Hydraulics

Dr. Arup Kumar Sarma

Department Of Civil Engineering

Indian Institute of Technology, Guwahati

Module No. #01

Introduction to open channel flow

Lecture No. #01

Introduction to Hydraulics

We in hydraulics, particularly emphasis on the water; of course, it does not mean that only we are talking about the water, orderly cools are also dealt in hydraulics. Then what is the aim of hydraulic engineering? The hydraulic engineering aims at if you go systematically, and in the step by step way, then we can say that understanding the physical processes of fluid flow analytically and empirically.

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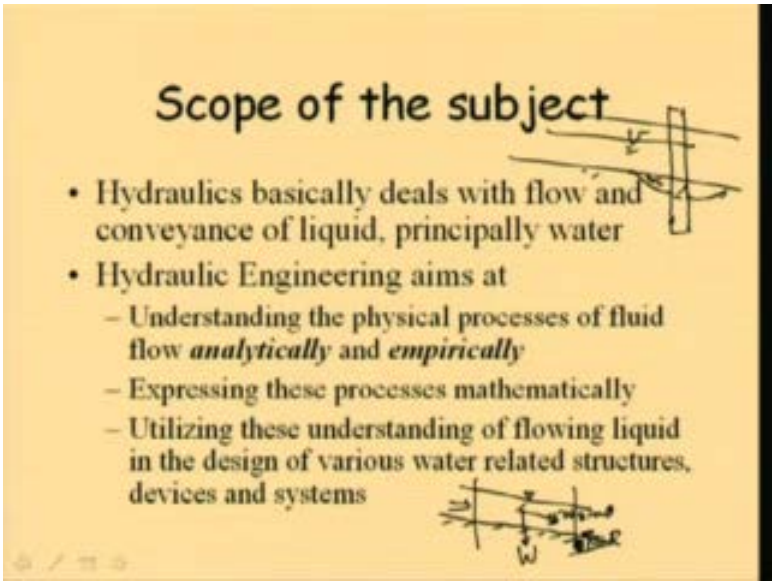

Now, what we mean by analytically and empirically? First, we need to understand, what is the physical processes; and for understanding the physical processes involves in hydraulics, one must have the very basic background of physics. Say, for example, if you consider a stream, say flowing like this; the stream is like this, it has some water, and say this stream has some background, well and indeed an water is flowing like this. Then

what force is basically, making the water to flow in this direction; water is flowing in this direction, well; the force means the weight of the fluid is there, and because of the weight of the flow fluid, there is component of this particular weight in the direction of the flow.

So, the force that is guiding the flow or there is driving a flow in this direction is the component of the gravitational weight of the fluid, in the direction of the flow. And then when something is moving, there will always be the resistance offering to the movement, that is the weight of the stream, then sight that is the bank of the stream from all the side, there will be resistance force that we can show like this; there is a some resistance force acting from the opposite direction. Now, when we talk about how we will understand analytically a flow, we can say that when the things are moving in equilibrium, then the force acting in the direction of flow, and the force resisting the flow are in balanced position.

So, that way this is a very simple and very preliminary concept, I am just trying to explain what we mean by analytical understanding of the physical processes. Then of course, some of the things may be very, very complex; and we may not be in a position to explain each and every physical process involved in the whole phenomenon right. Now for that situation, sometimes it happen that we need to take recourse to some observation; we need to understand the process empirically, maybe we have to take the a recourse to the lab, laboratory experiment or we may have to take the recourse to some of the practical field observation.

Say, if I talk about a water again flowing, let us the water is flowing here; and suppose it is a river, and we are putting a say pile, say wooden pile putting here for some purpose. Then, the flowing water when it will be passing through or passing around this pile, there will be different type of flow formation here, which will cause the bed; and if this bed is suppose alluvial bed, sandy bed, then it may cause the bed to erode out, and ultimately after sometimes you may find , the bed is becoming like this, what we call as scouring. Now, the process of scouring how much will be the scouring drift, all these depends on various factor like what is the size of the sediment, then what was the flow velocity, then what is the drift of flow? So the drift of flow is this much, if the drift of flow is higher, then again this factor will be different; if the sediment type is different that is the bed material by which the channel has been formed is different, then again our inter

processes is changing; if the water is flowing to high velocity, if it is in a steep slope, whether it is a flat slope, all these influences this particular processes.

And that is why, in this sort of things, all though we understand the phenomenon to some extent, it may difficult for us to getting a full understanding of the entire process; and then, we need to know what is going on, so that we do through some experimental observation or by some field observation; we can have several feel experienced which as and we can see at this step, how much is the scouring, at these velocity how much is the scouring velocity; for this type of soil, how much is the scouring; and those things, we can assimulate in laboratory also physical laboratory, and through those physical modeling we can understand what the process is.

So, that way we should first understand the physical processes of the fluid flow that is why physical processes, we need to understand analytically as well as empirically. Now once we have understood physical process, the next step will be to express these physical process mathematically; well when we talk about mathematical expression of the physical process, say now here if I say we consider one steep of the I mean, one segment of the stream, and say this water, this portion of water having some weight w, and then if these channel has angle theta, then this component that which is acting at this direction of flow will be say w sin theta that is what weight multiplied by sin theta sin component of the weight and the resistance force again we can derive by some means right.

Righ now, I do not want to go into the detail of that. And t then when will be equating this to will be getting a governing equation, which defined when the flow is moving in equilibrium, then we can equate these two, and that will lead to some governing equation. So, that way this is a simple situation. Now for complex and complex flow, we can express the physical process mathematically, then we get some governing equations and these governing equations and define our flow phenomenon, we can then (( )) various problems that are related to hydraulics. We can apply mathematics, and we can have better understanding of the processes.

Well now, we are doing these things, what is we are trying to understand what the physical process is well; we are trying to understand what the mathematics of that physical process; basic intension is that our objective is to do something for the benefit of the mankind definitely we are all working for that. Now so, next step is initializing

these understandings for the design of various water related structures, and not only structures water related structures and devices, and say different water system, like say (( )) or different sort of systems it can be.

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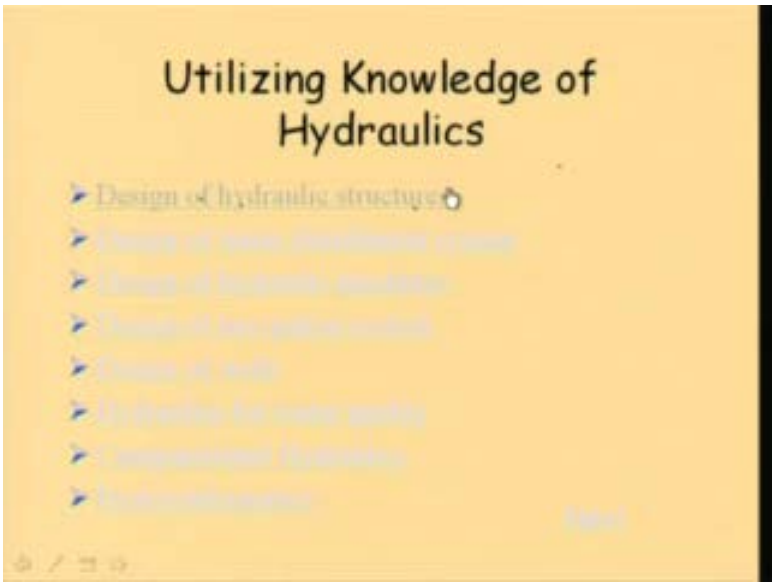

Saying so, to go more detail into what sort of application we can have in hydraulic engineering. There you can see that we talk about design of hydraulic structure, what sort of design structure we are talking about, well. So, when we say about utilizing this knowledge of hydraulics in different aspects that is considered first that we are utilizing our knowledge for constructing various hydraulics structures.

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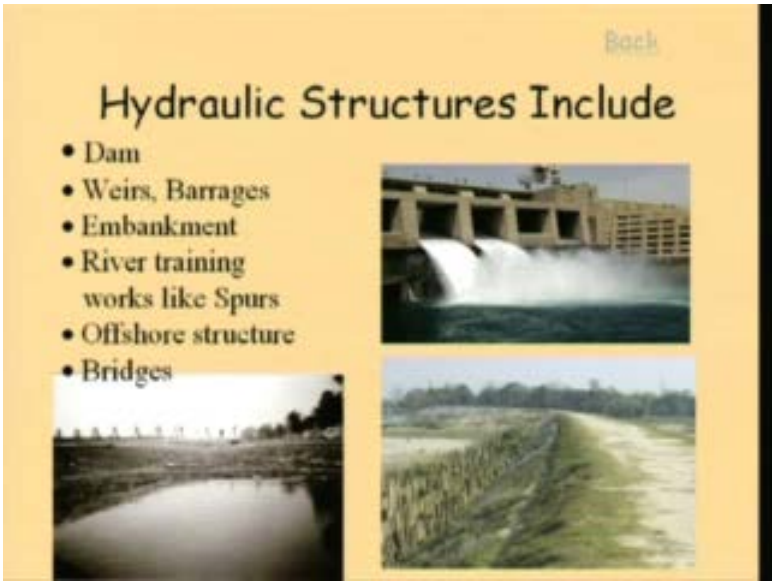

Now, by hydraulic structure what we mean that it can be dam, so all of you know about dam that is not a problem; all we have seen the utility of time. Then it can weir, barrages different sort of things like where we do not store water, and rather we just keep a ponding ponding on the upstream of the weir, and then we release it, and then in barrages, the gate section on its little higher like that different structure hydraulic structure we construct. And then at embankment, as you can see here, this is one river embankment that we construct for preventing the flood water to move into the village area. Like that then we can have other short of reverting involved like spurs, well many times people suffer due to flood and erosion.

And when suppose the water is going very near to the river bank, and causing lot of erosion and that is leading to devastation. Then we tried to put some hydraulic structure, one may be a spur, by which we tried to just force the water or try to deviate the direction of the water away from the river bank. So that it can be protected from the, this bank can be protected from the erosion. Then sometimes suppose the channel is very near to the bank then we tried to put some other structures; like that here I am showing one percu point screen like that, some other bamboo screen can be leak, and all that sort of screen, we try to put, by which we try to promote sedimentation, and try to soak the channel. So that will all these channels we try, and how do you these are will perform how this will perform really that we need to understand.

So, we need to understand the physical processes, we need to understand the physical processes means, we need to understand the hydraulics of that, then sometimes we need to modeling; so knowledge of hydraulics is very, very essential for all those aspect. Then, we talk about offshore structures similar, in the sea I mean, what I am talking about in the sea also we have different type of structures. Now people are constructing even in Airport in sea's then small structures are always there, and that on the sea shore, so that sort structure we need to construct, and there also knowledge of hydraulics is very, very important; and bridges when you are constructing bridges particularly, the sub structure of bridges, when you talk about that the hydraulic phenomenon, as I was just explaining that scouring, how much will be the scouring in the bridges.

If you construct a bridges, which appears that is supporting the bridges, and if that sphere fails to enter, then the bridges fails; and so we need to understand the hydraulics that is going in the river, on which we are constructing a bridges. So, that way in all those different structures, these are not of course, the only structures there can be lot other hydraulic structure, I am just giving you some example that and in all those hydraulic structures, we need to know that basic principles or knowledge of hydraulics; and that why it is important. Then let us see, another devices that we talk about design of water distribution system.

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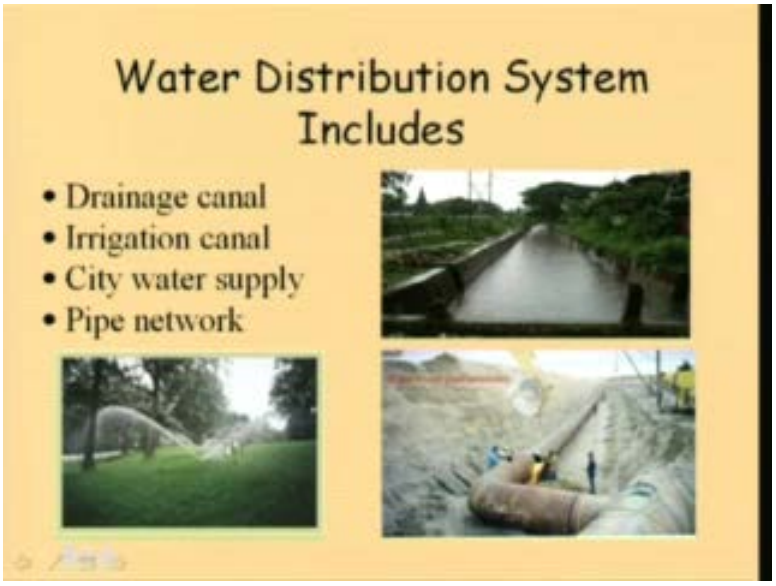

What do mean by water design of distribution system? Now in irrigation, we can have irrigation canal, then similarly sometimes from area, we need to drain out the water in city also, we need to drain out the water that is the storm water that is coming. So we need in drainage canal. So, it can be drainage canal for that say in a city, there will be a network of drainage canal; and in city water supply, when we talk about we need to supply the water to the various part or the area or the city; may be through pipe. Then all those city water supply, it will lead to a distribution system; and that we use sometimes pipe network.

Now, when we are using a pipe network, a pipe may be coming from a reservoir, which is at a higher elevation; now this pipe will be carrying water to certain distance; now whether it will be I mean, there will be some loss, I will be coming to depth on later. But in all those different aspects of designing water distribution system, we need the knowledge of hydraulics, and this is another example that I am showing here, you can see that it has been used say for irrigation purpose, there is a pipe from which the water is just spreading into the area where some say agriculture is going on, and that sort of how how much distance we want to spread it, depending on all those aspects. We need to design this particular system, and there also we need to know the knowledge of hydraulics.

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Well, then when we talk about say design of hydraulic machine that is also very, very important. Now, design of hydraulic machine that again can include say pumps, turbine, then hydraulic press; like that, here you can see one turbine, one turbine and turbine is very familiar known to almost all of us now. And this is how to design a turbine. Now sometimes in some cases, we may have more water in our hand, but the water that is falling from what height to the turbine may be less. In some case, we may have less amount of water, but that less amount of water is falling from a very high height. So, that way this depending on those things to design different type of turbine, they need to design different type of turbine well. And what type of turbine will be best suits for what situation to know that we need to understand the very basics of hydraulics.

Similarly, the pumps sometimes, we need pumps to lift the water to very high elevation, sometimes we need pumps to lift the water not to very high elevation, but we need a large amount of water to be lifted. Now, depending on all those streams, on all those different needs the pump required for us will be different; and that is why to decide and to design a required pump for our required objective, we need to know the very basic fundamentals of hydraulics. And apart from this very well known equipment like this turbine and pump, we have some other hydraulic machine like hydraulic press. So, well right now, I do not want to go into detail of these aspects, but what I want to emphasize that for design of different hydraulic machine, we need to know the very basics of hydraulics. Well, then again design of navigation system, for that purposes also, we need to know the hydraulic fundamentals.

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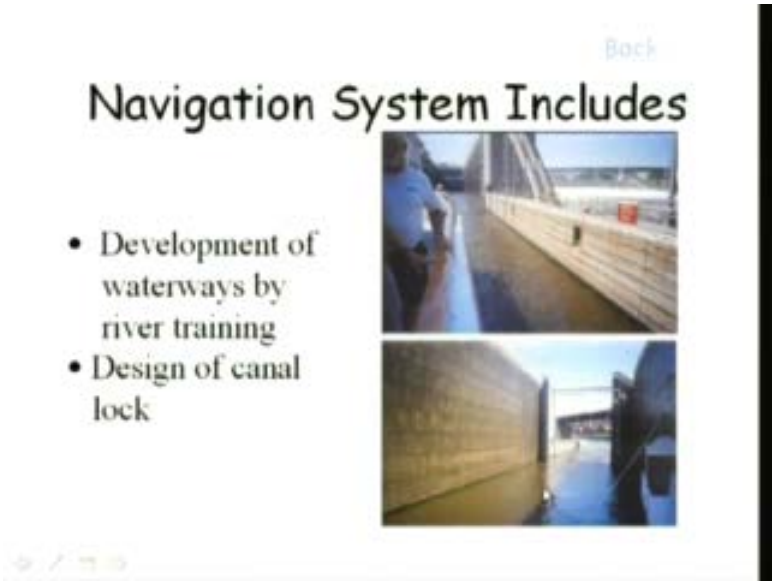

Now, see there are different need can be there in the design of navigation system; for example, sometimes we can have a river, which is having a steep slope in a particular region; like that this river is flowing from here, and it has a steep slope here, this is the Mississippi river, and then our ship need to travel from this side to that side; now how it will just travel, through this slope it cannot come down. So, what we need to do? We need to put some devices that we call as a canal law, that you call it as a canal law; that means, by putting the canal law, what we can do? We can close the first there will be a gate on this side, and on other side also there will be a gate, so these gate we can close first; and we can allow the water to flow here, and because this gate is closed. So, the water level in this part will be rising at some time, and the water level here will be becoming in the level of this particular higher side; and then the seed can enter through the gate here, which is open.

Now once it is open here, you can open the gate, and then this water will gradually of course, before opening the gate, you need to have devices through which we will allow the water to move out from these canal to some other direction. And then water level has come down, you open the gate, then you are on the lower side lower elevation, which sees equal to the elevation here; on the lower side of the stream that is the downward of the stream, and then you can move swiftly from these, your seat can move safely from this lower elevation to meet the downstream part of the stream.

So, way in designing this sort of canal law, we need to know the very basics of hydraulics well sometimes again we find that in river breaded channel I mean, where lot of sands sort are there, which is not uniform like that sort of river like Brahmaputra that we get you drift required for this to move, you may not get it in all part of the river; sometimes we are finding that well the drift required here is not sufficient. So, we divert the water from other part of the channel to that side that it takes an action in putting like some benzelene, we avoid the water, we promote the scouring at this point; and that we try to create a water so for doing all those activities, you need to know the basics of hydraulics.

Then another aspect that we are talked about till now, this is a design of well right now what we are talking about all on the surface of the water I mean, surface of the (( )) we are talking about the water existing on the surface of the m water remain there in the under the arch as ground water.

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And for many of our wall, we need to have it is ground water we go for pumping the water out to the surface for our defend uses; and (( )) we need to design some equal, we need to know that we were suppose to need a particular amount of water in a particular time, then we need to know that if this is the well size, then we can get that amount of water now at what date, we can get all those things, we use to know and say well system is required for drawing ground water for various purposes.

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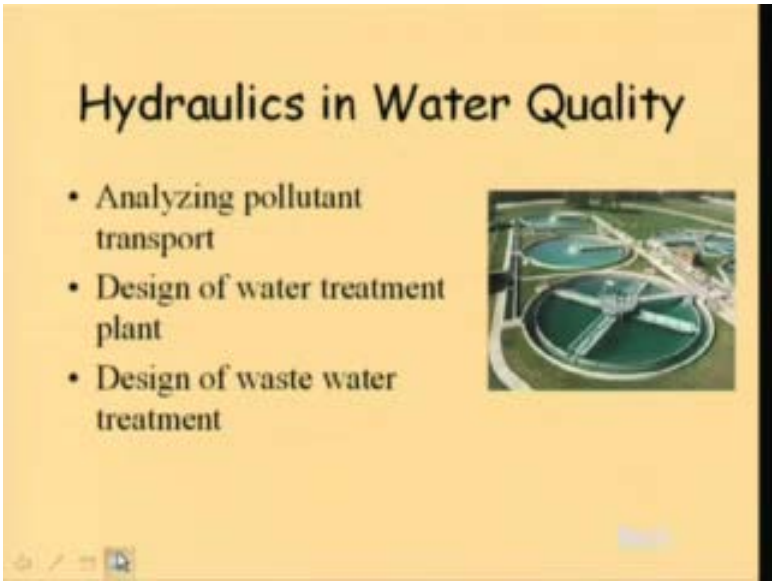

Such as if you say such as so domestic use including drinking, irrigation and agricultural area, we need to, we need water for that purpose also, and sometimes we need water, we need to draw water other for other purposes like when in a area, you would drawing water is the very high level that is very nearer to odd surface, then also there are many problem that crops are not growing, because the crop to grow it leads a as well as water if all entire area is full of water, then all set of crops cannot grow there. And in those situations, we need to pump under water for making this area free from water that is the… So in the water logging problem, d water that we call so for all these different activities, the knowledge of ground water hydraulics is very, very important, well.

Then now we talk about hydraulics for water quality, till now we were talking about various aspect of hydraulics in the quantitative way that the quality of water is also very, very important. And in the quality of water, in understanding the quality of the water, the use of hydraulics is very, very essential; say for analyzing pollutant transport, we need to know hydraulics how suppose well, I would like to give you one example from the surface water say, a city is there, and just on the side of the city, one revels there and lot of collision that is coming off from the city, where releasing two a particular point in to do a refer; now duct pollutant will be travelling with the water to downstream of that particular rework.

Now when it is travelling downstream gradually, its pollutant will be mixing up with the water and concentration of the pollution will gradually decrease downstream. Now you assume that the downstream may be is a 1 kilometer downstream or 2 kilometer downstream from that particular point, you have another index structure from huge, you are taking water for the you for utilizing for different domestic use of course, you may have a treatment plane to which you are carrying the water from then downstream point, and then you might be distributing, but that intake water or input water, what you are give in to the treatment plant is also important, And we were to know that fader the water we had collecting will be of the proper quality of other it is pollution free; how much pollutant is there; what is the pollutant pollutant there; what is the concentration of pollutant there.

And those you need to know that is when you note at concentration of pollution at upstream point, how it will dispose, and what will be the concentration at a downstream point, we need to know, then we need to know the hydraulics of water, how it will mix up if how to mix up with water, and how gradually this concentration will come down so that is, then again when some… We are talking about this thing, then when we talk about ah the, suppose what are treatment plane there also we use different devices for treating the water, we put some chemical for mixing the mixing that with water, and we try to just remove the pollutant from that water.

Now for all those posses also knowledge of hydraulics become essential, and of course we are talking about say your listen water or your polluting a particular point in a water to minimize there to minimize the pollution, you go for waste water treatment; that waste water that is coming from a city, we try to treat it, and then we try to release it apart from I did not knowledge of environmental engineering, the knowledge of hydraulics is also important there various very basic fundamental knowledge of hydraulics is also essential; and designing all these different component of this sort of treatment plane, waste water treatment plane, water treatment plane and all these sort of other activities, well.

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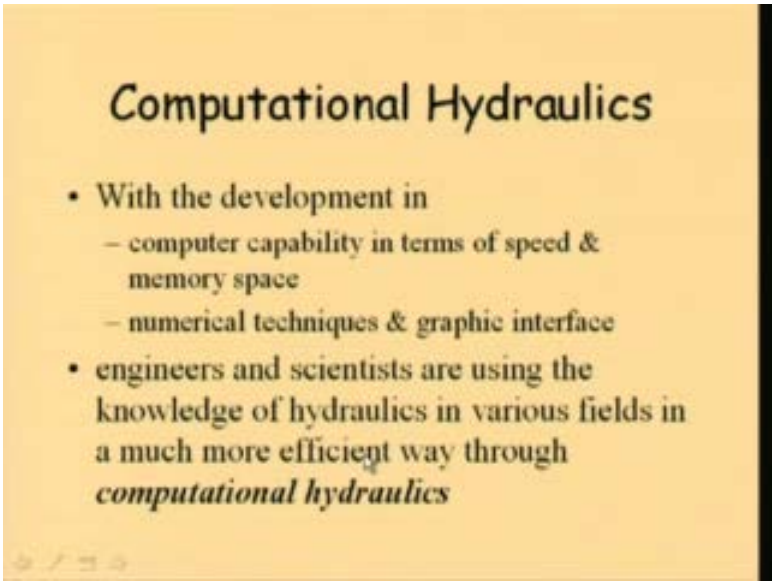

Then we can have now this say computational hydraulics is becoming a very, very important of peak and advanced of peak through, who each you can do lot of work say with the development in the computer capability in terms of speed and memory space. Now, we have a very big computer, big computer may size is small, but we are having lot of memory space there, then the speed of the computer is very fast, so that's what of advantages we are having n; also parallely the numerical techniques and the graphical interface, all these things are in proving and all this improvement has encourage the engineers and scientist for using the knowledge of hydraulics well the computational hydraulics.

So by computational hydraulics, what do we mean that it is now gaining popularity day by day that because the computed capability is increasing by computed capability, what do you mean that it is increasing in terms of its speed and memory space that is available, and then the different numerical techniques, I also in proving and the graphical interfaces also increasing. So now we can have different models and by introducing our advance computer, and advance computing technique various problems of hydraulics can be solved; once you know the once you know the very basic knowledge of the hydraulics of course, we need to work under and just I want to emphasize this particular respect by one example.

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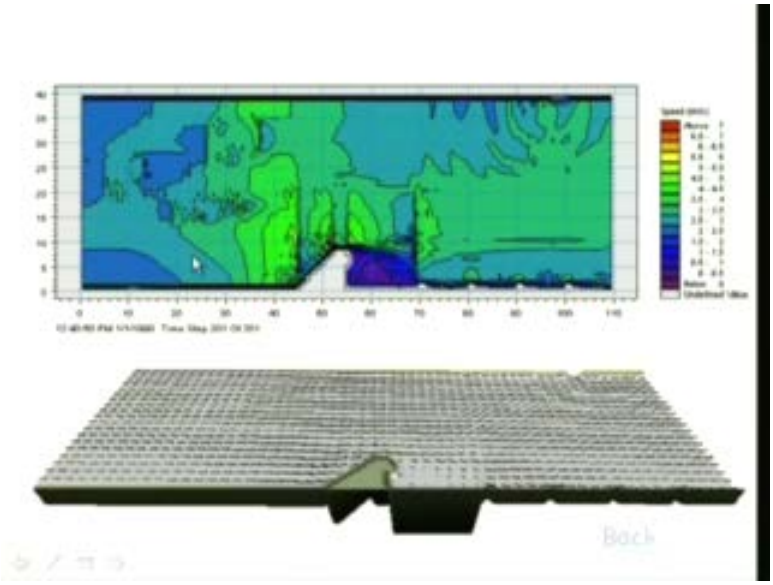

That is say this is a problem, what I am assuming that in a river in a river say, that is a evoke, and site of the river, and when the water flows then what is… What happens that it is moving like these, when the… is there on the site, it is a pan view.

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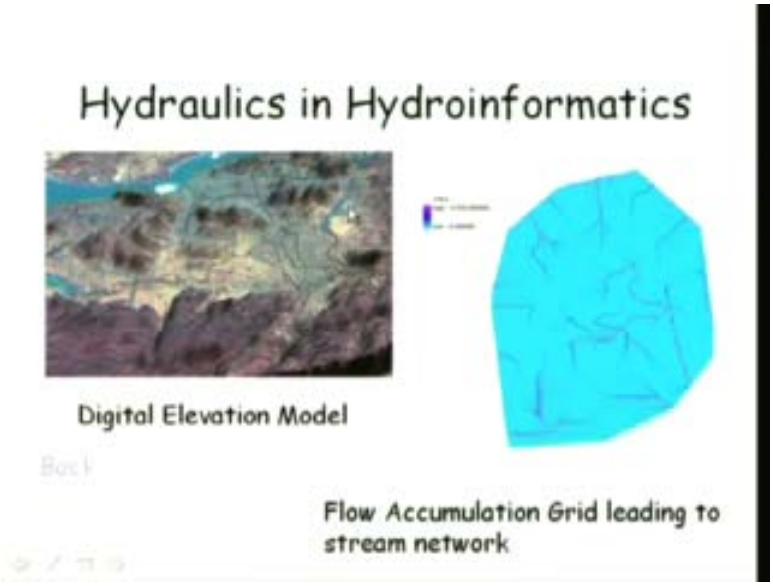

So when is just getting extended into the river, when water the flowing it will be moving like that sorry it will be moving like that, and it is coming like that; so these sort of circulating current, we may get; and that may cause follow that causes erosion in the bank, it depends on of course, soil quality on all these things that if soil quality is to use

one dam, it causes erosion, and then we need to provide solution to there. So when we have the basic knowledge of hydraulics, what we can do? We can go for model study of that, and then we can understand that we can provide spares like this that we are placing here.

And when we place the spares, how the velocity is changing; again see that this different colors are showing different velocity, and then the modeling, we can see that how the velocity changing in different area; then here the area is showing that how the flow is moving that turning about, and then this we we can so various problems of hydraulics engineering. This is as to one example that we computation on hydraulics is coming in a very big way, and very basic knowledge of hydraulics is essential another topic the hydro informatics, when in hydro informatics also this is becoming now very, very popular with the development of say geographical information system, and with the development in remote sensing technique, and at the same time, with development of some other devices like global positioning system says going to a particular place you know, what is your location in trans of that issued and so one all these things are coming up.

Now you can utilize all these things to develop see a digital elevation model of particular area combining all these things, and then once you develop the digital elevation model this is a area for the city and this is the river brahmaputra like that. And so once you have this digital elevation model, then from that if you have the basic knowledge of hydraulics you can utilized at and you can find out, there is a way that we can develop a flow accumulation grid, which lead to the stream network that we can have the stream network of that area by a plain some capability of g i's, we can apply there, and of course in developing these things very basic knowledge of hydraulics is required.

So s has what we have seen that knowledge of hydraulics is required for various purpose is and once we have this knowledge, we can utilized this knowledge for benefit at the mankind through different uses of course this a not limited to these uses on the what I have said here but it is I mean, it can be applied to many other field it can be applied to many other field of course, as you have seen the scope of hydraulic engineering s as is very vast, it is very vast and the course this particular course hydraulics, what will be taking up it may not be possible definitely, it will not be possible to go into detail of all these different topic, and so what will be studying in this particular course that let us discuss before going into the actual courses.

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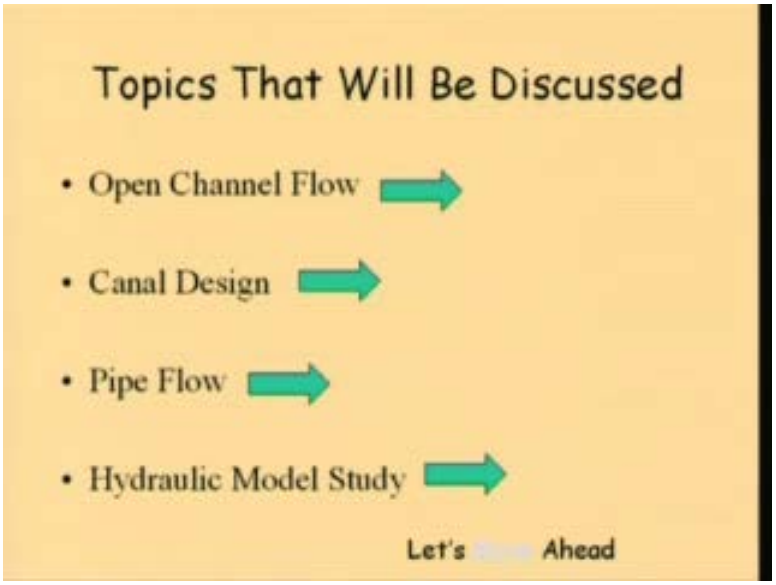

The topic that will be discussed in this particular course are thus in broadly, we can divide it in to this type that is one is that open channel flow, then canal design pipe flow.

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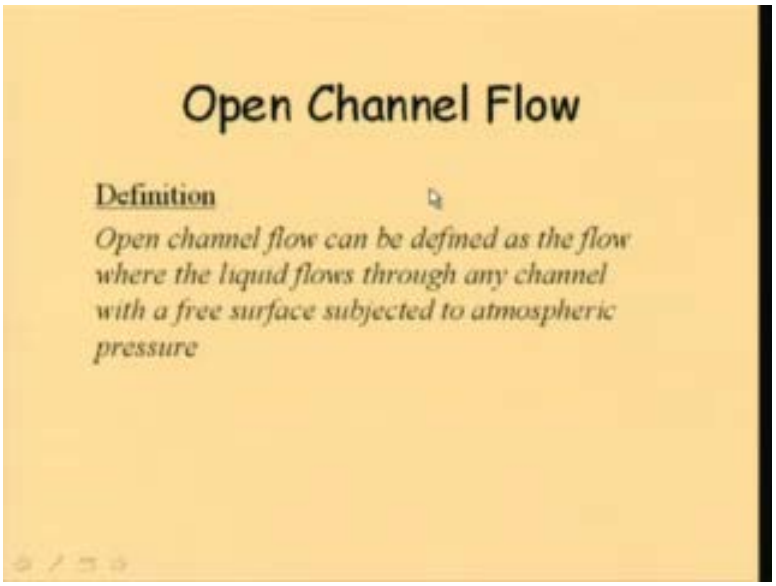

Then we can talk about hydraulic model study, well; and then this open channel flow, what do you mean by open channel flow, well a definition of open channel flow can be given; and this way that open channel flow can be defined as the flow, where the liquid flows through any channel with a free surface subjected to atmospheric pressure. Well, that is very important that the surface of the water is subjected to atmospheric pressure

well a definition of open channel flow can be given in the way that open channel flow can be defined as the flow, where liquid flows through any channel with a free surface subjected to atmospheric pressure; well a subjected to atmospheric pressure is very, very important.

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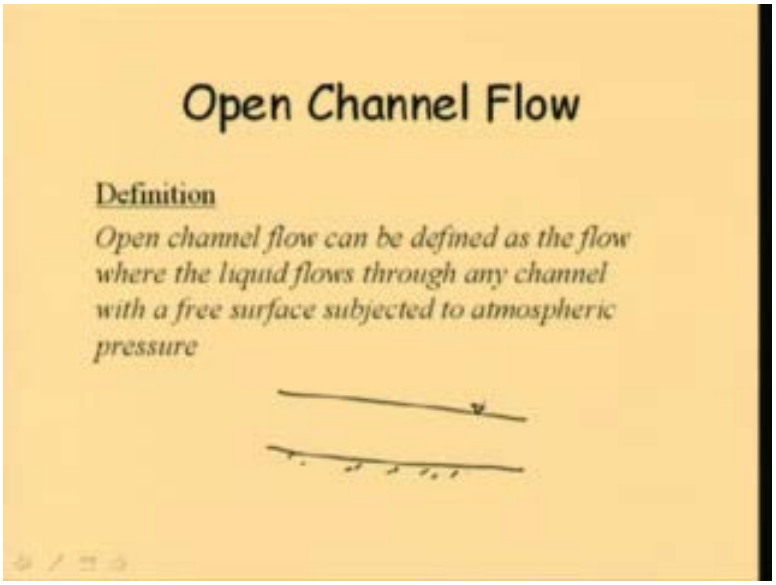

So, if I draw a channel like this say again this is the of the channel, and say this is the water surface; now this surface must be subjected to atmospheric pressure that is the we should be free to the atmosphere, and that's why it is also called free surface flow, and that is the very basic definition of open channel flow while and what is the difference between open channel flow. And when we talk about a flow through pipe that things will be coming later, but right at this moment, when we to know that what you mean by a open channel flow well now, then that look very simple that open channel flow we are talking about the channel, where the free surface is subjected to atmospheric pressure.

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Now, what type of channel we are talking about? I will be talking about a channel of this sort, which is very small, and which is not having any lining on the side, water is flowing fine. Are you talking about the channel of this small size; which is suppose site may be little v site or we are talking about channel of this sort.

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Vast difference between these two channels, say when we talk about this channel or when we talk about this channel, it is quiet wide channel, and that other one is very narrow, here we do not what is the actual gate site. It may be u shape site or it may be of

some other site. Are you talking about I mean, these two sort of channel; are you ready to discuss the open channel concept for these two different type of channel or are you talking about the channel of this kind?

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It is a drainage canal or channel, I would like to say, where you can see that there is a lining there is a lining, we have a concrete lining or masonary lining, I will talking about these sort of channel or I will talking about channel of this sort.

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Where you can see the flow, there is lot of turbulence, and you can see the flow is moving here below the road level, this is the road on the side, and the water is moving below these things. Now the time, when we talked at open channel flow here of course, the surface is not open, there is the road moving and the flow is moving to this part. Now let at this will be a open channel, can we refer this also an open channel. Well, I will be talking about a channel, which is come and quiet, and moving in almost level ground like this.

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Or I will talking about channels, which are moving in street slopes would lot of turbulence in yield.

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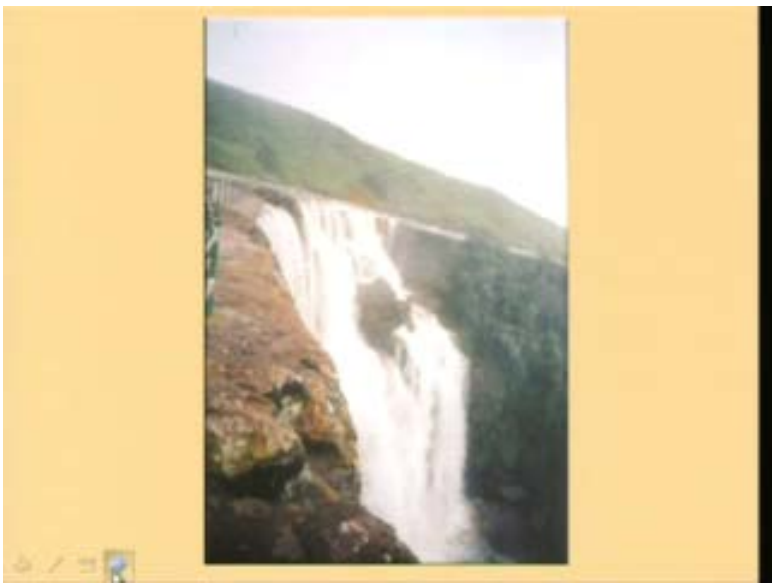

If you have a closed view of that, I will be talking about a channel of this kind, where we can see so much of turbulence is there, when it will come, it is coming down it is coming down into lot of energy, if we get something sure in found, it will erode it out. I will be talking about this sort of channel.

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Well, then there are some other criteria, I will talking about this sort of channel, which is located just in the mid of a downstream; where as I told that there can be all pollution is coming here or there can be breeze like this sort of structures can be there on the streams or we are talking about a channel, again the site is suppose lining is there, which influence the frictional collected yes, I was talking about the frictional channel there is the resistance that will offer that will be offered by the bed on the side, that will be here that is the complete lining we have, whether we are talking about a channel of this kind or we are talking about a channel, which is there in a very remote area.

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Like that so all vegetations are there and the frictional characteristic would be totally different between this, and the channel, what I have shown there right now. So, whether we are talking about this sort of channel or of course, much more interesting channel can be there.

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I will talking about a channel, which is braided in nature say the channel is coming, then one part may be moving this way, another part may be moving this way, there may be chamber between, and then these here it is like that; in a mean period, suppose when the

flow is here it is like that, when the high flow is coming again everything may be full of water and during that process, it may this erode this chamber, and there may not be any same chamber existing in the next year. Suppose this chamber is vanishing, and then another chamber is coming up somewhere here stream pertain changing.

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So, I will talking about the complex iteration well; or I will talking about the channel which is in the deep gaurge, which is in the deep gaurge like that one; where of course it is very steep, the big material is very different, and it is flowing in a zig-zag way of course, it may not erode the hills. But in a plane, if it moves in a zig-zag way, it can erode the site. I will talking about this sort of channel or we are talking about a channel, which is flowing through a completely different set up that is all the site are the bade is made up of it is a boulders.

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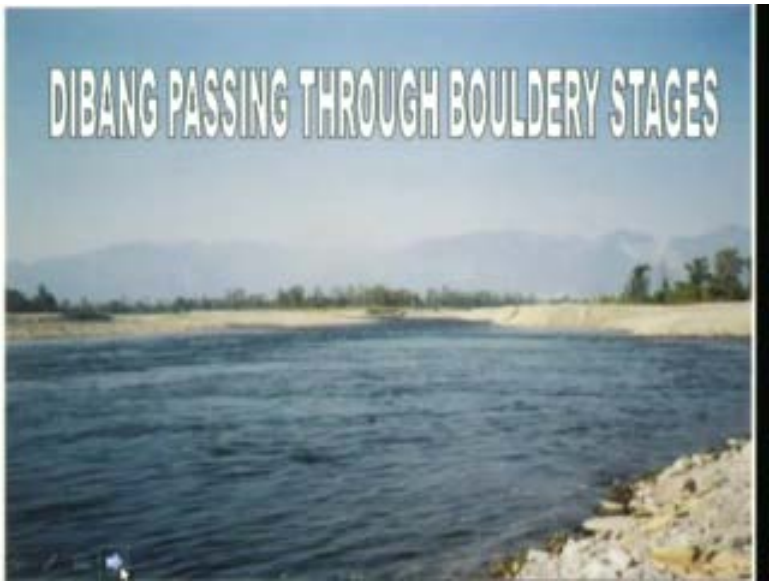

So when a channel is moving through a situation, when through a natural set of you have vegetation, where you have generally that will we have in a different way, then the channel moving closes a boulder way.

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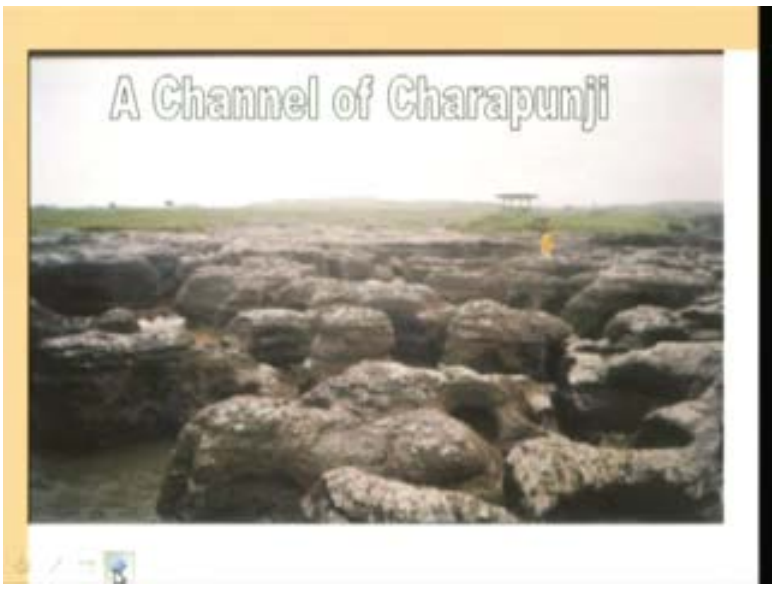

So I will talking about this chart of channel well, then this is a quiet interesting pixel. are you talking about a channel of this side, which is being erode it originally, this word in the level ground, and then this has been erode it by the flowing water and we are having a channel in a very zig-zag way, and it is moving some part in this way some part other

way, and then it is flowing who want to know suppose, how much flow will be there how this will be influencing how whether it will be eroding the rock move. So, those complexity will all be here. So this is a channel from the charapunji area.

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Now, I will talking about a channel of well, this is a sea water of course, then what I want to so that some channel may be having that sort of turbulence also.

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Then will talking about channel of this kind that is we can see the of the channel, water this water, the color itself indicates that this is containing lot of sediment in it. Now the

flow behavior channel, when it is lot of sediment will be totally different form the flow behavior with channel, which is not caring that sort of say sediment in heat.

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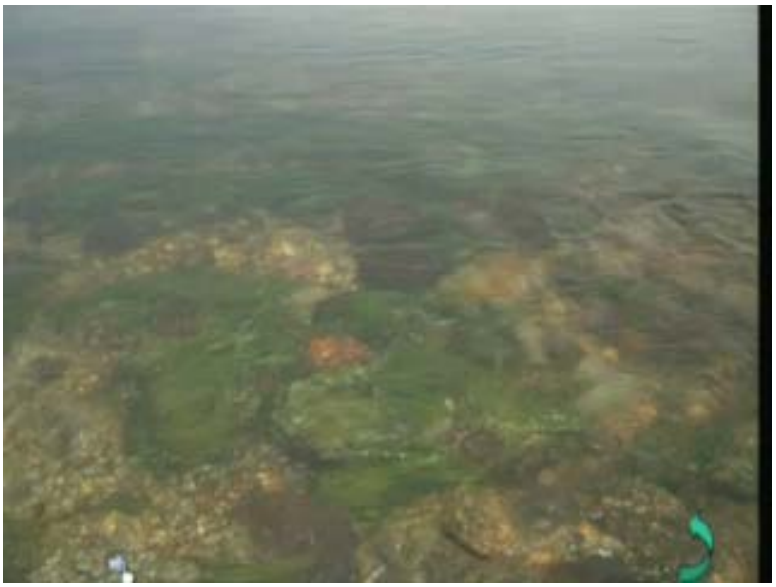

So, we are definitely talking about channels, what I seen earlier or we are talking about a channel, which is clean enough where we can I mean, water is clean enough without element which is sitting there, but the water is so clean that we can see the green vegetation going in the bed, you can see the different bolder small that is there on the bed of the channel.

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So, are we talking about all these different types of channels yes, definitely when we are talking about channel flow, we need to deal with all these different kinds of channels well as we are requiring to deal with all different kinds of channels yes, we are talking about all these different kind of channel or we need to handle all these different kinds of channels as ours what do we get from these from these pictures that there can be channel of different types, and there can be again flow of different type not only channel. There are different type of channels definitely in those channels depending on the stiffness of the channel depending on the wideness of the channel, the flow that is moving through the channel and again depending on the amount of the chur that is coming into the channel the flow pattern will be different.

So, as in open channel flow we talk about different type of channel first, and then we talk about different type of flow, and then we talk about understanding the physical processes of these different kind of flow then we talk about that how we can mathematically deal with different kind of flows existing in nature. So, all these will be discussing in the topic that is open channel flow well our second topic again off course at one point I have here I have open channel flow, I have shown you in this picture that is one instant of time that we are finding that we are particular instant of time the flow is like this.

Now there may be a situation, when the flow is moving like that just at this movement the flowed rate and the channel rate is suppose we are getting x 1, then after sometime we are getting the flow drift to be different say if I take an example if I take an example say one dam is there there will be another situation that is the flow is not remaining or flow parameters or drift or parameters are not remaining constant with respect to time this is changing, we take one example it may not be very referral suppose, you have a dam here we are constructing a dam here and we are trying to store water here.

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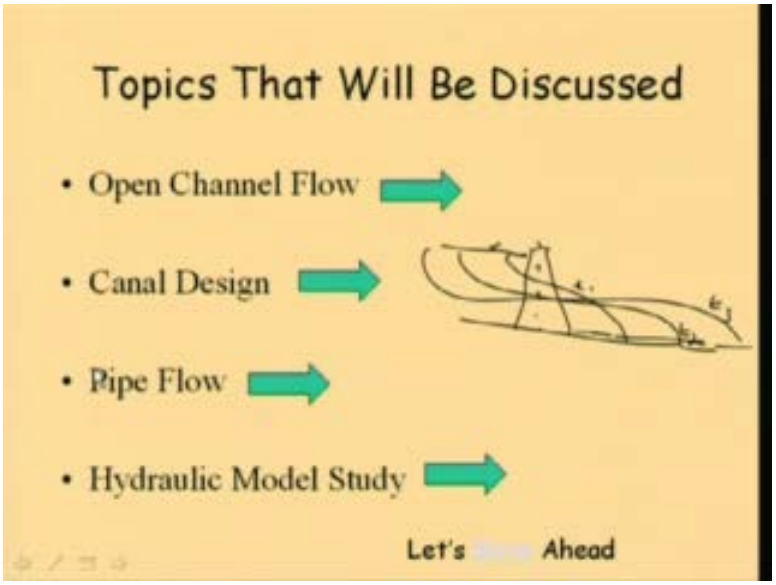

So, suddenly we have seen that due to some reason may be reason, we I do not want to discuss the various reasons here anyway due to some reason the dam has failed and on this side you have dry channel or may be very low level of water flowing in the plain stream. Now what will happen if this dam is removed dam what will happen its flowing like this say a time t1 it is here, then after some time it will be here, after sometimes it will be here like that at time t2 it is here, and time t3 it is there. Now while we are observing the sort of flow or interest may be to know that how this flow is moving and say at what time the flow will be reaching the particular point, because there will be lasers and all those things here difference here.

So, our interest may be to know these things and here with time flowed it interflow is changing that sort of complexity also we need to handle in open channel flow, that will be coming under unsteady analysis without much detail going into depth. We can go to the next topic that will be offering traced, we will be discussing in this particular courses suppose canal design as we have seen that nazal channels are of different type and that man mad canal or channels can also be called of different types, and we need to design the canal to serve our purpose.

So, here we talk about canal design we talk about canal design. So, canal can be arten canal that is unline, and hence unline means no lining, do not have concrete lining messomary lining, and hence this is acceptable to erosion or we can have a line canal that

is lined with concrete or messomary or some other sort of lining in some interior area lining is given by them also. So, this sort of lining can be different here, and hence the channel is known erodible erosion is not a problem for them. Again we have channel as I already shown that it may be clear water or it may contain sedimal water, then the location of the channel it may flow through elevial alluvial formation means, say river is in flowing over and the formation and it or it may flow through a rocky way.

So, if it is flowing through a alluvial formation then scouring problem will be more important here, when it is flowing through a rocky bed problem you know, it must be right now this sort of different canal we need to design; that means, when we are designing the canal we need to know our which area; and for what purpose we are just designing canal, then depending on these type of different need our design criteria will also be different that is most of the cases, suppose if we are having a line canal were the erosion is not a problem, we can go for most economic canal basically, when we try the engineering practices we try to do in the original way.

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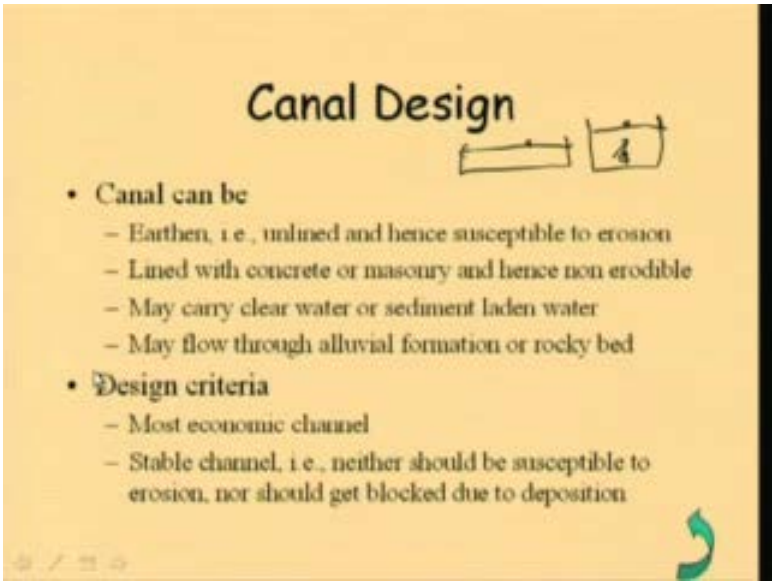

So, we try for minimum cost, and then suppose for a particular discharge well we may have a channel of a size well; let me take the pen here, and let me draw well say when we are interested in a size of the channel, when we are designing a channel say, when we talk about studying amount of discharge through a channel suppose this size is sufficient

that is to carry a required discharge is sufficient means, this is a flowing safely to this and you have some free spaces over that.

So, that if somehow some more discharge comes out or some (( )) over flooding, then this is sufficient, but the same to carry the same amount of discharge q one may that not to go this one, I will be going for a channel of this kind, which is too wide and which is drift will be this, but it will be wide. Now which one you will be selecting, because it depends on if you select this one your cost of lining may more in one cost of lining may be less in one.

So, that way our objective will be to design the channel considering all those aspects to have say minimum cost or we call this as most economic section or a efficient section, which will be the water efficiently well this can be one concept of this design then another is that; suppose it is a channel, which is located on an unline area or you are designing an unline canal, then in that unline canal if you design your channel for a particular shape it may happen that water is flowing it is sufficient bath, the velocity is much high in that channel, and it is causing erosion of the channel or it may be a river also that is suppose the water is flowing through the channel is scaling some sidimentity from the (( )) somewhere and your size is of the velocity is not sufficient to carry the sediment along the flow.

So, sediments are getting diposed it into the canal. So, this not this will make a channel the sediment getting deposed into the canal or the water erode the canal then your purpose is not sufficient for which you designed the canal in that case most economic section may not be the best section and in that case we need to design a channel or canal such that there will not be sediment dipostion water is getting sediment there will not be scouring the channel.

So, for different objective our design criteria will be different and again different theories are been (( )) how to design a canal as a channel or canal which will not cause scouring nor it will cause slickening. So, all these will be discussing in this canal design well then if we go back again that is what the canal design aspect different theory that are available that will be discussing and will be doing some practical example some problem of canal design in these courses then we talk about pipe flow well that is one topic which is of importance for various purposes.

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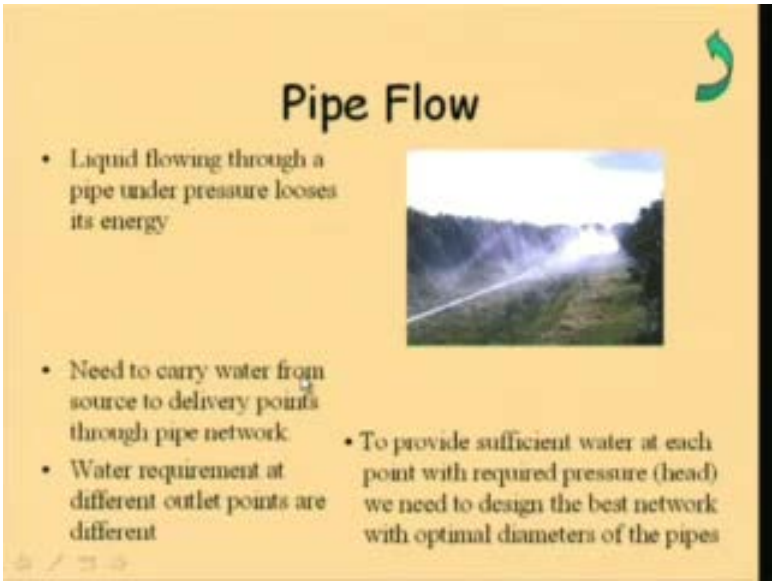

So, liquid flowing through the pipe under pressure losses its energy; first, before going to that part, if we say that why water flow from one point to another point; it flows, because it has high energy or high head on the upstream point and low head or low energy in the downstream point. Well, head means the energy per unique weight from the flow, that way it is flowing. Now, when it is flowing from one point to another point, then the water flowing through the pipe always flow under pressure, it is not like that in an open channel, the flow is always subjected to the surfaces of that atmospheric pressure. But in pipe flow, there will not be any free surface; the water will be under pressure.

And that why, when there is a puncture, you can see pipe is there; and when there are suppose holes or say nozzles fitted into the water, it is just going out like this, it is forced it is forced like this, because the pressure outside, which is atmospheric is less than the pressure inside the pipe. So, pressure inside the pipe is higher. So, it is moving out from this as a spray. Well, now we need to know all these different hydraulics for analyzing the pipe flow; and suppose to what distance you want to carry this water all those things should be coming up. So, but the point is that water when it is flowing from the pipe will lose its energy, so the pressure will also gradually drop. As you know that energy is the combination of pressure, velocity and all; so when the pressure is getting drop, suppose the pipe is very large, and during the process, how it loses the energy if you talk about that how it loses the energy basically, it loses the energy in overcoming fictional

resistance of the pipe, there is one. And then it loses it loses energy in passing through the bends and contraction etcetera.

So, there may be bend in the pipe, there may be some contacted portion, there may be some joints. So, when the flow is moving through all these different abstractions, then it lead to do some work; and as it is doing somehow, the energy is getting I mean, energy is getting dissipated in this point. And because of that our problem is that this is the very basic region that water is when flowing through a pipe is losing its energy. And we need to carry water from source to delivery point through pipe network in different you know, for different purposes.

So, water requirement at different outlet point are also different; say in a city, we have different outlet point that is the different area, where we need to supply the water that water, amount of water required is different. And again we need to provide the water at a required pressure, because suppose if you talk about a house hold, there may be a storage tank on the top of the house; now when there is a storage tank on the house, the supply go to the top of the house, and for that it need to be, it need to have some amount of pressure, minimum pressure.

So, to provide sufficient water at each point, which requires pressure, we need to design the best network with optimal diameter of the pipes. For deciding for designing all these things, what what we basically design? We design that what should be the actual network, shape of the network, and then what should be the different size of the pipes. Well, other than that also much more complications are there in simply in simple, I am just explaining that all these different forms of pipe flow will be discussing in our topic of pipe flow.

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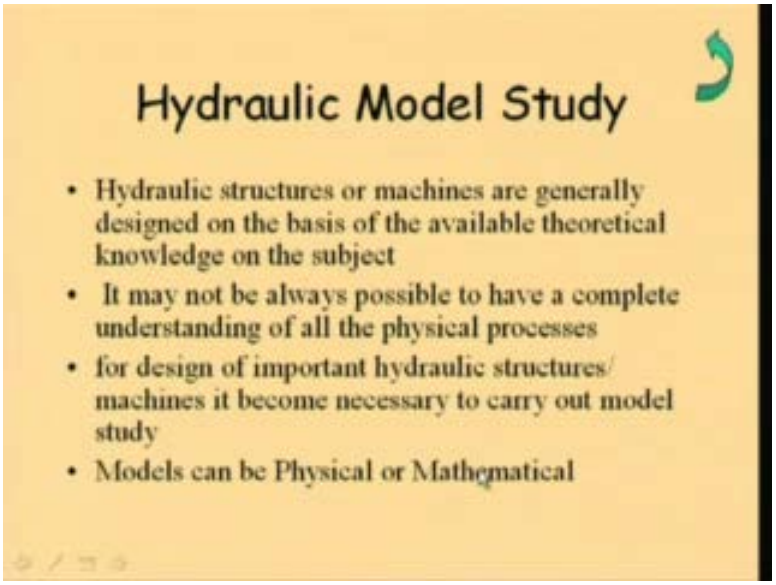

Then of course, we will be going for a model study. Well, that is the hydraulic structure or machines are generally designed on the basis of available theoretical knowledge on the subject. However, say this available theoretical knowledge, when we talk about, it may not be always possible to have a complete understanding of all the physical processes; and because of that, when we design some important structure, while we rely on our theory, but still we need to have a verification of why what we understand, we need to go for model study, because as I did explain in the very beginning that some of the phenomenon are so complex that representing that simply by our you know, how may not be possible, in that case we go for physical model.

And sometimes (( )) that purpose, for suppose we have complete understanding of the processes, but still at a particular location, if we were taking a particular action, suppose wherever if you if you talk about, if you are constructing a bridge, then it will be having some say influence on the downstream also. Now, to do that; well, to know that effect, that what how what will be the effect on the downstream, we need to carry out model study; and then we see beforehand, what is going on. So that way that for designing important hydraulic structures or machines like turbine or a machines; it become necessary to carry out model study, and this model can be physical or mathematical, that is we can go for laboratory model or we can go for a physical model that we can or mathematical model or mathematically also we can design a model. Then we can carry out experiment on that.

So, these are the dropped topic that will be discussing in this particular course of hydraulics. Well, as I did explain in the very beginning, the course is very vast, and it is not possible I mean, I am not talking about these courses or subjects is quite vast, and it may not be possible to cover all the different aspects of hydraulics in detail, but what is our objective is that we need to learn the very basic in a much more clear way.

So that the foundation once build can pass while going into different and advanced topic of hydraulics. So, with that concept in our mind, let us move a head which will start our journey, let us start our journey to the course of hydraulics, and we hope in this particular course, we will be able to clear some of the important issue of hydraulics, and it will help us in going ahead to the higher and higher topic to the advance and advanced topic of hydraulics. Thank you very much.