1; this is channel section 2 2, you we already mentioned as this is a step procedure. So, properties of section 1 1 are assumed to be known. So, you have to be provided by a known section first that is usually the control section for example, in the in the m 2 profile where the m 2, I hope you understand what is meant by m 2 profile.

In the m 2 profile in the upstream section the control section, section can be provided and based on that where the normal depth is there you can start evaluating the profiles that is one method. So, here whichever section that is being given as control section the properties are known to you. And the next section you are going into the next section and trying to evaluate the flow depth. Therefore, at channel section 1 1, let us consider that all the things are known. So, I can rearrange the equation y 2 by keeping all the unknown quantities on one of the sides. So, alpha 2 V 2 squared by 2 g so it can be plus or minus we are not sure based on the magnitude of the velocity plus 0.5 S f 2 into del x minus I am just writing it like this y 1 plus S 0 into del x plus alpha 1 V 1 squared by 2 g minus 0.5 S f 1 into del x plus or minus K l alpha 1 V 1 squared, V 1 squared by 2 g. Like this you can bring. That is in this equation all the things have been bought into the right hand side of the thing equation.

So, this theoretically speaking it should be some function of y 2 and for the exact function of y 2, mathematically it should be 0. Because y 1 is a known quantitative here known quantity for you here. So, all these things V 1 squared S f 1 all those things are known to you y 1 are known to you and it is not an unknown quantity. So, this entire equation is function of y 2 only y 2 is the unknown quantity here like this. We can easily write it, so f of y 2 which should be theoretically speaking it should be a zero value. So, what happens?

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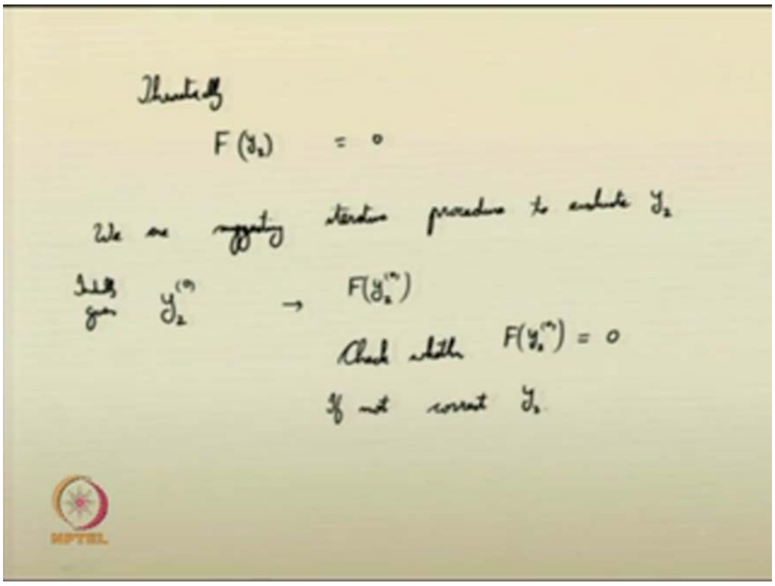

Thus theoretically F of y 2 is equal to 0. So, that means if your computation of y 2 is correct then this relationship will give you 0 f of y 2 should be 0. But how will you evaluate F of y 2 on based on what criteria? So, we have to suggest some iterative procedure, we are suggesting iterative procedure to evaluate y 2, say you are beginning say giving some initial for the y 2, some value you are giving now using this particular value of y 2, you are going to compute the function F of y 2 and all. Once you compute this thing, check whether F of y 2 and whatever guess value you have given, check whether F of y 2 is 0 is equal to 0 if not, then correct y 2. So, how will you correct them?

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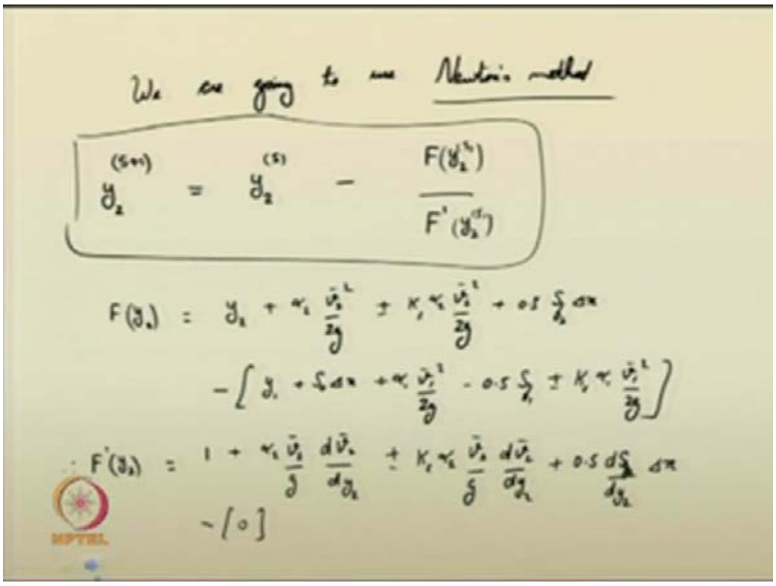

How will you correct them? We are going to use Newton's method. So, this is a very famous method so in our standard step method we are going to use Newton's method to improve the value of depth of flow. So, what is this method suggesting? It suggests that y 2 at any S plus 1 iteration this is nothing but equal to y 2 of S in the that is y 2 in the previous iteration minus F of y 2 using the S iteration value divided by the derivative of the function F of y 2 at the position y 2 is equal to y 2 of S. This is how the Newton's method works now. How are you going to write F of y 2, f of y 2 is nothing but y 2 plus alpha 2 V 2 squared by 2 g plus or minus K l alpha 2 V 2 squared by 2 g plus 0.5 S f 2 del x minus y 1 plus S 0 del x plus alpha 1 V 1 squared by 2 g minus 0.5 S f 1, then plus or minus K l alpha 1 V 1 squared by 2 g. So, whichever are there in these brackets they are known values to you. So, you do no need to worry on those things, you can easily evaluate them by the y 1 value which are you are aware of that so your F of y 2 is evaluated in this particular form F of or if it can be given in the following form F of y 2.

Therefore, F dash y 2 can be easily written as say 1 plus alpha 2 V 2 by g d V 2 by d y 2 isn't it, because you know V 2 is function of depth y y 2 that is velocity of section 2 2 is function of the depth of flow at section 2 2, similarly, plus K l alpha 2 V 2 by g d V 2 by d y 2 plus 0.5. Now you recall how using manning's equation; you have evaluated the energy slope S f or the friction slope S f. So, you can incorporate those things so you will see that energy friction slope S f is function of the depth of flow y. Therefore, this quantity can be written as 0.5 into the derivative of S f 2 with respect to y 2 into del x minus whatever these quantities are there in the bracket do you think they are function of y 2 they are not so minus 0. So, this is how you evaluate f dash of y 2?

So, using these expressions you use substitute them in Newton's method improve on the iteration. You can start say whatever value of whatever depth you had you have been provided for this section 1 1, you can give them as an initial guess for depth y 2 and start the iteration, this due to this particular form formation of whatever formula is there your iterative process will converge or it will improve the value of y 2. And you can continue the iteration till y 2 gets converged to a particular value. So I can suggest that.

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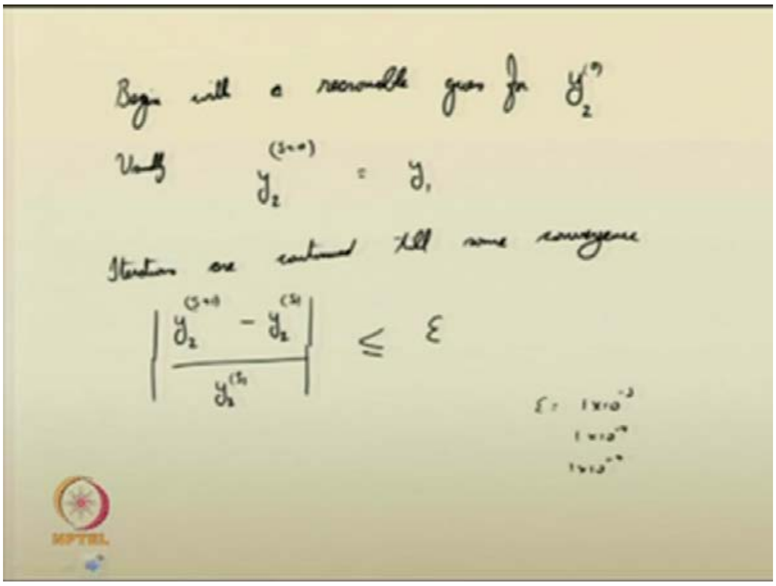

So, begin with a reasonable guess for y 2 at the iteration number 0. You begin with a reasonable guess usually y 2 for the iteration number 0 is taken same as the known value y 1. So, you continue the iterations, iterations are continued till some convergence is achieved. For example the convergence criteria can be given as y 2 in the S plus 1 iteration minus y 2 in the S iteration modular. We are taking the mode only y 2 in the S iteration should be less than or equal to some convergence criteria value given, say epsilon it can be 1 into 10 to the power minus 3 or it can be 1 into 10 to the power minus 4 or it can be 1 into 10 to the power minus 2 whichever problem according to the type of problem and all. It has to be appropriately used or that is so that your computations are not getting exceeded too much. So, based on this particular formulation we are just going to continue or we are going to do I am not going to extensively demonstrate the problem. The problem you had done for the direct step method.

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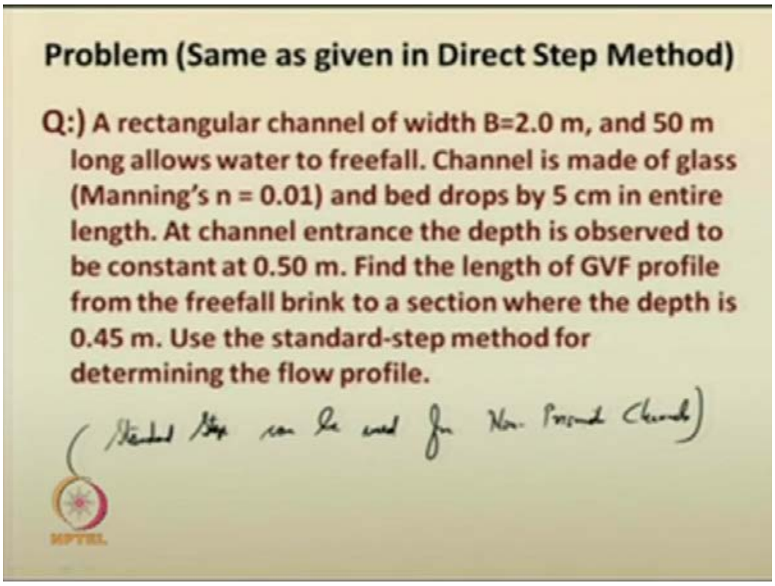

In the direct step method, we had given you the same problem. If you recall them we had suggested a rectangular channel of width 2 meter and 50 meter long allows water to freefall. The channel is made of glass and the bed drops by 5 centimetres in the entire length. So, at the channel entrance the depth is observed to be 0.5 meter. We have asked you to find the length of the gradually varied flow profile from the freefall brink to a section where the depth is 0.45 meter. So, here you use the standard step method for determining the flow profile. So, please note that the standard step method can be used for non prismatic channels here. We have given you a prismatic channel just to demonstrate the computations. You can use non prismatic channels also if you have some problem or if you have some readymade problems with you already there for many rivers in India.

You can evaluate these; you can use this method this particular method direct step method, standard step method to evaluate the flow or evaluate the profile. So, there are many standard softwares also that use the standard step method for example, heck r S and all. They use these methods for evaluating the profiles so we are for the demonstration purpose we are using a prismatic channel here.

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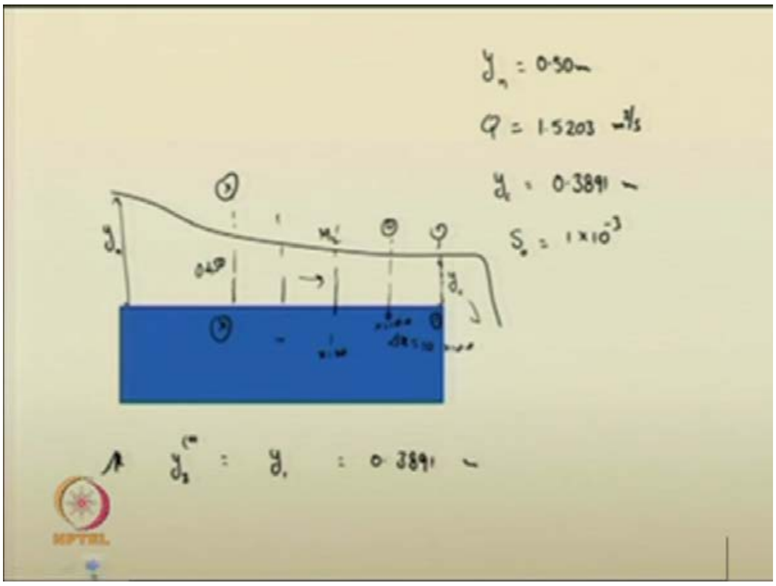

So, if you recall so this is the freefall, this is the brink, this is the brink and at the brink if you recall it should be a critical flow. This is the normal depth of the flow at the channel entrance. So, normal depth it is already given to you as 0.5 meter critical depth. You had evaluated the discharge; I am not going to compute it again at that time. You had evaluated the discharge as 1.5203 meter cube per second.

Subsequently, you evaluated the critical depth as 0.3891 meter there, then you came to know that this is an m 2 profile isn't it. You had also evaluated the bed slope to be as S 0 is equal to 10 to the power of minus 3 in this particular case. So, the flow is in this direction. Now from the brink this is your brink. So, this can be considered as channel section 1 1. You can go now into the upstream and find the location or find the section find the section x x. Let me suggest it as section x x we do not know which at which is this we are at how many or how far is this section x x from the brink. We are not aware of that, but the question is we have to evaluate this or find this section where the depth of the flow is 0.450 meter, that is the question.

So, how can you do these things? You can start from here; you can divide this entire portion say of 10 meters of 7 meters or 8 meters 7.5 meters like this. You can just divide these things say del x is equal to 5 meters or let me see in the table which I have given 10 meters. So, del x is equal to 10 meters. So, here x is equal to 0 0 here x is equal to 10 here x is equal to 20 like that just go on. So, we do not know at which location is the 0.45

meter depth is available. So, you proceed it in this way 10 20 30, try to evaluate the things. So, when you go for this section 2 2 you know the properties at section 1 1. So, y 2 in the 0th iteration is taken as y 1 which is the critical depth 0.3891 meter.

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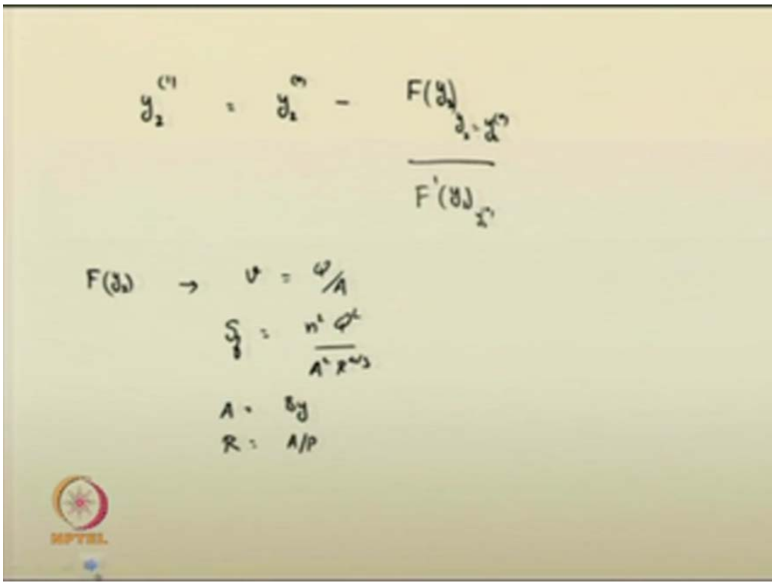

Then you will be using the relationship y 2 in the first iteration, this is equal to y 2 in the 0th iteration minus the function y 2 that has to be evaluated at y 2 is equal to y 2 at 0 divided by the derivative of the function f of y 2 at the location y 2 0. So, how will you evaluate this function, for the function f of y 2? You require the velocity which is given by Q by a this you have to evaluate, you have to evaluate the energy slope, now friction slope that is given by n squared Q squared by a squared R to the power of 4 by 3 A. You have to evaluate B into y r; you have to evaluate as A by P, on evaluating these for each value of y 2 each iterative value of y 2 you will be getting the corresponding iterative terms of F of y 2. You can have the corresponding derivative term F dash y 2 substitute them like that you are going to evaluate them.

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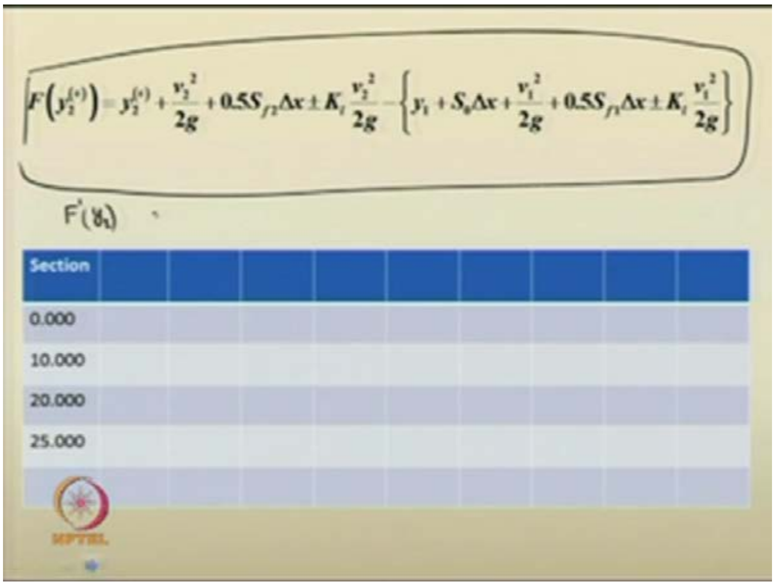

So, here for each section say I am taking section 1 at 0 0 section 2 at 10 meters from the brink; section 3 at 20 meters from the brink; section 4 at 25 meters from the brink like that you can just think. So, F of y 2 at any iteration it can be given the following form you see here F of y 2 at any iteration f is equal to y 2 of S plus V 2 squared by 2 g plus 0.5 S F 2 del x plus or minus K l V 2 squared by 2 g minus. Subsequently, the all other terms, these are self explanatory you can evaluate the corresponding quantities from this what is F dash y 2 that can be easily identified isn't it. So, we have already shown you how to find f dash y 2.

So, you can complete this problem now as a homework, because we have in extensively explained to you the direct step method as well as the Runge Kutta method how the computations can be done now at this stage you should be ready to do we have given you the step how to evaluate the thing you use them try to compute the depth of profiles for these sections using a iterative procedure. So, F dash y 2 is given to you. So, we will be proceeding in this particular form, you can you can compute or you can calculate the depths you can do it as an homework and submit to us later. So, the next thing next topic which we are going to deal is the spatially varied flow.

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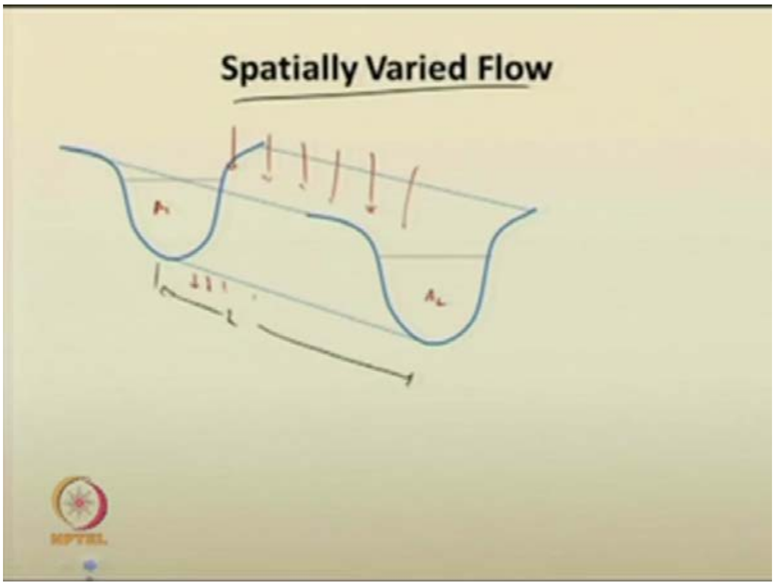

So, you have to understand what is meant by spatially varied flow? What is spatially varied flow? It is a type of non uniform discharge that occurs in the channel due to the addition or deduction of water from the reach of the channels, say in this non prismatic channel if this is a reach of a channel that we are taking into consideration between this reach. If certain quantities of water if they are added, if they are added into the thing, then the discharge of the discharge from this section will be higher compared to this section isn’t it. So, that is causing means that is causing changes in the flow. Therefore, it is called as spatially varied flow. Similarly, if you are deducting water from this reach, then the discharge at this section A 1 and this section at A 2, both are different. They are also called spatially varied flow. So, spatially varied flow why we have to deal it separately compared to gradually varied flow? Why we have to deal it separately?

Due to the addition of water or deduction of water there will be much change in the energy or the energy and momentum are getting changed. So, you have to already use those correction factors not only that, you have to employ certain principles so that as a discharge is not uniform you cannot directly use whatever principles are used for gradually varied flow in such cases.

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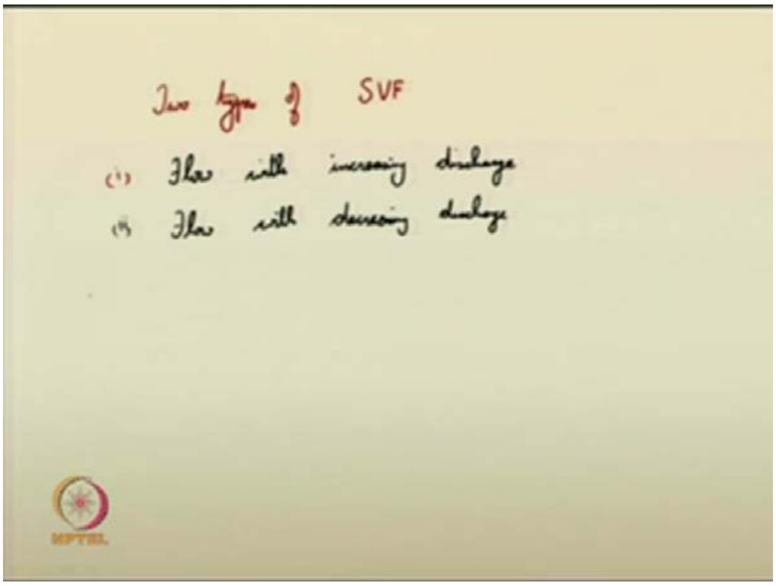

There are 2 types of, there are 2 types of spatially varied flow, I can give it in short form SVF. So, those are flow with increasing discharge, so within the reach the discharge is getting increased, say it is getting increased due to addition of water. So, the discharge here will be more compared to section A 1, and then the next one is flow with decreasing discharge. So these 2 principles these 2 types are already present now. What happens a flow with increasing discharge? As you have noted in the previous standard step methods for non prismatic channels and all you have to incorporate eddy losses.

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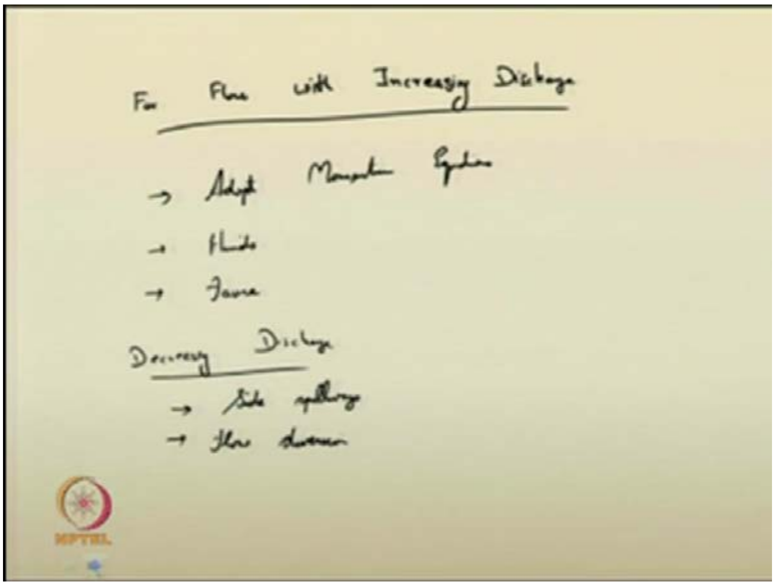

Similarly, for flow with increasing discharge for flow with increasing discharge water from 1 side or 1 particular this thing if of, if water is flowing through a particular channel. And if other discharges are coming into that due to the mixing there will be turbulent action. So, turbulent mixings will be going on that may create high energy losses means the energy that is the energy differences will be there in such situations. So, those things need to be incorporated. And you may see that especially for flow with increasing discharge. It is very much difficult to use the energy equation for solving the problem.

So therefore, we normally adopt momentum equations for flow with increasing discharges. So, scientist Heinz had developed one of the first fundamental differential equation for spatially varied flow. Later on scientist Favre had developed by incorporating certain friction terms and component of velocity terms in the axial direction, so as to develop the differential equations, governing differential equations for spatially varied flow. For decreasing discharge for the decreasing discharge, you will see that they are mainly used for diversion flow problems where the flow diversions are required especially in dams, where you need to divert water to a particular canal and all for such situations they are used.

In such problems you will see the energy loss is not that much or it is not that much significant where it cannot be applied. So you can still use the energy principles for solving flow having decreasing discharge. So, they are used for sides spillways or flow diversion problems and all.

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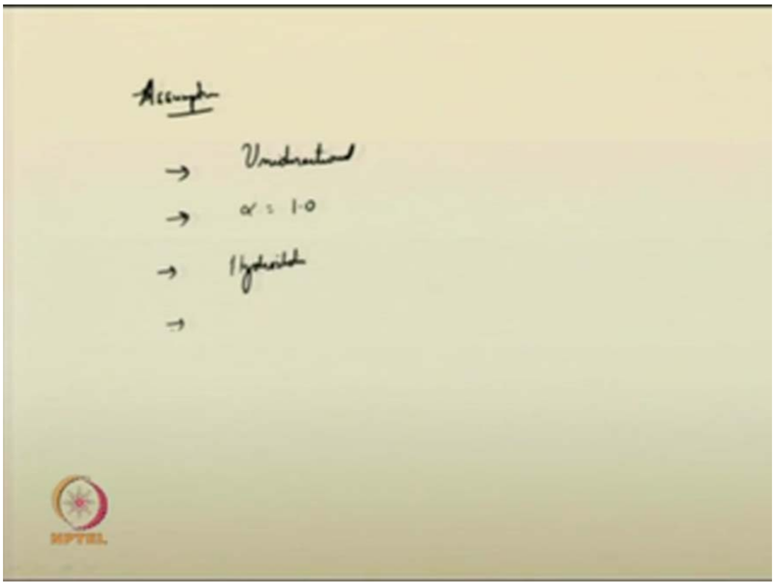

So next class, we will be deriving the spatially varied flow dynamic equations for that some of the assumptions are; some of the assumptions to derive spatially dynamic equation, dynamic equation for spatially varied flow, we consider flow as unidirectional. So, in this age of computation fluid dynamics, where you can solve for all the 3 directions or n directions, this unidirectional is not much significant but, still we can apply them, so that the computations can be reduced.

The velocity distribution is taken as uniform across the channel section that is you incorporate the velocity correction factor as 1 in the channel cross sections pressure is hydrostatic, hydrostatic pressure condition as in other flows, then the slope of the channel is relatively small manning’s formula is used for evaluating friction slope and friction loss also the air entrapment or entrainment in the channel they are not being incorporated in the analyses. So, these assumptions are required when we derive the dynamic equation in the next class. So, based on the following things we, we have discussed, we can have a simple quiz today.

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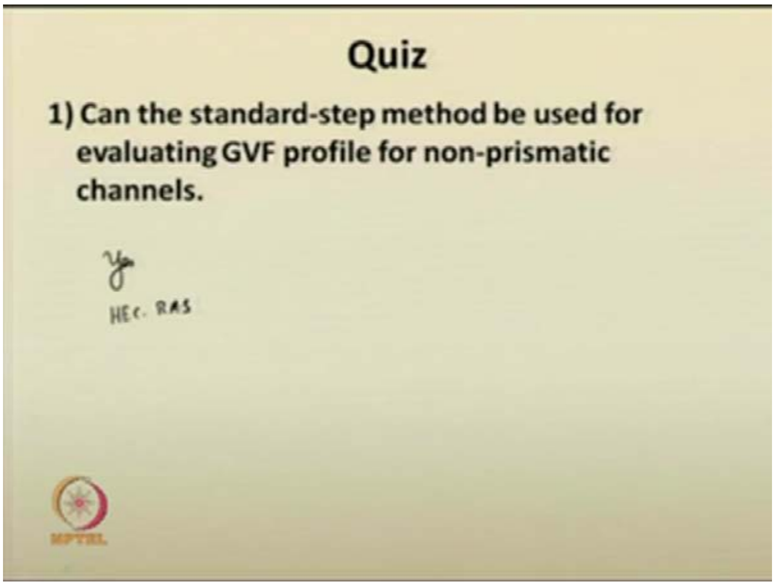

The first question which I would like to ask to you is "Can the standard step method be used for evaluating gradually varied flow profile for non prismatic channels?" Can the standard step method be used for evaluating GVF profile for non prismatic channels? You can give the answer in a simple way.

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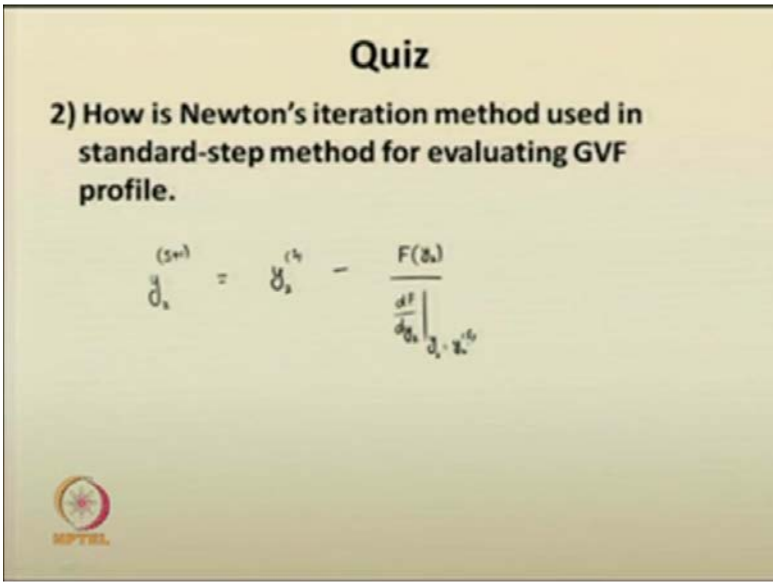

Your second question "How is Newton's iteration methods used in standard step method for evaluating GVF profile". Newton's method you should know; you should be aware that it is not only related to open channel hydraulics. So, you have to tell how that method can be used here?

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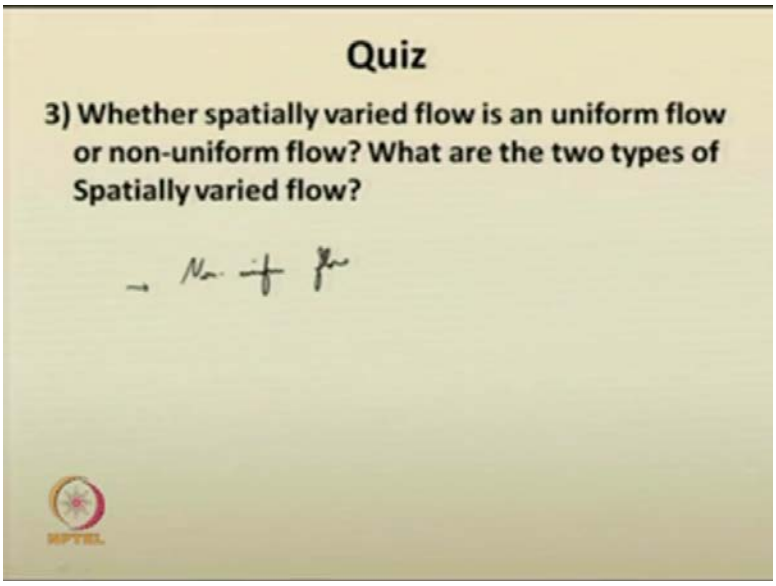

Your third question “Whether the spatially varied flow is an uniform flow or non uniform flow? What are the 2 types of spatially varied flow? Yes, you can use the standard step method for evaluating gradually varied flow profile for non prismatic channels. In fact, this is the best method for evaluating GVF profiles, many standard software’s like HEC, RAS and all they use standard step method for evaluating profiles, how is Newton’s iteration method used in standard step method for evaluating g V f profile?

Newton’s iterative method as it is being suggested it gives improvement for the various iterations. So, it can be given as in the previous iteration, whatever value is there by some function of y 2 divided by d F by d y 2 at y 2 is equal to y 2 of S, like this you can write it. So Newton’s procedure can be used for any function and these things we are using in our open channel hydraulics for evaluating gradually varied flow profile.

So, whether spatially varied flow in an uniform flow or non uniform flow, what are the 2 types of spatially varied flow? Spatially varied flow, it is a non uniform flow. So, this is a non uniform flow, why this is a non uniform flow is, because your channel properties it can change or not only that the discharge is getting increased or it is getting decreased. Therefore, based on discharge also it is a non uniform; non uniform conditions prevailed in that. So, it is entirely a non uniform flow. The 2 types are spatially varied flow due to increase in discharge and spatially varied flow due to decrease in discharge. These are the 2 types of spatially varied flow available in general. So, the equations or the principles related to that we will be dealing in the next class, that way today we conclude our lecture.

Thank you.