Coastal Engineering
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Module - 3
Coastal erosion protection measures
Lecture - 7
Coastal erosion protection measures –VII

So, we have seen the effect of groins, seawalls etcetera. So, we will continue the topic in the field of coastal engineering. So, now we will move on to effects of submerged breakwater or emerging breakwater in the off shore.

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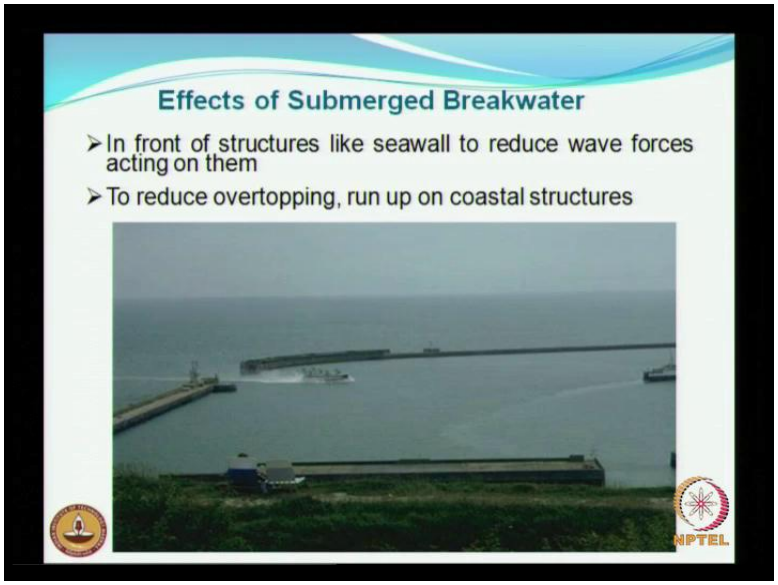

See, earlier what we had seen is the effect of a structure, and that is off shore detached breakwaters.

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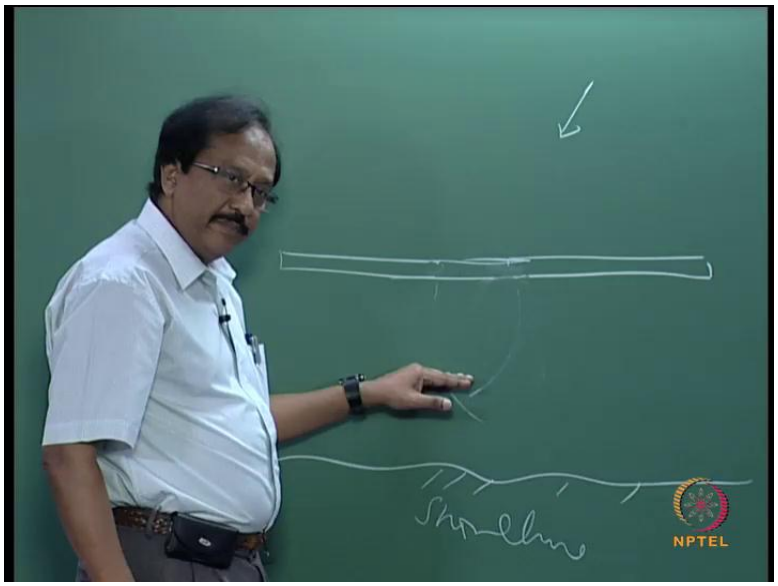

So, if you have a shore line, then you see what happens to the shore line. So this will act as a, when the waves are moving, then you have the phenomena of diffraction and then, so you have something like this. All these things we have seen in detail. So, here we are having the breakwater. What the break water is doing is, it is diffracting the energy and because of which the attenuation of wave energy, somewhere at this location, on the leeside of the break water takes place.

So, suppose if it is continuous like this. Even in the case of a groin, we were discussing about submerged groin or emerging groins. So, same way if we have a structure like this, as you can see here, emerging type of structure, but here again you have a gap. That gap is for entrance of a vessel. So, but if you simply have something like this, what will happen to this energy here? Energy here is going to be; this is a shore line, so energy here is going to be less compared to the, because the presence of this breaker water is going to attenuate the instant wave energy. But this breakwater can either be submerged or emerging type. As you see here, this is a long breakwater. So, here this is going to serve as an attenuator. That is, it will not allow the wave energy to propagate.

So, these types of breakwaters are also widely used as a tsunami barrier. Particularly in protecting power plants. Now here, we have a gap. So, we call this as a harbor. The purpose of this breakwater is for harbor. So, but, submerged breakwaters are structures,

which are protected, which are constructed in front of existing structures, which is in which are in distance.

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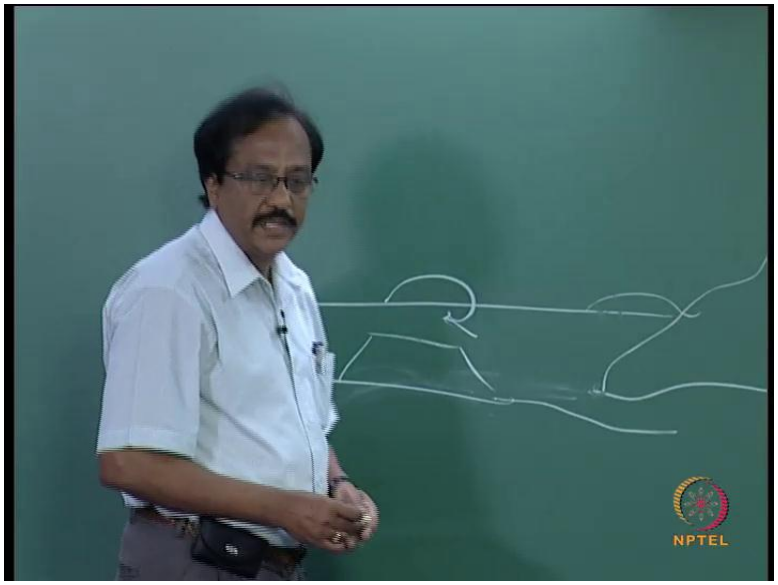

For example, you have a structure, which exists something like this. Some monument, it would have been existing like this.

So now, slowly your shore line has gone. Then, the waves are breaking somewhere on this structure itself for example. Then, what will happen? Initially, the shore line was here. I mean the water level was here and there was not much of problem for this. Now, there is a rise and other things and then, you have the erosion taking place and you want to protect this. So, you can have something like a submerged reef. This is nothing but, I have already told you, this will facilitate premature breaking somewhere here and then, leave a calm area here in between these submerged reef and the structures. So, you will have the beach formation as illustrated in this slide.

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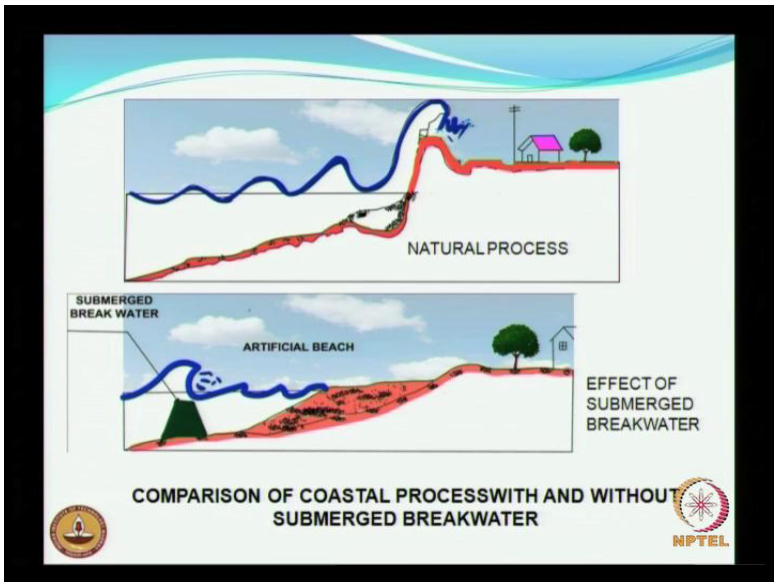

So for example, you see that there is a dune and now and you have the coast with properties. Now, when there is a natural process, when there is a costal hazard, what would happen? The water level in the ocean will go up. That is what we have seen when I explained about the process by which the coastal erosion is taking place. So, what will happen? This is what is called as a flooding.

So, if this kind of flooding can persist, this whole thing can easily be removed also. This whole thing depending on the soil character, the whole thing will go and then, it will have a easy access for the waves or the sea water to come into the land. So, unless you have a precautionary measure, you will not really be able to save the property. So, one such example is having a submerged breakwater as you have to as as shown in this sketch, the bottom one.

So now, these days as I have told earlier, the plantations are also being talked in a very big way as attenuators. So, this part I have already explained now. What is important is, what should be this distance from the affected area? What should be the clearance between the water level on the top of the breakwater top of the barrier, artificial reef or artificial barrier? And also, the width of this, top width is also very important.

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So, there has been a lot of work done particularly in T.U.Delft. People who are interested, they should visit this site. I mean you can just google and then, check for the report. There are a lot of reports available on the performance of crook low crusted or broad crusted submerged obstructions.

So, how wide it has to be and what is the clearance between the water level and the top of the structure etcetera, all these information you have and some empirical relationships derived from experimental investigations. In our case, we have also carried out here submerged semi circular breakwaters. So, the face would be something like this. You will have a submerged breakwater. So, you will have the waves moving over it and then, this will go in. This is may be offering the required attenuation. So, but mostly a trapezoidal one, the width also, the top width of the breakwater submerged reef also is very important.

So, there are different kinds of submerged reefs. Again, this submerged reef also, what I have been discussing here is kind of a rubble mound structure. But, there are other kinds of submerged reefs to enhance fish growth. I mean the availability of the fish catch can go up. So, all this and there are lot of work being done.

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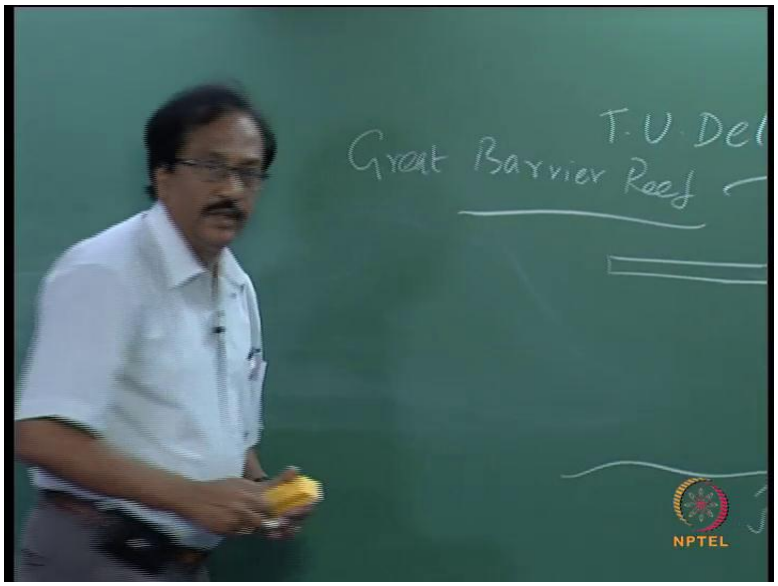

Another thing for this, in the other cases, you can check the Great Barrier Reef. Again, you can just google for this and then, check the information. This is somewhere in Australia, where you can get lot of information about this submerged Great Barrier Reef.

So, I am suggesting a number of additional information. Additional reading and that is required when you are trying to follow the basics of this course. Is that ok?

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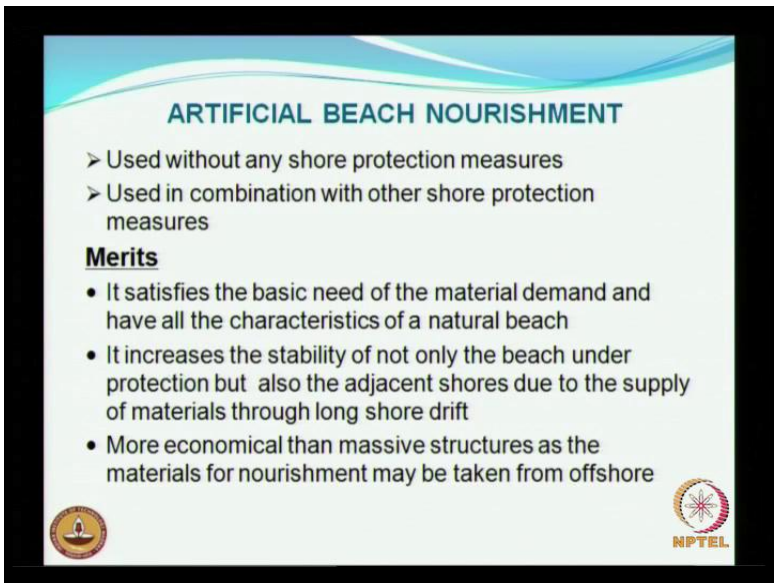

Now, we move on to artificial beach nourishment. What we have seen so far are all structural measures, whether you are using stones and other kinds of material or the geo

synthetic material. Still it is, although we call it as echo friendly, I mean the geo bags or geo, but still it looks like a structure. Right? Now, there are other things like real eco friendly. I would say like artificially without meddling with the existing structure. Just like soft kind of a measure and that is called as the artificial beach nourishment. So, used without any shore protection measures. You do not envisage any kind of protection measures in areas where it is eroding. It is used in combination with other shore protection measures. So, both possibilities are available for you.

So, you artificially nourish the, try to nourish the beach but, you want the sand that has been sent to the affected area to be retained. Then, you go in for some kind of a structure to retain the sand over a particular stretch of interest. So for example, this stretch is very important for the tourist. So, you take some sand from somewhere and then, put it here and then, you want to retain it. Then, you can construct some kind of a barrier here, so that it can be retained.

Merits. It satisfies the basic need of material demand and have all the characteristics of a natural beach. That is the beauty of artificial beach nourishment. Because why, after all, why we are interested in saving the coast from getting eroded. In one way or other, we have to make sure that the beach is available. First, you protect your coast, but then only, even if you protected the coast, only if you have the beach in front of it, only then it is really something very nice you know. So, that is what the first point says. That it satisfies the basic need of the material demand and have all the characteristics of a natural beach.

What is the next advantage? It increases the stability of not only the beach under protection, but also the adjacent shores due to supply of materials through long shore sediment transport or long shore drift. So, that is, if you are trying to protect this much of stretch of a coast, naturally the sand will move slightly down drift. So, thereby, if you are planning for this much stretch of the coast, still there is an extra stretch that can get automatically protected, provided your sand bypassing system is working alright in all respects.

More economical than massive structures as the materials for nourishment may be taken from offshore. So, if you can take the material from offshore and then dredge it, take the material by dredging and then, bring it and supply it to the coastal eroding site. Then, it is going to be very economical because, you are not dealing with any massive structures. So,

another thing what we have seen earlier, later not earlier, later you will see that wherever, already I have explained to some extent, wherever you have abstractions, the down drifts site gets eroded in an environment that is dominated by long shore sediment transport. This is very clear.

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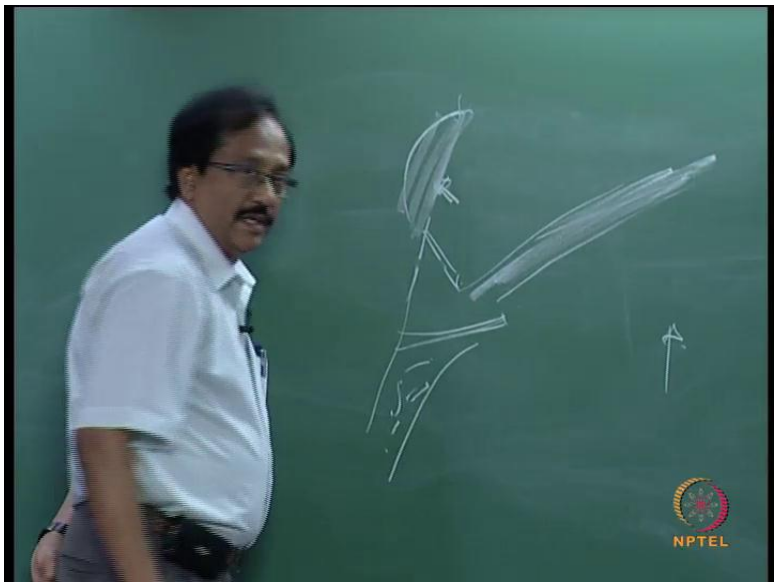

So now, if you have a harbor, so as I said, when you want to have a harbor, you naturally have a pair of breakwaters. This is also known. So, naturally you are going to have, if the sediment transport is assumed to be in this direction, as in the case of east coast of India, which we will be seeing through from case studies, this area will get the beach formation advantage. But then, this area will get eroded. Disadvantage. Now, this artificial beach nourishment comes very handy in such an environment because, you see that the approach channel will be something somewhere here. Approach channel has to be maintained for certain depth. How do you do that? You keep on maintaining; see one is what is meant by capital dredging. Capital dredging is done for formation of the harbor, initial formation. Once the harbor has been established, then you keep on dredging it. May be yearly once and that is called as your maintenance dredging.

So now, when this is being dredged, naturally how do you dredge it? You have a, you need a dredger. You certainly need a dredger. So, the dredger moves around this place and dredges the sand and it has to be dumped somewhere. So, if it can be dumped here, then this can get nourished. At one time you are trying to solve two problems. One is dredging

the approach channel and also solving the problem of erosion on the site. Is that clear? So, this is an ideal kind of a project, wherein your artificial beach nourishment can really work well. So, one typical example is the Visakhapatnam port along the east coast of India, north of Chennai harbor. I did show you an example of this port layout. I mean, I did show the layout of the Visakhapatnam port when we did the lesson on diffraction, wave diffraction. In wave diffraction coefficient, I showed you the contours, by taking care of the Visakhapatnam port layout. Please look into my lecture material on wave diffraction to have the idea about the harbor layout. So, in this case, how it was done?

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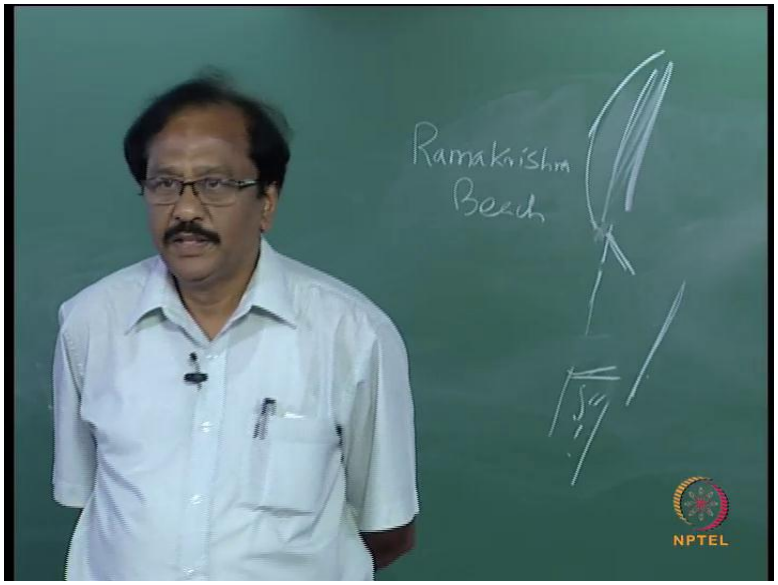

They used to, it has a eastern breakwater something like this and then, you have a inner harbor and have you have a small breakwater here. This area is called as Ramakrishna beach. I will write here. So, this is Ramakrishna beach. Anyone from Visakhapatnam? So, you must be, so that is why I see lot of smile on your face. So, you know about this area right? Ramakrishna beach. Very popular beach. So, it was actually eroding and now, they have, the port has dredged the sand and they have nourished the beach. Sometimes, they stop due to some unavoidable circumstances. But it has, one thing is for sure that it has proved that artificial beach nourishment can be very very effective, provided it is properly done; carried out. So, you see that, it also says that, you can take the beach for example, what does where is it? So the last one. More economical than massive structures as the materials for nourishment may be taken from offshore. So, offshore means, I just gave you an example of approach channel.

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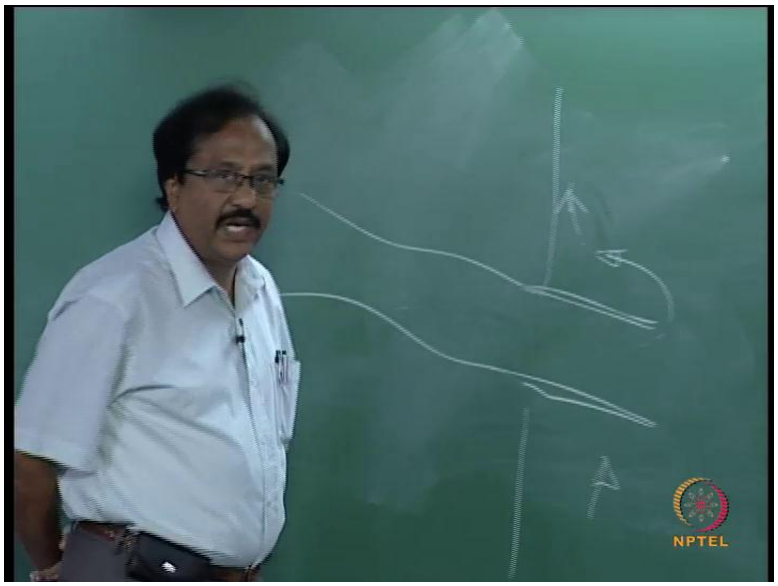

Then there is another case. For example, you take for instance of an inlet. I think I have already explained in brief earlier. If you take a inlet, now this is going to be blocked on the assumption that you have a net drift in this direction. This is going to be blocked. We will be seeing an example of this later. So, this is another area where this artificial beach nourishment can be very effectively tried. So, one way of protecting is having a pair of training wall. Will that alone be helpful? You need to do the capital dredging, so that you have a free exchange of sea water, so that the flushing is taking place. So, this entire thing can dredged and then, it can be nourished to this place, so that this is the intact. So, this is what is a combination of artificial nourishment with structures.

Earlier, you have already constructed a harbor. But in order to maintain the harbor is a natural process. You are dredging and then putting it on the down reef site to maintain. But here, you are using this as a protection measure. The problem is sand siltation. By putting this you have erosion. So, in order to stop that, you just try to use this because even without having a wall, you can still try this.

You can keep dredging and bypassing. That is in the absence of structure. The problem is one. This problem can be solved either without any structure, just resort to artificial beach nourishment or with the process of a structure. Like you have a pair of a training wall and then keep on doing the dredging. Is that clear? Any of you have any doubts? You please forget about the camera and then, just you feel free in asking any questions. Any problem?

Where is the Raman? Yourself last beach. So, relax and ask me any questions. Students being under tension is not only here. It is a universal problem. So, do not bother about the camera. Please ask me whatever questions you have.

You do dredging near the port. I mean near the harbor. You told that there might be instability in the and if we remove the sand, so and what is the consequence in that?

No no. You are not. See, that dredging also should not be excessive. You should not do excessive dredging. There is a kind of a limitation. So, that is why I said this needs lot of planning. It is not just like taking the sand from one location and it may sound like that when I am telling just dredge this and take it. But, dredging has to be done in a very systematic way. You have to look at the levels. Excessive dredging also is not good.

So, all these things are associated in this artificial beach nourishment. But, without any proper planning, earlier I used to, during one of the earlier classes I have said, without planning do not jump into conclusions. Just even for a short term measure, do not jump into conclusions. Wait and understand the problem and then only you should go in for this protection measures. Because planning for coastal protection, a lot of parameters are responsible and it is based on a number of assumptions. If you make any small mistake in the direction of littoral drift, you had it. Because if you have not taken proper care about the direction of sediment transport in location where you are supposed to keep the mouth open, your structure, if you have put some structure, it will facilitate excessive deposition. So, you will get an adverse problem. Your solution will lead to adverse effect. So, that is why you have to be extra careful. Although the problems like putting the structure etcetera, it is only just vertical lines or horizontal lines. It will look so simple but, it is not so simple. It is really complicated.

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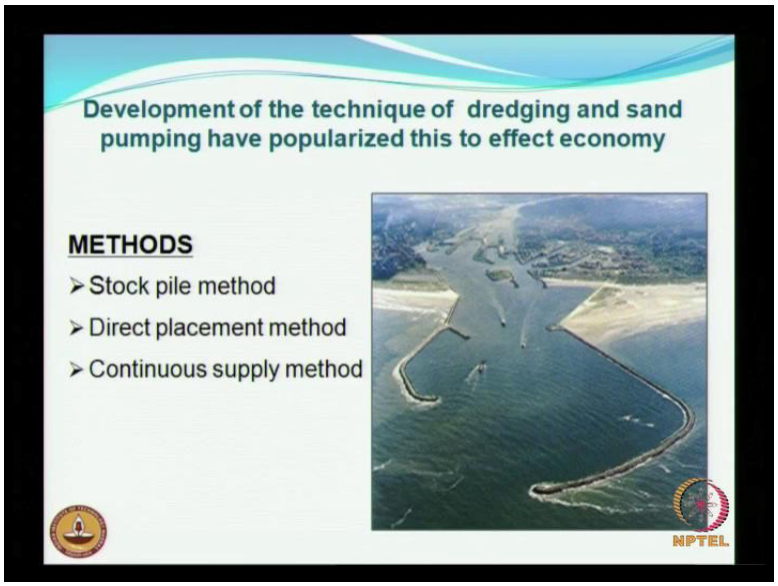

So, development of the technique of dredging and sand pumping has popularized this. Look at this development of that background picture. Looks so nice you know. So, you have a huge Marina. Some think like marina here but, it is of course, a water way, which just allows the vessels to go a smooth passing of vessels. Then, you have the three direct methods for this artificial beach nourishment. One is stock pile method. You have a stock and then, you try to have some kind of obstructions and then, you just nourish the beach.

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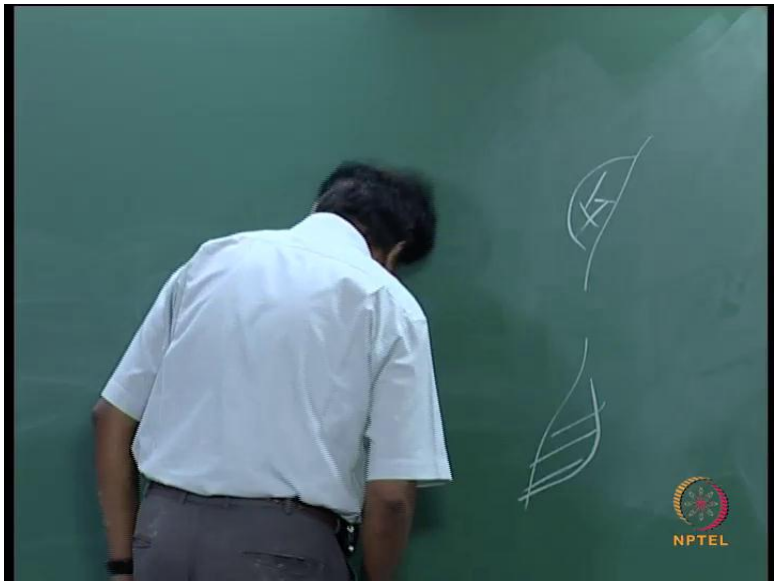

The direct placement method. You take, you can, direct placement means, wherever, if you have a, if you have an erosion here and if you have a deposition here, you remove this and then place it here. You just take it and physically place it here. That is direct placement. Then, you have a continuous supply. What is continuous supply? See, you can have for example, one typical example; I will be covering that under a case study.

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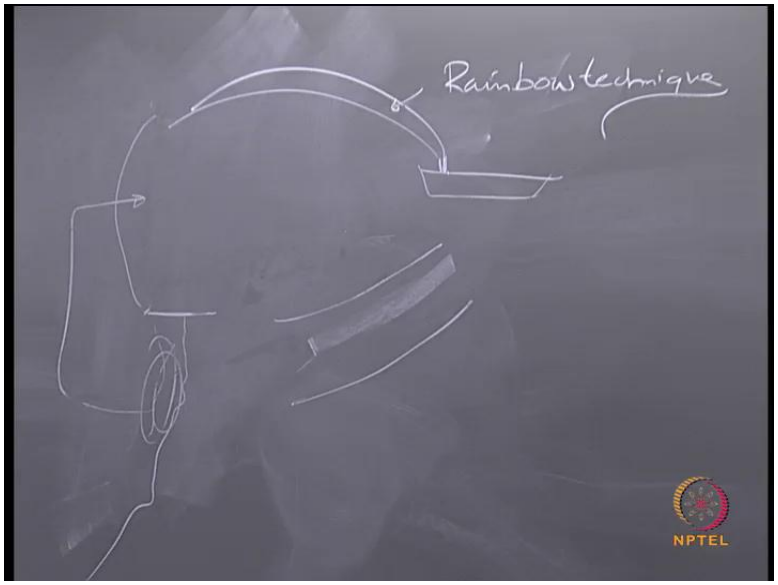

Suppose for example, if you have, I will remove this. So for example, you have a structure here and then, this area is getting eroded and you have some amount of beach formation here. So then, this can be, this sand can be removed and it can be bypassed here. For example, you can have a pipe line, continues pipe line, so that the sand is automatically pumped and then nourished. In the case of that Visakhapatnam port problem, I was telling. So, when you are dredging, an approach channel, recollect what we were discussing about the Visakhapatnam port. See, this is dredge and then, it is brought. But, your dredge will not come up to the coast. It cannot come up to the coast. So, what will it do? It will have a vessel. This is a vessel, wherein, it will have some way of transporting the sand from the vessel, from offshore. You understood? So, this is what is called as rainbow technique.

You can again check. You can visit the google and then, put rainbow technique hyphen dredging, you will get some pictures. In fact, I had a nice picture. Somehow, I do not know it got missed. So, both can be continuous. This also can be continuous and this also. As dredging is continuing, it can keep on dredging. So, in this case, you see that the nature of

the sediment is also very important because, it is something like holding the sediment and then firing the whole thing. So, that trajectory and all those things will be governed by the sand characteristics. All those things will dictate the dredging; the quantity to be dredged and to be nourished and the quantity of material that has to be put in order to nourish the beach. That will also, that is going to be very important. Anyway, some of these things I will try to cover under the case study, so that things will be made more clear.

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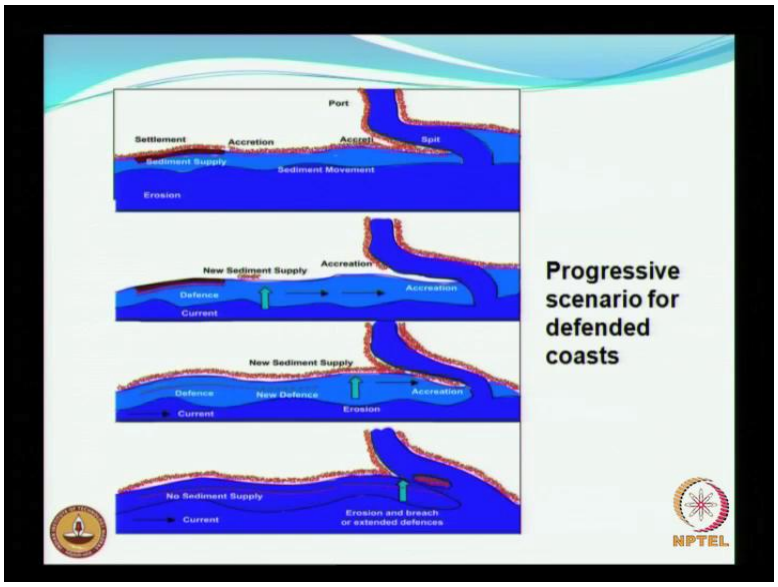

So, this is taken from some book, wherein, when you are, this only shows, because we have other, see for example, you have an inlet here. When you have an inlet here and you see and there is a movement of sand in this direction. When there is a movement in this direction, you see that the sand will be washed, will be drifted and then, it will go on and before this place, it will get settled. Then, this par and this process will keep on continuing and as the strength of the littoral drift keeps on increasing, this we call it as spit as I have told you earlier. There will be a kind of a progressive growth in the spit and this will keep on growing and finally, see you may it may reach a situation either the spit will grow parallel to the coast, it may not close the mouth but, it will go parallel to the coast.

We will see with an example how it has happened. So, what will happen? Although the sea and the (()) will be connected, the flushing will reduce. There will be an exchange. The sea water and fresh water are connected, but the exchange of sea water will be less. Are we interested in exchange of sea water are not? We are interested. I will illustrate that with the

help of case study. So, after sometime, there is a possibility that this gets cut and then, there is an isolated something like a small offshore breakwater. So, such things can happen. But, it is not 100 percent universal that it has to happen this way. This is only a kind of an indication. So, this can never happen. This cut can never happen and it can keep on propagating, but spit formation you see, that spit formation will take place, whenever there is a predominant long shore current in a particular direction.

Looking at the geomorphology of the coast, you will be in a, you can easily tell how in which direction the sediment is moving. For example, you just go and take some satellite imageries. From the satellite imageries, if you look at, if you come across such kind of formations like a land mass near the mouth being drifted in this direction as you can see in this picture, this clearly show that the sediment transport is in the direction of the speed formation.

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So, having seen this, now let us look into some of the coastal engineering problems along our coast. Because, some of these actually, the length of the coast line is said to be, Indian costal line is said to be 6500 kilometers. This itself is becoming a big question mark. Some say it is around 7000 kilometers. But, recently there was a meeting held, a high level meeting held on the discussion about the length of the coast line. They are coming up with value of 11000 and odd kilometers, the length of the Indian coast line. Because, the length of the Indian coast, length of the coastline, how this is defined?

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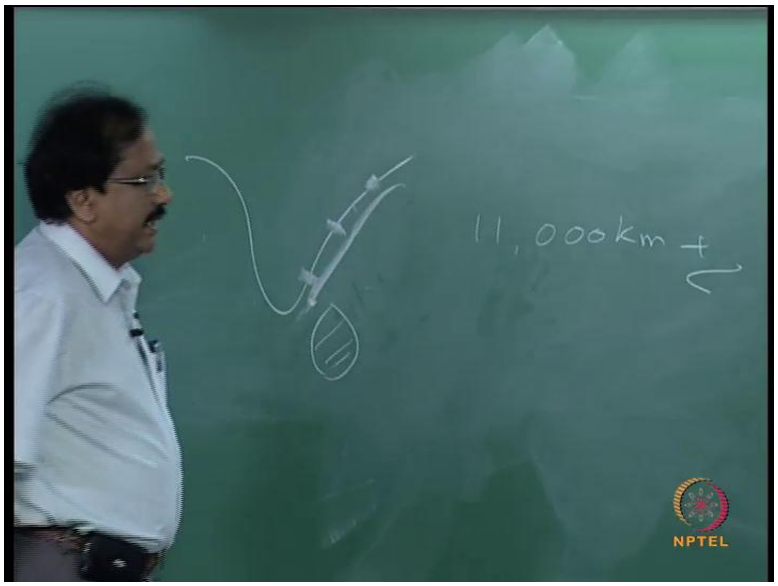

That itself is a big problem because is something like, every time I draw Indian map, I just stop like this. But that is not Indian coast line. That is not at all Indian coast line. Particularly, when you go into Gujarat or look at Andaman Islands or Lakshadweep islands, all the more complicated. So, there has been an exercise recently to come with a value for the length of the coast line as close as possible. So, since this is still under preparation, I will not go into the details. But, it is said to be more that 11000 kilometers plus, but definitely less than 12000.

But you see that most of the major rivers drain into the Bay of Bengal. When they drain into the Bay of Bengal, what happens? There is some amount of sand brought by the river here. There is some amount sand brought to this coast. So, at different locations, different rivers bring with different quantity of discharges. So, there is an imbalance in the sediment distribution along the coast. This is apart from the kind of activities that undergo and also some stretches of the coast, you have harbors and some stretches it is open. So, all these things, wherever you have obstructions, as I said earlier, that also causes lot of disturbance to the stability of the shore line.

So this, major rivers draining into the Bay of Bengal and that is going to result in imbalance in the sediment. Now, what are the problems? The problems along the east coast are much more dominant than the west coast. It is only a relative term. Problems are all over except somewhere here, because of what? So, we need to thank Sri Lanka because,

the entire island is acting as a barrier, acting as a natural breakwater for us. So, this area is quite calm. So, I suggest some of you go and see this area. Quite calm. But, what are the problems related to the Indian coast? Silting up of interest channels, which we have already seen. I just emphasized. Closing of river mouth also I have highlighted and problems concerning aquaculture. Now, that aquaculture is banned. Even if some, we do not know what will happen in future, but, if such a thing gets reverted back, then we do have problems with aquaculture also.

Then, silting up of intake structures. Intake structures can be for so many purposes. Maybe for power plants of our chemical industries. So many activities are going on along the coast. So, for which needs continuous supply of seawater. So, if the intake structures get silted up, then you land up in trouble. Then, the final one is the erosion along the coast. This is very important. So, we need to look into; all these are some of the problems which we need to have.

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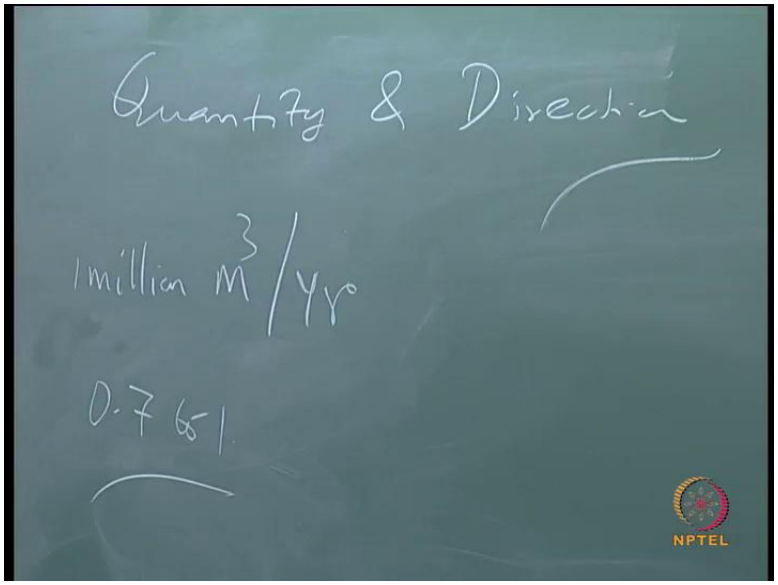

We will talk about the quantity and how to estimate the quantity etcetera later. But, please remember that it is estimated to be around 1 million meter cubed per year. But, maybe it is around 0.7 to 1. It is not 1. So much of sand is moving. The net drift, I am telling the net drift is moving towards the north. In a year, so much million meter cubed of sand is moving along the north and this is one of the highest in the world. One of the highest. Hence, it is very very important to find out how this varies.

So, there has been a number of studies done in this area mainly to address the quantity and direction. Quantity is important plus direction and we have a, it is seasonal. So, during the north east monsoon, October to December, the sand is going to move towards the south. South west monsoon, May to September, it is going to move towards north. Non monsoon also it is going to move towards north but, the net drift will be towards north. Please have this in mind. Along the east coast of India, sand moves, the net drift along the coast is towards north. With this we will try to look into all the details etcetera. Because of this, what are the problems we have been facing, what are the kinds of solutions we have arrived at and what are the effects of these solutions etcetera, we will see in the following class.