Coastal Engineering
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Module - 3
Coastal Erosion Protection Measures
Lecture - 6
Coastal Erosion Protection Measures -VI

We were seen or which are going to be seen, I will just project some of the case studies mostly pertaining to Indian coast. So, that will give you an idea about all this structures and application and their effects. Now, revetments we have seen already in the sea walls.

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Now, what are revetments? Revetments are mainly to improve the stability of slopes. So, these revetments mostly it is constructed along the banks, and even sometimes it also refer to as a revetments, even if it is constructed along the coast. Provided it is occasionally, exposed to the wave action may be during a storm. Extreme event when it is exposed and those type success are also, sometimes referred to as revetments, but mostly the revetments are for protecting the slopes. That is in which case it is mostly preferred along the river banks.

So, the very commonly used revetment is the riprap revetment like you have the connectional sea wall where in we use the rubber bound stones you know, so just dumping. So, we dump stones that is also usually, it used to be called as revetments. See any kind of structure which

is used to protect the slope from further damage is called as a revetment. See usually, what will happen if you have a bank getting eroded.

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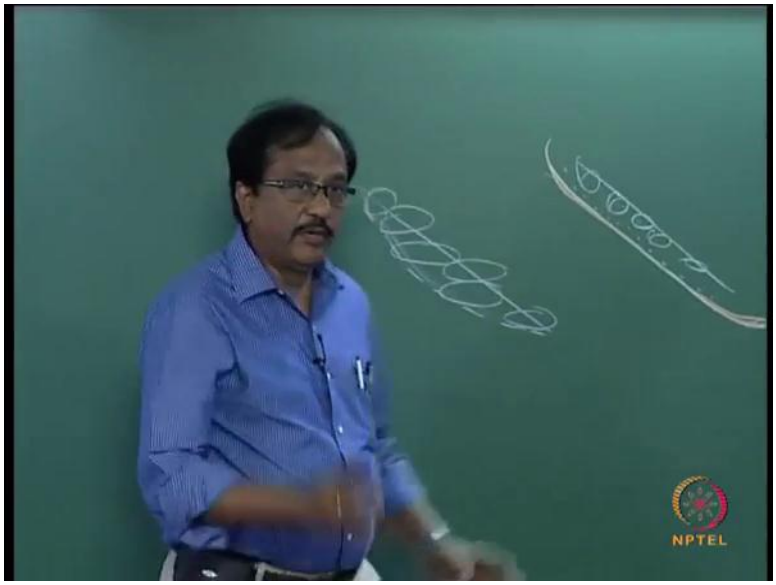

So, if it is getting eroded like this how do you protect. As an immediate measure what they do is they dump gunny bags, or gunny bags in the sense sand bags, bags filled with sand they keep dumping. So, that it will it will with stand some extent it will protect it is only a temporary protection measure. Slightly better than sand bags is just put a stones instead of sand bags, or they have sand bags over which they can also put the stones. Always you remember that when you want to protect sand a slope you have some kind of a filter layer, and over which you have the stones.

Now, these days we have what is called as the geo synthetic material that is the geo textile over which, a filter layer is placed over this the filter layer is placed over this the filter layer is this is the geo textiles. So, you have the geo textiles over which you can have the filter layer and over which, you can have the a stones put. So, this is the general way of protecting the.

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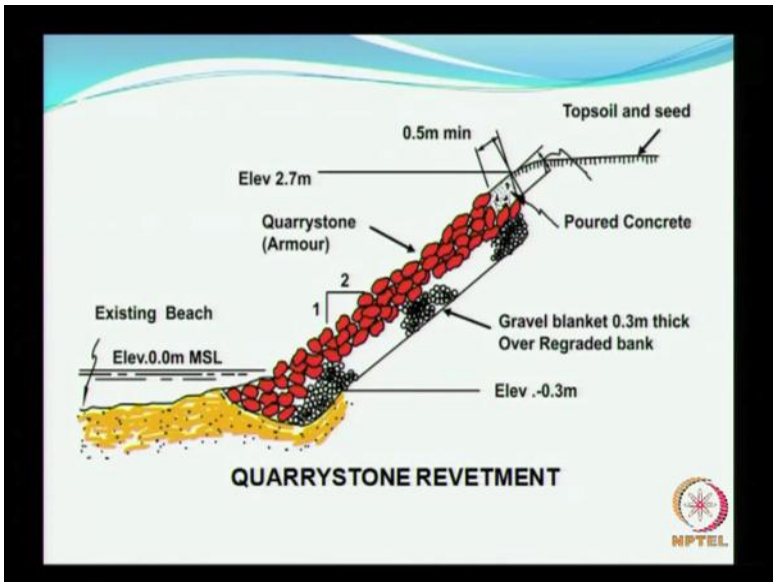

I mean adopting the revetments for protecting your banks. So, this a typical construction I mean the cross section of revetment taken from the coastal engineering manual, the old show protection manual. Coastal engineering manual was referred to as earlier show protection manual prior to that it was referred to as T R 4. All these things are from U S army corps of engineers. So, these this volume of this contains volume of information's or coastal protection. After attending this lecture the best way of educating yourself is to refer to this coastal engineering manual, or there are some other textbooks and a manuals, you have what is meant by rock manual that also you can be referred. So, all these references will be given at the end of the lecture.

So, here you see that as I said as I was explaining here with the board on the board, see is this is the area which is going to be protected. So, you have a small blanket or filter layer over which you have the armor unit, on the top concrete is set you have the concrete cap. So, that it is intact and then you have you are suppose to have some amount of protection here. So, this is typical cross section of a revetment some of the problems here would be. Suppose, if you do not properly take care of this then during monsoons, what can happen is if this not properly filled some kind of a filter layer with stones with by applying geo textiles.

So, if you do not have anything like this is some geo textiles with a protection of filter layer and small quarry like stones here, what can happen is what would happen particularly, during the monsoon. As I said earlier the sand the water can get drained here, and then this will

become very loose and the entire structure can collapse. There are several instances along our coast as this kind of leading to such kind of a failure. Particularly, along the Kerala coast we have noticed a number of structures, and this was during the tsunami during the tsunami most of the sea wall sections have failed along the Kerala coast, have failed because of this kind of a phenomenon because you.

During the tsunami there was a serious severe increase of the water, and then the down rush back to the ocean that is much more with it comes back with a tremendous speed. So, what will happen is this percolation of this tsunami water as resulted in failure of the revetments, as well as the sea walls mostly, sea walls. What I am the phenomenon is almost same whether it is a sea wall and or a revetment. So, the same thing can happen if you have a flooding in the river so you can have the overtopping and then you can have the removal of the stone from the land site. So, this has to be kept in mind. So, every time and have dumping of stone is a again is a an eye sore. So, instead of dumping stones quarry on stones you can they have come of with concrete interlocking concrete blocks.

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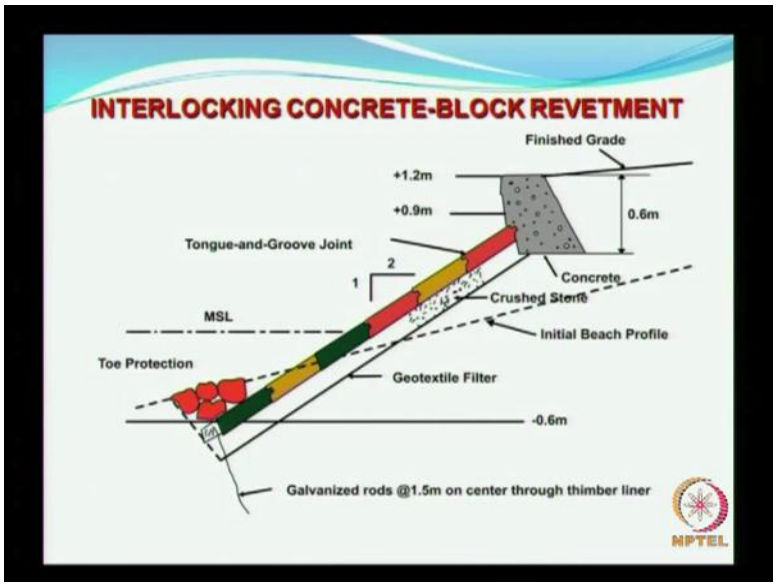

As you can see in this, so it has a male and female joints, so that it will get ah itself glued to each other. And then it will act as a monolithic unit. So, but only thing is you have to be careful in providing a strong toe protection there is although, there is an there are some advantages like aesthetic point of view it is very good. Where you do not have much of projections as in the case of rubber mall, and it has a nice finish and it gives a good look and

but there is one problem suppose in case it yields somewhere here, the entire unit can also come down because it can act as a monolithic unit.

So, but the adjoining layers also are going to be bloomed to each other, but this is also possible. So, you have to be careful when you are using this it has advantages mostly, the advantages are really and also the material you are using for the blocks if the centre material which center the slab, which you have casting is not satisfactory then the that can be lot of problems, and this is one common problem which we have with the pre cast slabs of this nature. This is yet other type of harbor unit.

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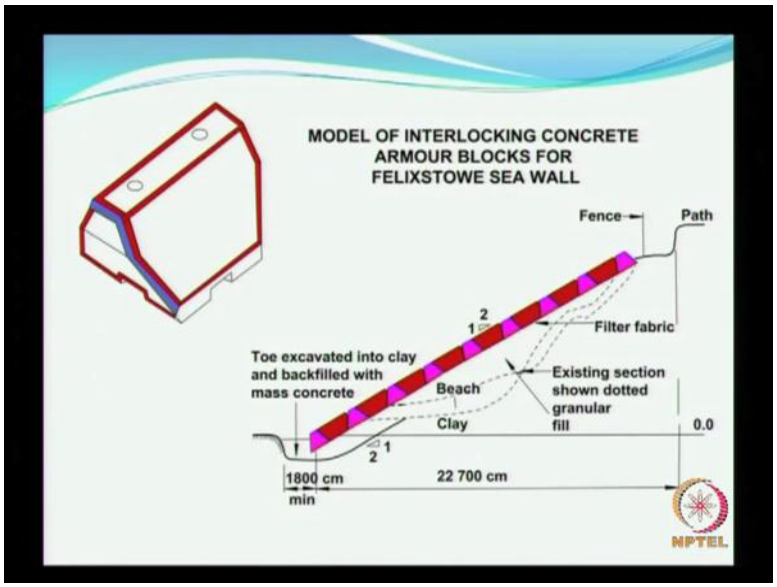

Again all these both these type of blocks have come from the U S army corps of engineers. So, it is all available in the book, you just see what is happening here. So, you see the existing section shown in dotted. So, you just try to fill first if there is an erosion with some kind of material and then get a smooth finish and then place the blocks together. Now, in this area only the geo textiles have has found wide application because geo textiles membranes are used mostly, has been adopted for high ways now it is very widely used for protecting banks, as well as in the case of sea walls extra is that, okay?

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So, these are typical durable and environmental friendly coastal I mean erosion protection problems, protection systems of berms, slopes, river banks as well as for shore lane the top one is shown for a shore line. So, we have a variety of choices, but then you have to be careful in choosing, and then you have a cast benefit aspect which you have to you need to do. And some of these things also require skilled labors whether see. For example, placing rubber, rubber stones you may at require skilled labor, but using this you need some kind of special machinery special skilled labor etcetera.

So, all these things have to be going into when you are trying to plan for yours structures is that clear. So, there are other types this is science lab which is been introduced in Malaysia, and it was done by one institute in under the university technology Malaysia, where they have used what is called as science lab.

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So, it is something like this it is goes and glues to another and this is how the revetment can be formed. So, you see that there is a filter layer and this acts as a berm, acts as a armor layer. Now, you look at this although it gives a nice aesthetic from aesthetic point of view, not only it gives from aesthetic point not only it is good, but also you look at this projections. All these kind of projections, when you have lot of projections it is going to offer lot of friction. When you have more friction the energy is getting dissipated that is the advantage, and added to this if you have some kind of plantations along, along with this kind of slope this could become a very good protection measures, but then you need to look at the cost, cost implication.

And also the importance of the project now for example, you also please note that there is a toe protection always have in mind that whenever, you are talking about an a construction of any obstruction in flowing water, or along the coast be it inside the river or along the banks or along the coast or the inside the off shore, you need to have a protection of the toe structure. If you do not do that you are asking in for trouble.

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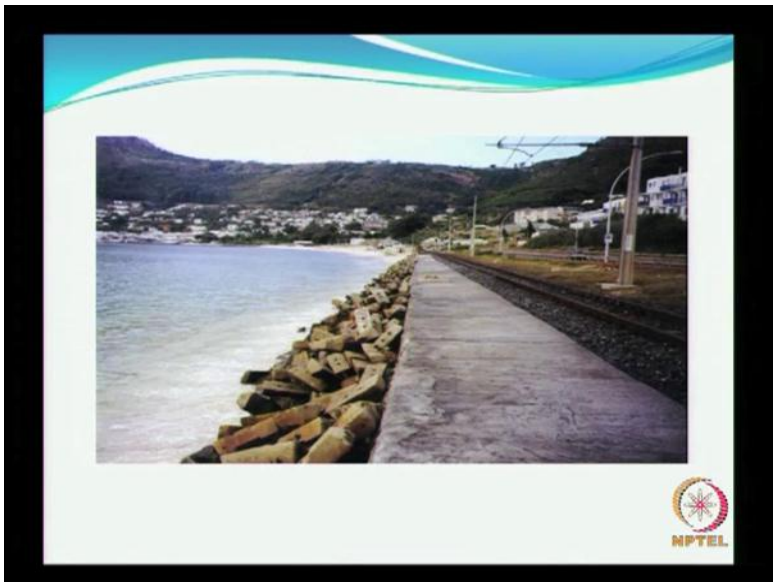

So, this is a typical photograph which shows that see look this is somewhere in Cape Town South Africa, where in see the this is a railway line and you see that they wanted to change the railway line. I mean the sleepers were not in good condition, and they want to get away with the sleepers and they want to renovate all the sleepers of this railway tract. What they did, instead of dumping it somewhere they have just used this along this, along this protection measure. Now, this is acting as a buffer and it does not create any problem and it is acting as a protection measure.

So, sometimes such a situation can arise where in you try to use this material, which is not needed for protection measure, but I will show you later as an example where such a situation took place where in we have used, we did not want the concrete pipes. We removed the concrete pipes, and it has been used as a protection measure just because to protection measure for preventing erosion along our Chennai coast. So, there you see that although the effort was to try to use the material instead of taking away from that place because the mobilization cost, and de mobilization cost is going to be quite high.

So, when they used it they found an adverse effect here you have a positive effect, but where there you will see an adverse effect so at that point of time I will also refer to this cape town sleepers. So, that there I have just told something about revetment, there are some other information's for other particular. I mean details for on revetments or any other structure you

should again refer to some other references. Now, this picture was has been presented by Toyoshima in 86. We have seen the sea dikes.

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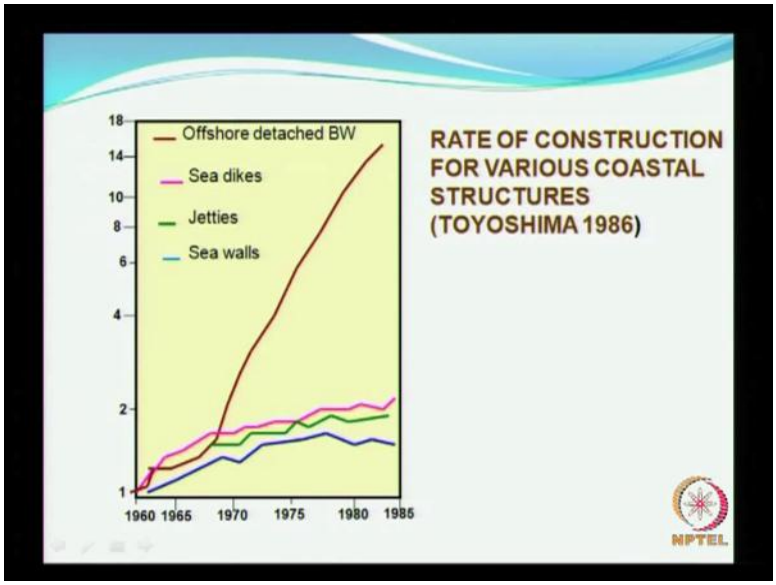

Jetty sea walls extra, all these things are grain field look at any of these structures, which has been adopted as a coastal protection measure. The rate of increase is something like this that is the number of projects, which has adopted a particular type of measure I mean protection measure. You see that there is not much of a difference here and the rate is also almost constant after sometime that is after 75, you see the almost a constant. And even the rate of increase also quite gradual from 1960, but there is one difference you look at this offshore detached breakwater.

The rate of increase in projects that are being implemented with offshore detached breakwater as a coastal protection measure has drastically, increased and because it has its own advantage, but there are small disadvantages also. This is the rate of in increase particularly in Japan and also in other developed countries where European countries, or the American, Americas or Europe's. So, you have number of projects which are number of protection I mean coasts with the protection measures as offshore detached breakwaters. So, let us see what is offshore detached breakwaters?

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So, this is you have a picture down below. So, general it is used as a shore protection measure, the structure is parallel to the shore the structure is parallel to the shore line. Again similar to groin field it is preferred at the locations where long not preferred, it should be adopted at locations where you have long shore sediment transport, and which is quite significant. This is as is said earlier increasingly adopted compared to other protection measures particularly, in Japan.

Again here again you can have exposed or submerged remember I have already told you when we when we spoke about the grain, the grain can be like this or it can be completely submerged also, depending on the quantity of suspended sediments and bed load sediments. So, here again you have exposed when you have exposed or even you can also call it as partial exposed because it will be exposed only during low tide, during high tide it can be submerged or it can be continuously be exposed. That means, even during low tide even during high tide it will be it will be same. So, all kinds of possibilities are there, but there is one disadvantage here not disadvantage. What I would try to say is I will try to come back to this later trying to give some kind of comparison between groins, and offshore breakwaters.

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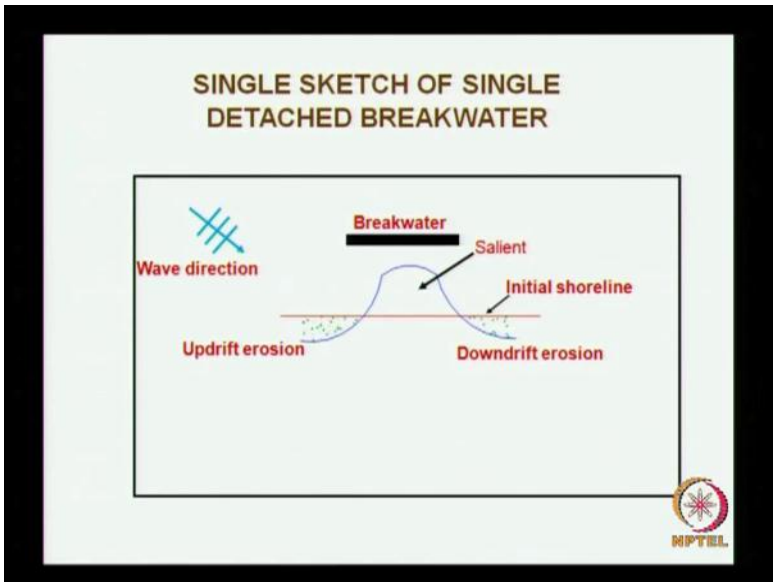

When you have a single breakwater detached breakwater, we have already seen when during the introduction that the under the phenomenon of diffraction. We have seen that the a way of climate in between the shoreline and the break water is going to be very calm compared to the adjoining areas. And hence, you have the sand coming from higher energy to lower energy that is on the lee side of the breakwater, you will start getting the build of the beach and this formation.

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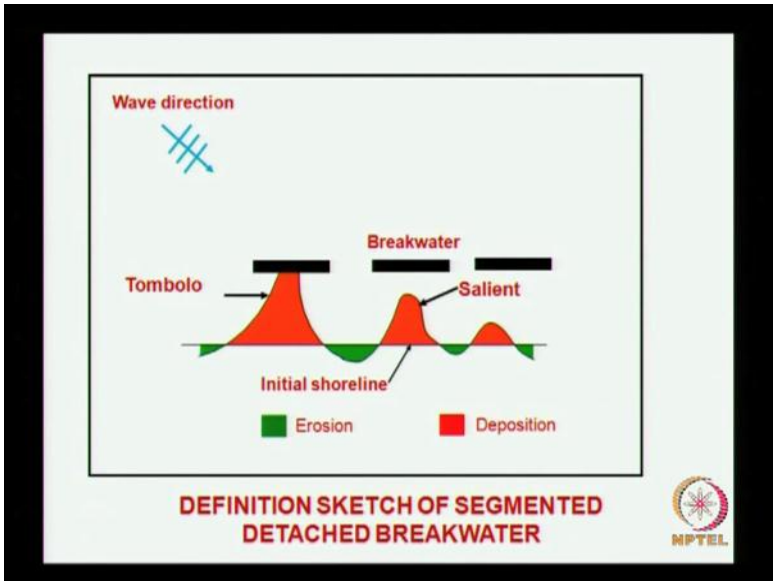

Of the beach is called as the salient. So, as the (( )) as this propagates. So, still it is not contact with the breakwater. So, in such a case this formation is called as a salient. The moment in due course when this formation reaches the breakwater, then the formation is called as tombolo. So, once you have tombolo the beautiful place where you can because there are some locations, where this is been very effectively being used as a play, it can be used as a playground, but one thing you should be very careful in determining the distance between the shore line, and the breakwater.

That is the length of the breakwater the gap between the break water all these things are going to depend on the geomorphology of the course, the wave climate like the wave height wave period as well as the directions. So, all these things and there are host of other parameters which are included, which need to be considered. So, when you try to plan for such measure it is usually done by with the help of numerical modeling, followed by or just with numerical modeling or with a experimental physical models. So, based on this they you can determine the parameters that are needed for the planning, and design and construction of offshore detached breakwater.

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So, effect of effects of exposed offshore breakwaters. So, this I have already explained about tombolo, and salient. Shoreline changes I have already explained. Now, also the breakwater and segmented breakwaters also I have explained.

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So, now this is what you see in the typical example in the Baltic sea, this is (( )) a old photograph, but this photograph is used only to just show you how the shore line can change. So, you see that there is a off shore breakwater here, there is a an off shore breakwater here is the gap and you see the salient being formed. Now, the situation I do not know this was taken in quite old picture. So, again you have to be careful in rehabilitating the offshore breakwater.

Now, these days instead of rubber bond you can also think of having geo tubes, and you can have long geo tubes separated by distance to replace those offshore detached breakwater, and that can serve as a good protection measure. Physically, I will the physical phenomenon is going to be the same weather because it is obstruction may be the only difference is the, but the phenomena of diffraction will take place, which is going to be the most important phenomenon. Where in through which you get the accumulation, or the advancement of the shear shoreline as a salient or later followed as your tombolo is that clear (( )). So, yet another view of the same thing.

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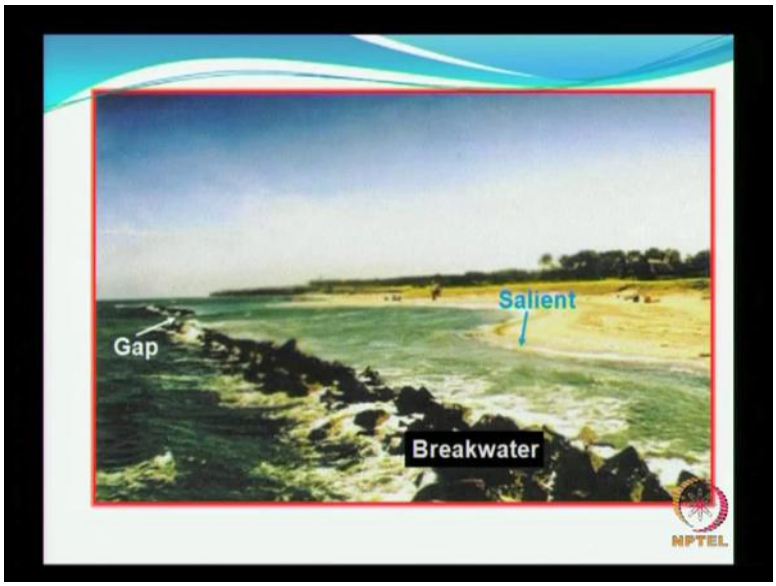

So, you see the salient the breakwater and the gap.

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So, this is somewhere in Tokyo an aerial view taken from some, some of the conference announcement I guess. So, just to show for the students how tombolo formation can look like. So, it is so it looks quite pleasing with nice it looks like small, small bays. So, you see that this can be a small bay, this can be another bay. So, this can be acting as something like swimming pool. So, you can have relaxing beach etcetera. So, these are some of the advantages of having this breakwater, off shore detached breakwater.

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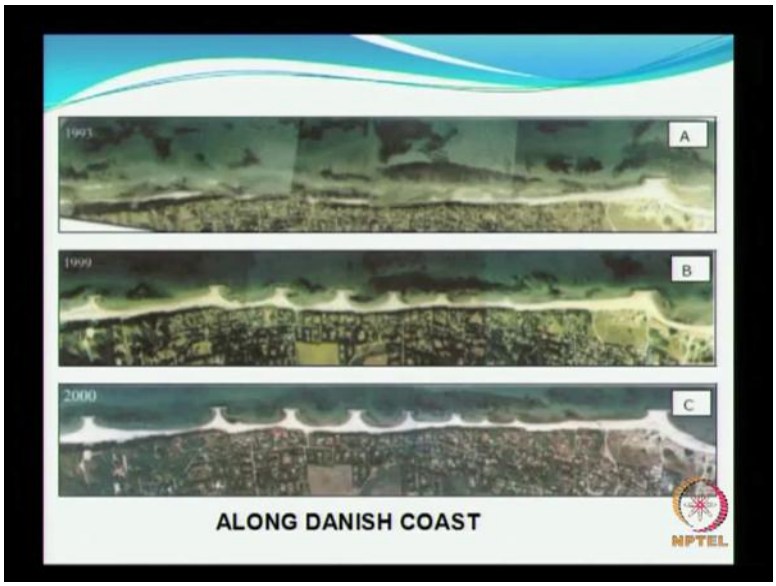

So, this picture shows along the Danish coast how the offshore detached breakwater has helped in the beach built up as this is taken from the satellite imagery. So, you see that 1993 you see what is the status of the coast and then 1999 look at the status of the. So, you have the slow building up of the beach the transport of the sand, trapping of the sand behind the breakwater and then once, it is trapped then you have the building up of the beach. So, then you see that you have nice beach here.

So, if you want enhance probably you can think of having one more small breakwater here, and that will that will (( )) that will result in the deposition of sand, or at advancement of the shoreline here. So, you can have something like this you understood. So, you can enhance one more small two bays in within one bay. So, this is somewhere in Italian coast, along the Italian coast.

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Now, you see that initially these off shore detached breakwater were dump and now, you have the advancement the tombolo formed. Now, since if you think that this bay is quite wide and you want to reduce the width of the bay, then you can still have small structures parallel to the coast, and then that will trap the sediments. So, you will have the reduction in the bay size you understood. So, this is the advantage of the offshore detached breakwaters, so yet another view of off shore detached breakwater.

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Where in this is protecting the building just adjoining the beach, adjoining the shore line. So, this gives us the feeling for the advancement of the shoreline due to offshore protect.

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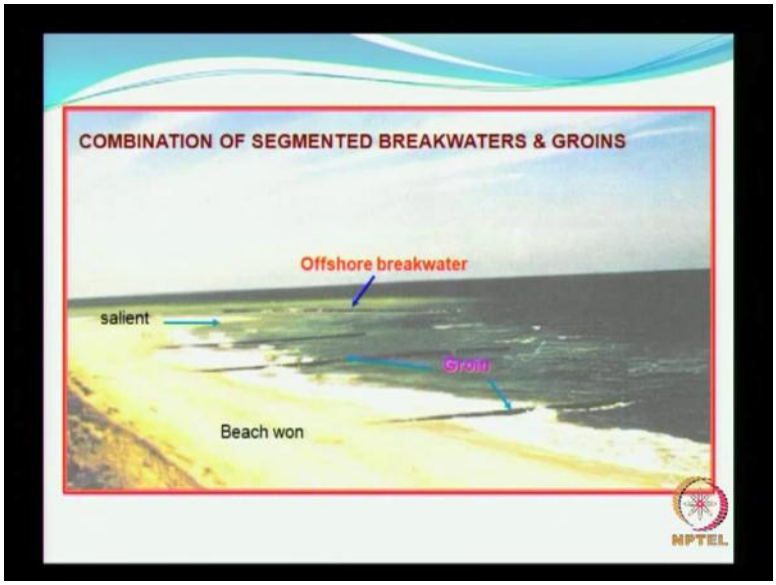

Sometimes combination of segmented breakwaters and groins are adopted this is of course, a bit expensive, but this is also being used. For example, you have something like this so you have the off shore detached breakwater here with a gap hare, and then you have the groins here. So, this will enhance the see enhance the beach formation by having off shore detached break water, there is another advantage because when the waves are coming towards the coast, the presence of the breakwater off shore breakwater reduces the incoming incident wave energy.

So, this is one way this is one of the method which is being used for protecting the nuclear I mean, the power plants along the coast when you have power plants along the coast its very diff it is very important to make sure that the waves, the water from the ocean does not come into the building particularly, during coastal hazard like a tsunami. So, one of the way is to construct off shore walls it is called as off shore walls something like break water, which will reduce the incident energy both in magnitude and its speed.

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So this is again somewhere in Italy, somewhere near Naples I guess. So, where in so you have a sea wall, but in order to make sure that the sea wall is intact, you have off shore detached break water also constructed there. So, sometimes you are going in for a structure to protect another structure this is also, this may also be the case.

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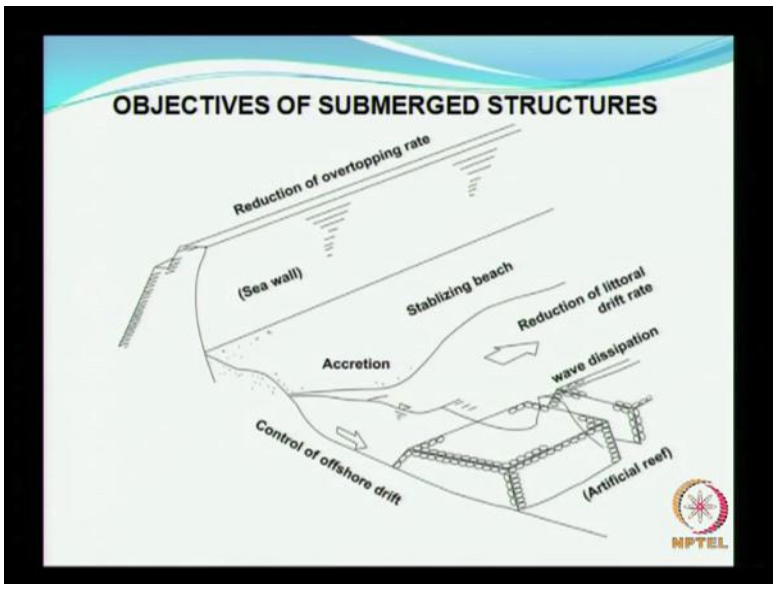

So, this is a submerged structure where in when you have a submerged structure I am going to talk about it again after sometime because of this submerged structure. What does the

submerged structure do (( )). What happens, when you have a submerged structure? Sir, it will prevent bottom slope, no, no I have a…

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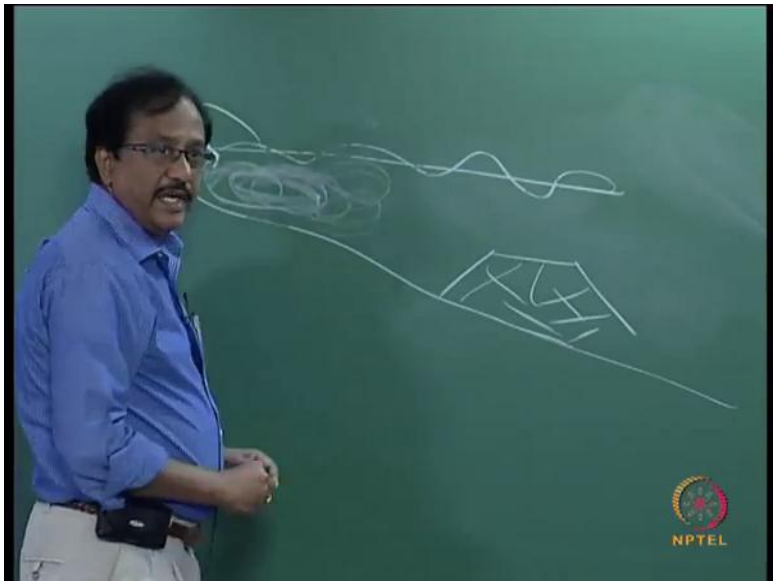

I have a beach, I have a sea bed and now you have the breaking and then you have the. Now, I am putting a submerged structure here, submerged structure this I am putting it as a this is an artificial structure, but there can be natural reeves submerged reeves. What will happen in this case? So, the instead of breaking here it will break here, what will happen if it breaks here? Energy is dissipated. Then what happens, if energy dissipates what happens to the sediments?

Sediment will deposit where, will it deposit here or here it will be depositing here because here is the location where the waves are attenuated, the energy is dissipated. So, the energy is less here so you can have the sand being deposited here. So, submerged structures are reeves enhanced premature breaking. So, this is the concept which has been widely adopted in certain locations, where. Now, when I am talking about geo synthetics, that is where again here instead of this artificial structure, you can have geo tubes to which will act as a structure.

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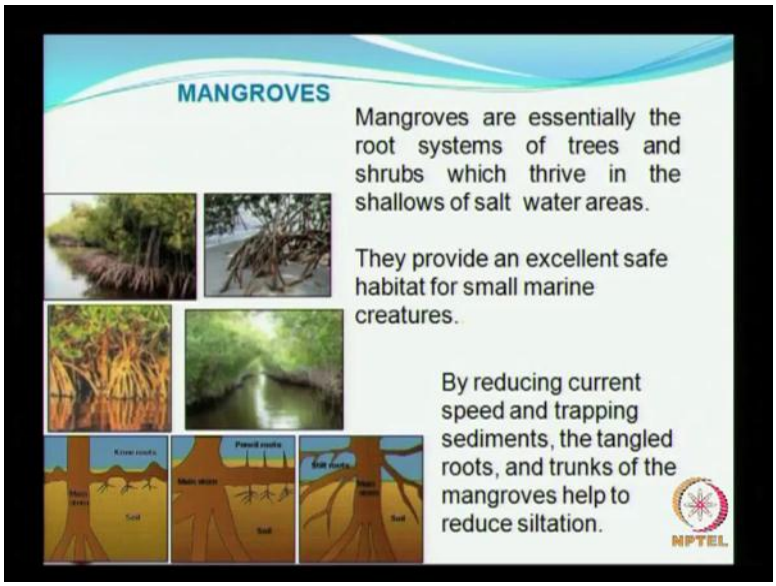

So, we have seen so far all the hard structures what are called as hard structures, what are hard structures? Hard structures are like construction of sea walls groins off shore detached breakwaters, using large boulders. The same kind of structure if you are using it with by applying geo synthetic materials like geo tubes etcetera. Then we do not refer it as hard structures, we can call it as soft structures. And apart from this what are the other soft structures if for example plantation, plantation can also be termed as soft structure it can be these are also termed as bio shields, bio shields.

Now, what is the other kind of soft structure, soft solution. Wherever you have erosion, wherever you have deposition remove the sand and nourish it. So, the beach where it is getting eroded. So, far we did some exercise about we tried to understand, what are the hardware structures now, we will just look at some of the soft structures that are available. See mangroves vegetation, vegetation the role of vegetation for coastal protection has gained enormous attention.

Particularly, after the 2004 tsunami because there are number of evidences, where they have seen that wherever you had plantation in front of structures this these structures survived or at least the damage was quite less, compared to locations where it was directly exposed to the tsunami. And the lot of research were going on how to understand although, we know that it can serve as soldiers against the, that kind of coastal hazard, but then we need to understand

the physics behind it, how the energy is getting dissipated. So, there to understand this only there are lot of people who are working in this area.

So, mangroves are essentially root system of trees and shrubs with thrive in shallows of salt water areas. So, look at the kind of roots all this these kind of roots, these kind of roots will be acting as a permeable media. When the water is going through it the energy gets dissipated, it is very simple. They provide an excellent safe habitat for small creatures that is an added advantage, then by reducing the current speed trapping the sediments the tangled roots and trunks of the mangroves help reduce siltation.

So, but only thing only disadvantage, not disadvantage the one you should remember that mangroves can really flourish at locations where there is exchange of sea, and fresh water. You cannot have mangroves all along the coast it will not thrive, another pitiable thing is many people the coastal village, coastal guys they try to people they try to cut this mangroves for firewood also, which should be banned.

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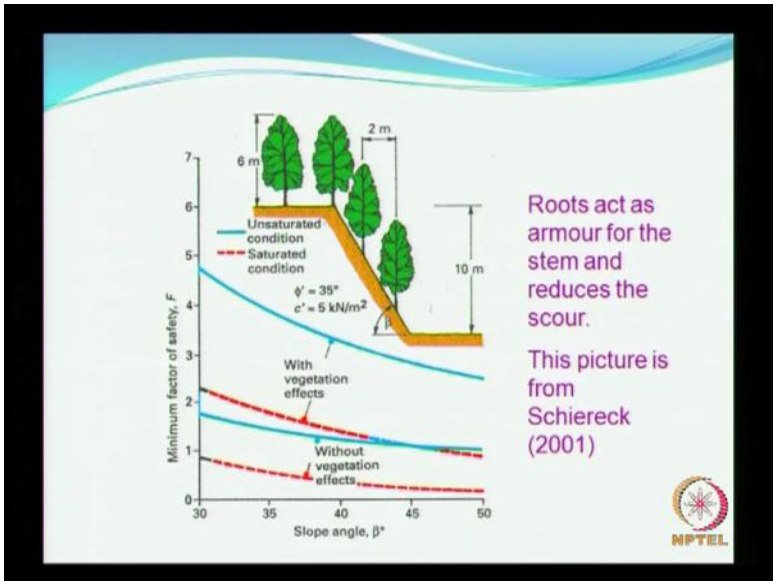

So, here roots act as armor for the stem and reduces the scour. This picture is taken from Schiereck in 2001 year's brought out a nice book, wherein he has given the slope angle beta for different slopes, how the minimum factor of safety. So, this minimum of minimum factor of safety this is vegetation effect without the vegetation. So, you look at with vegetation and without vegetation that with vegetation it is higher. So, you look at this, one is the blue color

is the unsaturated and the red color is the saturated. So, if you look at this so you see that this is with vegetation and this is without vegetation, so with vegetation.

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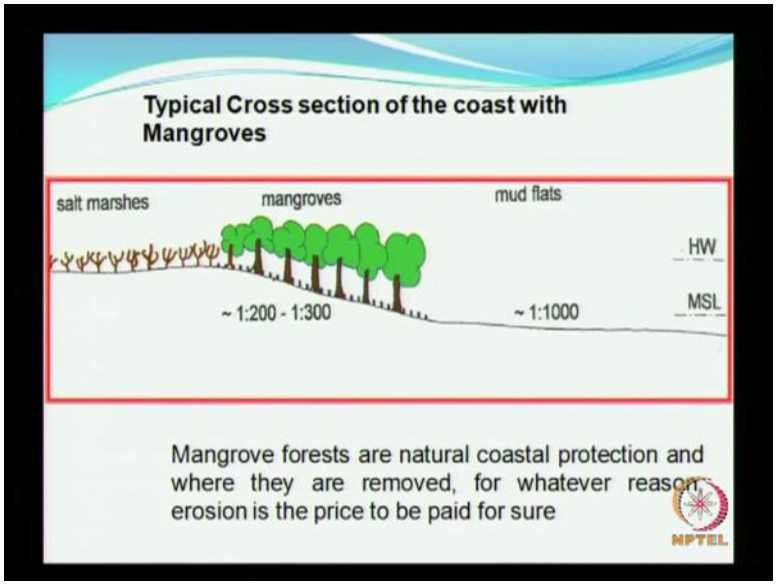

The safety is much higher. Now, the typical cross section of a coast with mangroves this is what how it should look, but seldom it looks like this, good beach. For example, where you have mangroves mangrove forest are natural protection, and where they are removed for whatever reason it may be erosion is the price to be paid for. So, this is the statement given in one of the books I think it must be Schiereck and then since, I like this sentence I have just placed it here. So, this is very, very important that we take care of the mangrove forest.

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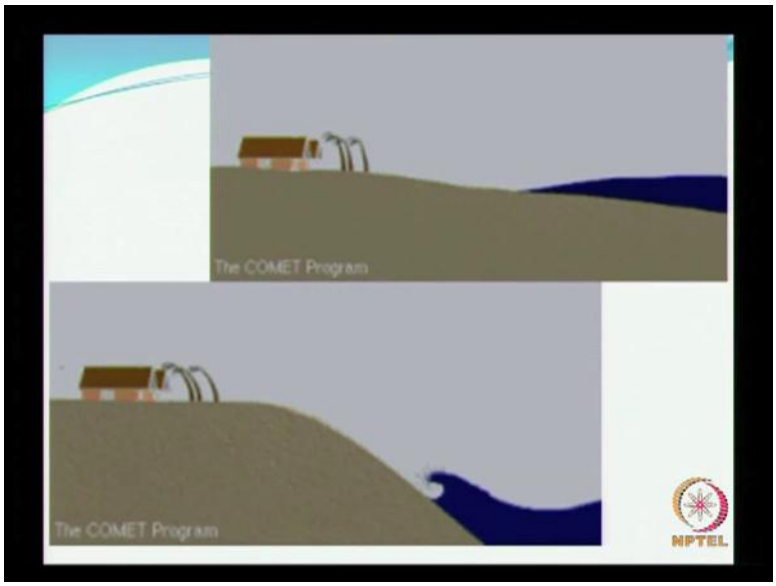

When you look at ah this picture this animation clearly shows, what happens when you have a flat beach and a straight beach, I mean a steep beach. So, flat beach is vulnerable for damage if you have a coastal hazard like the tsunami it will simply move, and then you see that if you have a thick I mean high density plantations that can definitely reduce the speed with which the water is moving. Otherwise even the plantations may not be of any help. So, it is the flat beach, where you should be very careful in dealing with the coastal I mean in regard to the preparedness for coastal hazards. Then coming back one thing I forgot to tell you that is when you look at the off shore break waters.

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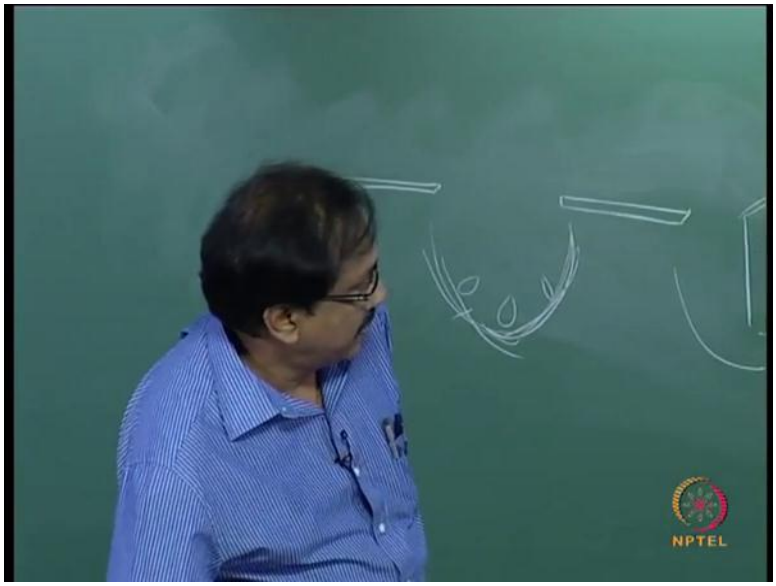

You have the off shore breakwaters here so you see that you have the bay, but if you have if you have the grain field here again you have the beach, here again you have the beach. Suppose, if you want to use this as a bay, we hear what we do is we can use this as the location for the beaches, for fisherman if they want to park the vehicles I mean the boats. Here this area can be parked, this is the area along which they the boats can be parked and here it will be like this. Tomorrow, if you want you can very easily it is not so difficult for in this case to extend one of the arm, if the predominant direction is in this way and convert this as a small harbor for it.

For example, you can have you should be having one more number of groins. So, instead of adding only taking considering only 2 or 3 groins you can have add a 4 groins, and develop this as a major harbor also major fishing a big fishing if you want to. So, that may be limited in this case and another problem here is the construction of off shore breakwaters is not so easy compared to construction of the groins because in the construction of groins, the material you may need the kind of machines you need its only kind of it is based on the (( )) method.

So, you have an approach throughout where in the truck with the stones can keep on moving over the slope. Whereas this the it is entirely based in the off shore and the construction has to be very close to the breakwaters. And any way I when I talk about the construction of groins I will slightly elaborate about the details, how it has how they have done etcetera. So, I think I will stop here.