Coastal Engineering
Prof. V. Sundar
Department of Ocean Engineering
Indian Institute of Technology, Madras

Module - 3
Coastal Erosion Protection Measures
Lecture - 3
Coastal Erosion Protection Measures – III

So, today we will see in this lecture about the different coastal erosion protection measures. In general you have sea walls, bulkheads, revetments, groins, jetties, offshore breakwaters.

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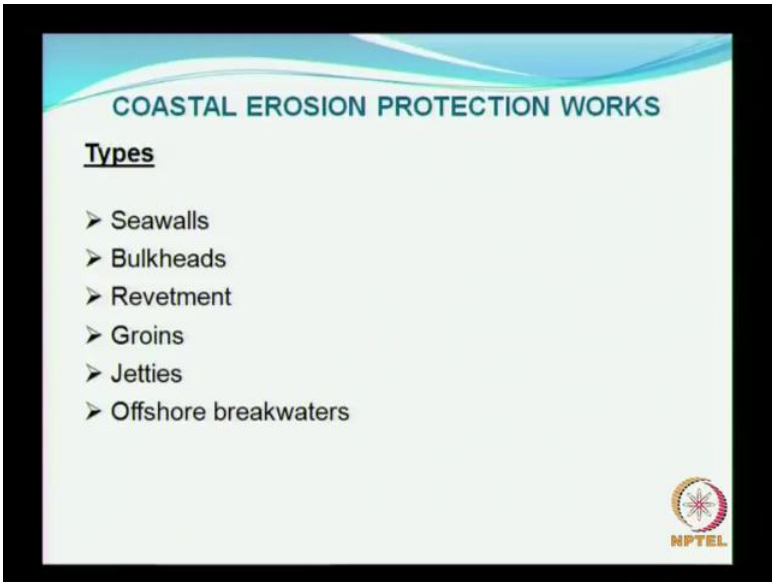

When you look at some of these structures for example sea walls, bulkheads or revetments or even groins and breakwaters, the type of material you use is almost the same like dumping of rocks. And there is a specific way of designing the structure, and the formula which you may be using may also be same, but why are they having different names? The names they derive is because of their different functional, because of its functional aspects based on its functional aspects, which we will see later. Now, let us consider one by one these structures and try to understand what they mean for us.

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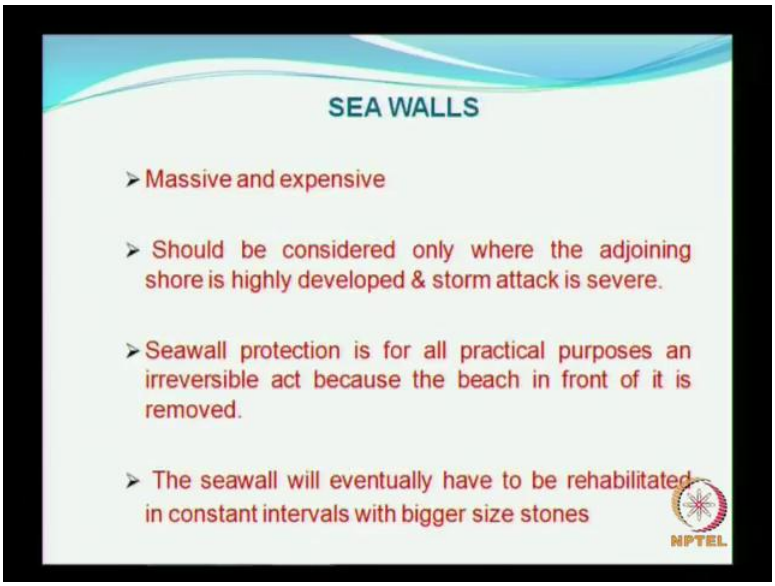

Sea walls, these structures are massive and quite expensive, should be considered only where the adjoining shore line is highly developed and storm attack is severe. These are all the general considerations. Sea wall protection is for all practical purposes and irreversible act because the beach in front of it is removed. The fourth point is the sea wall will eventually have to be rehabilitated in constant intervals with bigger size of stones if required.

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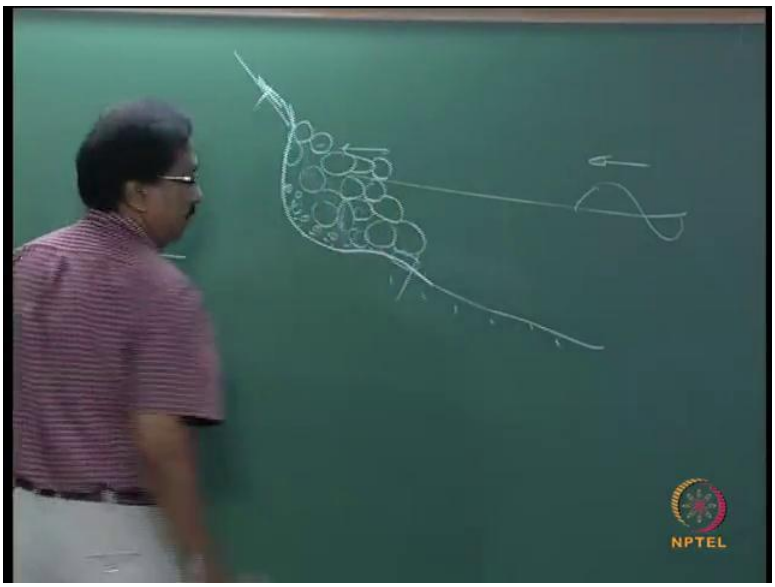

So, first of all sea walls if there is an erosion taking place, this is the plan and this is the beach profile. So, you have the, this is how you represent in section and this is how you

represent in plan the wave. So, these are constructed along the shoreline and in case this has eroded. What do you do? You protect it with with stones first you initially have smaller size stones, well these days we have what is called as geotextiles which can run through and anchored properly and then over which we can have the filter layer and then we have the bigger stones and the we also can think of having a burm, this is the this is the burm. I will come to that later, but make sure that u have a strong toe protection. These aspects also will be discussed later.

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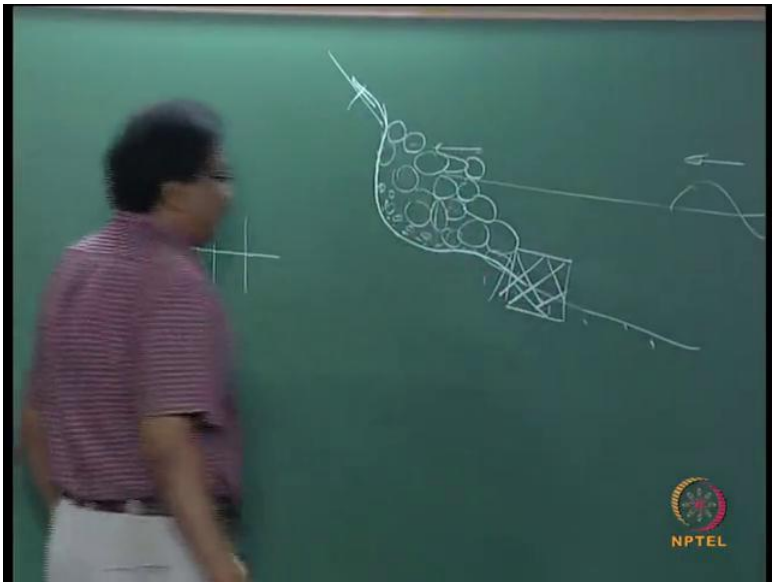

So, it depends on the length of the coast which is going to be affected. So, if it is like this there is no point in just considering only this location, you also have to consider slightly on the either side of the affected area. We will also see what happens at the terminal point of the sea wall when after the construction what to the, what happens because of the terminal effects. Sea walls should be considered only where the adjoining shoreline is also highly developed and storm attack is quite severe for example, here you may have a a industry which needs to be protected and similarly, you may have some village to be protected. So, it may be a long coast line.

This applies in general for all cases even when you are planning others costal protection measures because you should not think of only the local problem. Locally there may be some kind of an erosion a patch of erosion, but you have to while designing the coastal protection measure you have look at the adjoining area so that whenever you try to

implement some protection measure the adjoining shore line might have some problems. Sea wall Sea wall protection is for all practical propose and irreversible act because the beach in front of it is removed. What does that mean?

Suppose, this stretch of the coast for example, this stretch of the coast is last for over a long distance and this has significantly penetrated into the into the land and you want to protect this area and assume that you have lost something like 300 400 meters and protecting or protecting and also getting back up to the original location or original shore line, reaching the original shore line would not be possible at all. What you decide is, you decide that this is the area which needs to be protected. So, you protect it with the sea wall that is the moment you have protected with this this stretch of the coast that is this becomes your boundary and not this.

That is the stretch of the land, which has already been lost, is lost forever that is you do not try to pay offence with the waves. You play defense. So, you limit your stretch of the coast shore line you only assume that this is what you can protect and this is the area, which you have to forget about it which is lost is lost forever and the idea is that you make sure that you do not lose further. So, it is something like you put a fence, but you mean to say by doing this can you really protect the beach shore line? Yes, you can protect the shore line provided the structure is designed properly and you do not really anticipate severe costal hazards like severe cyclones etcetera. If you have such sudden outburst of costal floods then you are in for problem and when such a situation occurs what are we suppose to do? We are supposed to immediately rehabilitate the sea wall.

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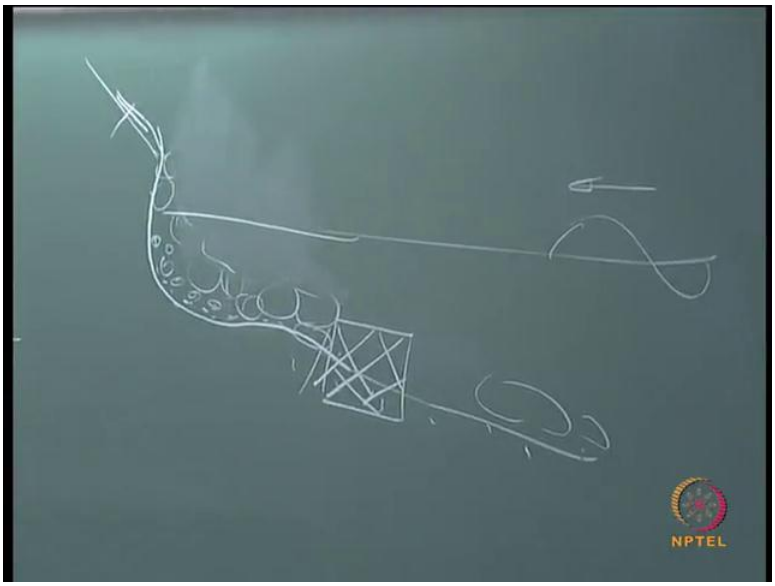

For example, we you have a very severe coastal coastal hazard where in what would happen all this stones would be removed and these stones would likely to go here. So, this stretch of the coast during one costal hazard has eroded for example, and you do not rehabilitate. When you do not rehabilitate the cumulate affect on the sea wall will continue to act and you are likely to initially get back to your original situation and still if you do not respond to the call of the waves then you can have much more than what had taken place.

So, it is extremely important that you have a continuous monitoring of the sea wall once it is constructed and then keep rehabilitating at regular intervals. When you talk about rehabilitation it will most likely it will be falling under category of identifying bigger size of stones because if you are going to have smaller size stones naturally it is going to be removed without any problem. So, you have to have all these things in mind when you are talking about the sea walls.

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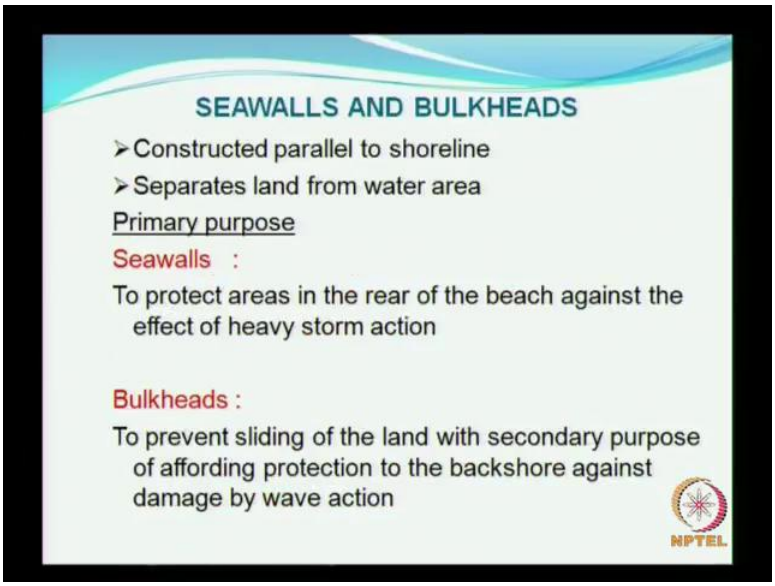

Sea walls as I said are constructed parallel to the shore line or along the shore line and now you have another word, it is this is called as bulkheads. Both bulkheads and sea walls are constructed parallel to the shore line they separate the land and water. Water means I am talking about the seawater, but they get that to, I mean they get their names only because of the primary propose for which they are considered. For example, that is sea walls its main propose is to protect the rear side of the beach against some storm attack.

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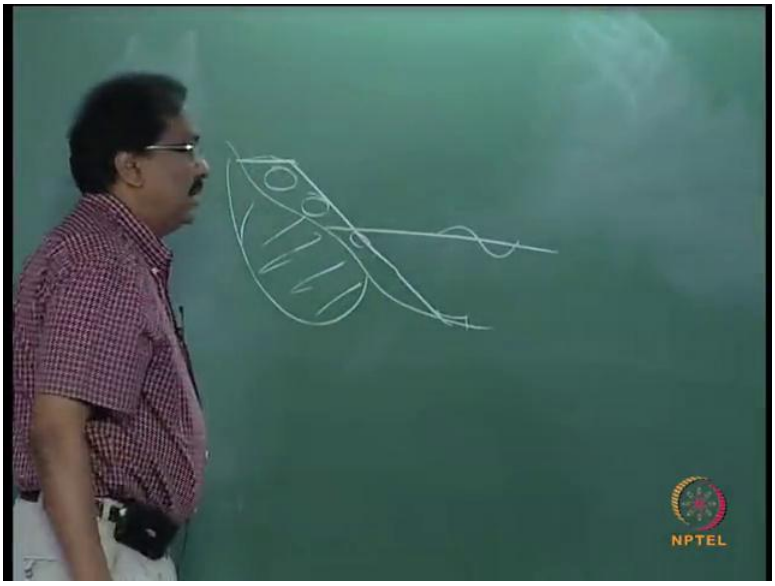

So, again so this side of the area is getting eroded so you put the sea wall. So, when you put a sea wall so when you put a sea wall its main purpose is to resist the action of the waves. So, that not more energy contained in the waves is acting on the shore line and if such a situation prevails then the sand will be removed. So, the primary purpose of a sea wall is to protect the land from severe action of the ocean waves. What is the purpose of a bulkhead? The bulkhead the primary purpose of a bulkhead is to prevent sliding of the land into the ocean.

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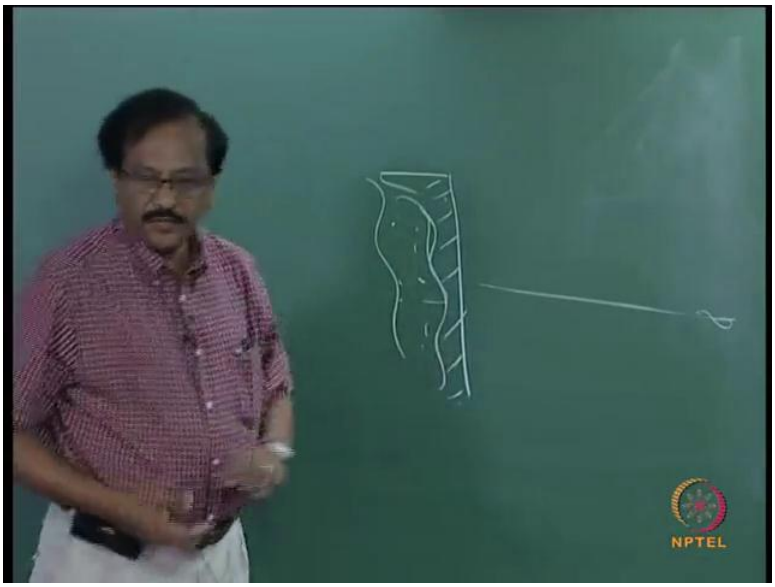

So, when you have some landmass. So, you can have you can have a structure like this which is a bulkhead, which is called as a bulkhead. Now, in this case the major force acting on this wall would be the earth pressure because it is retaining the earth and occasionally there may be some wave action on this wall. For example, the same thing if there is not much of wave action and only once in a while, very occasionally you have the action the waves coming and hitting the structure than it is called as is termed as bulkheads. So, here the major force which is coming on a sea wall is that due to waves and here in the bulkhead the major force which is that is coming on the bulkhead is the earth pressure. So, that is why they have two different names sea wall and bulkheads.

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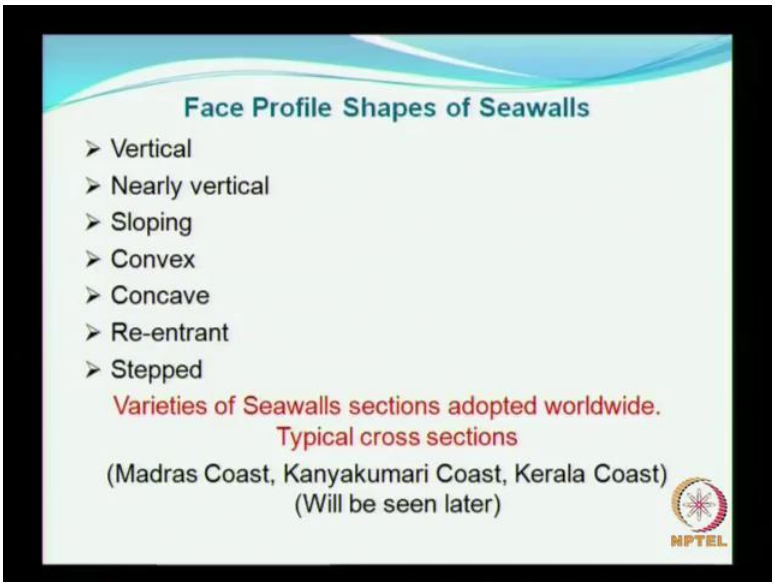

In this course I will talk more about sea walls. We will look at some of the case studies etcetera, face profile shapes of sea walls. Mostly, it was considered that just by dumping the stones you construct a sea wall. It, that is not the case, there should be a proper scientific method in order to arrive at the construction of a sea wall. When you look at the front shapes of the sea wall you can either have vertical, nearly vertical, sloping, convex, concave, re-entrant, then steps.

There are varieties of sea wall sections adopted worldwide. Some of this cross sections are adopted for our Indian coast for example, Chennai or Madras or Chennai coast, Kanyakumari coast that is the tip of Indian peninsula, close to the tip of Indian peninsula, then Kerala coast on the on the west coast along with some other few case studies etcetera we will just have a look at a later stage.

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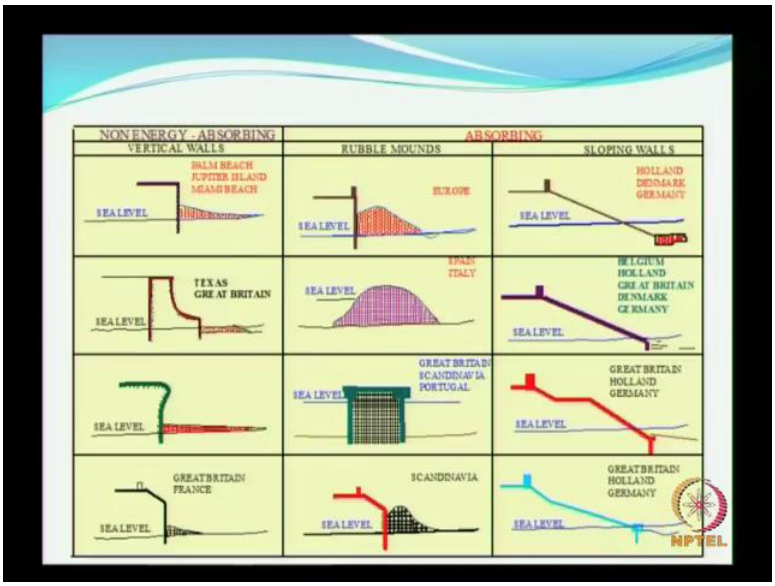

So, we will, we are now seeing one by one the different different measures that are available to us for protecting the coast. So, broadly it can be classified as non absorbing method as you can see here. Non absorbing method I mean measures of sea walls and then absorbing type of sea walls. On the non absorbing type sea walls you can have all impermeable kinds of walls. On the front face can be vertical as you can see here or it can have a shape like this or you can have a shape like this or you can have a slope.

Note, that the locations where some of these kinds of walls have been constructed are all incorporated in the slide and also note that all the pictures show here which is called as the true protection, which is very very important for taking care of the stability of the structure. How does, what is the purpose and how does the energy get dissipated, energy is not absorbed because the surface here we are considering is a smooth surface. When we are having a smooth surface in the first case the energy is lost only by pure reflection.

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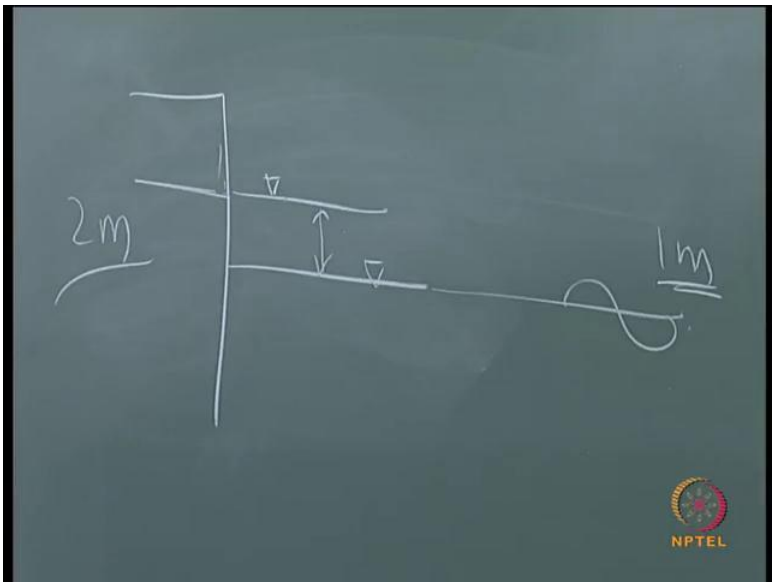

When you, we have already seen when there is pure reflection so when you have a wall I have already told you that the water level itself in front of the sea wall will go up by a certain magnitude and the wave height if it is 1 meter you expect the wave height on the wall to be 2 meters. That is twice the wave height, incident wave height. This is because of the sudden obstruction and for a, the wave height to be twice you need to have the wall vertical and also impermeable. So, when you have the wave height on the wall to be more naturally the orbital velocity etcetera will be more and so the force exerted by the presence of the structure is going to increase, you are going to have cover problem, you are going to have the forces being increased that would act on the vertical wall.

So, vertical wall is not preferred when you talk in terms of coastal protection. For that matter vertical wall structures should always be, are being discouraged for the simple reason that the reflection is going to be high and the forces exert around the structure is high. But you cannot avoid vertical type of structures in general. There are certain stages where you you are forced to have vertical structures for example, berths, open berths that is in the mid sea you can have open berths or inside the harbor. Inside the harbor there is is not much of problem, because the wave heights inside the harbor is expected to be less. There you can be afford to have vertical berth.

So, for coastal protection we generally this is not a good solution, but modification of vertical wall are being thought of. Modifying means what you have some kind of

perforations on the wall etcetera so that the energy will get dissipated when the waves are flowing through the walls. I will show you a typical structure later on this aspect. Now, the next one is here this kind of a convex or you have this kind of a structure or you you have something like this, all these kind of shapes it does not absorb the energy, but the energy is lost by when the waves are running over, when the waves try to run over it gets the energy gets reflected back into the ocean or the energy gets dissipated while it is trying to run over this kind of a a shape or this kind of a shape or even this kind of a shape.

Many times you can at several locations you have what is called as a curved wall which you see here a small protection on top. This curved wall can be may be thought of when the top level of the structure is already fixed and you have constructed the structure, but then after construction of the structure in a particular location you keep on experiencing continuous over topping from the waves or the level as sea level has gone up and you have frequent over topping of the waves. Then you can think of having a as a curve wall this can be implemented later, but you have to make sure about the stability of this curve wall after a when it is implemented after the construction of the sea wall.

So, this shows that how this different types of sea walls are considered and these are all non energy absorbing because the energy is not being absorbed and the energy is being spent either in the form of reflection or in the form of dissipation. Dissipation in the sense due to run up etcetera and at the absorbing type you use rubble bound as one of the medium for absorbing either the entire portion of entire energy which is not possible or maximum part of the energy. So, as you see here you have a vertical wall of course, you have a you see you can have a a curved wall plus you see the red one this the mound.

So, when the waves propagate this mount offers enough resistance to the propagating waves, energy is dissipated because of the permeable medium and less energy is going to attack or this wall is going to experience lesser wave force or you can have a a something like this, complete rubble mound which is quite common or you can have some kind of structure where in you can have the stones or the rubble medium rubble mound being enclosed inside a, to form something like a (( )). So, it is kind of a gravity structure, it will stand there. Well at the same time energy will be dissipated because of this rubble mound. You can also have a combination of this, you have the slope plus you have the rubble mound.

The idea is to dissipate the energy due to the presence of the rubble mound as well as the slope of the wall, the top I mean the sea wall is also going to have its own effect in reducing the energy. Then you can have the normal see walls as you can see here where in all these normal see walls are usually provided along with a curved wall and later dome sea walls have come into picture. All these things are used with rubble mound. It can also be an impermeable sea wall. If it is impermeable sea wall the energy dissipated because of breaking etcetera. It has to be really sloping, the gradual slope. If you have a gradual slope the energy can be gradual.

When you see later how a a sea wall breaks, it will break by the commonly know a slip circle which we will see later. So, adopting thus that which I will explain later they have proved that having a burm as shown here has proved to be more stable. So, this is set to be more effective and in many of the countries particularly Europe and other part of the globe. They consider the burm sea walls, but there are some problems, some minor problems when you construct a sea wall with a burm you need cranes that are lifting the stones and placing with a longer boom length.

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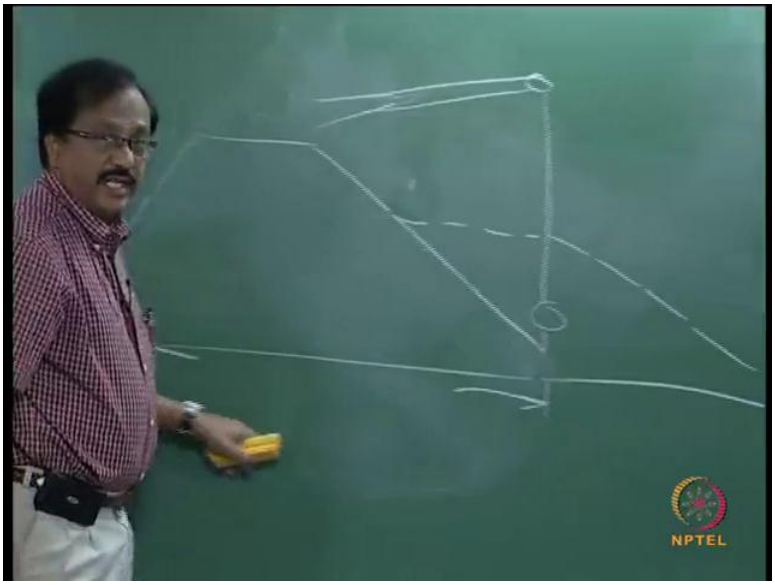

So, if you have a sorry for example if this is the original slope without the burm and you have a a truck which is moving and in needs it needs a a boom length to place the stones and its boom length can be up to this location. So, you can place the stones, but if you increase or if you have a burm then what happens the boom length has to be more. So, it calls for special

kind of cranes. So, these are all site specific so if you want to have and another thing, another problem is that the imprint of the break water is wider because it occupies you see instead of occupying this much space it is it is so for example, I will draw this.

So, instead of occupying this much space it will now occupy this much space. This was the original width, but now you have because of the burm you have the increased width. So, these are some of the demerits, but there are merits which are more towards the stability of the sea wall. They have claimed from practical experience that burmed typed sea walls or burmed break waters are more stable. So, you have to decide what kind of a while whether you need to have a burm or you may not, you do not want to maintain a burm, you want to go for a conventional break water or a sea wall and then make sure that regular monitoring is there and if there are some stones being dislodged you keep rehabilitating at regular intervals.

So, it so, hence this is based on the importance of the project for which this measure is being implemented. So, there are a lot of locations. Mostly I have what I have shown here are locations in US and Europe, but there are variety of other kinds of sea walls which I will touch, will, which we will see later.

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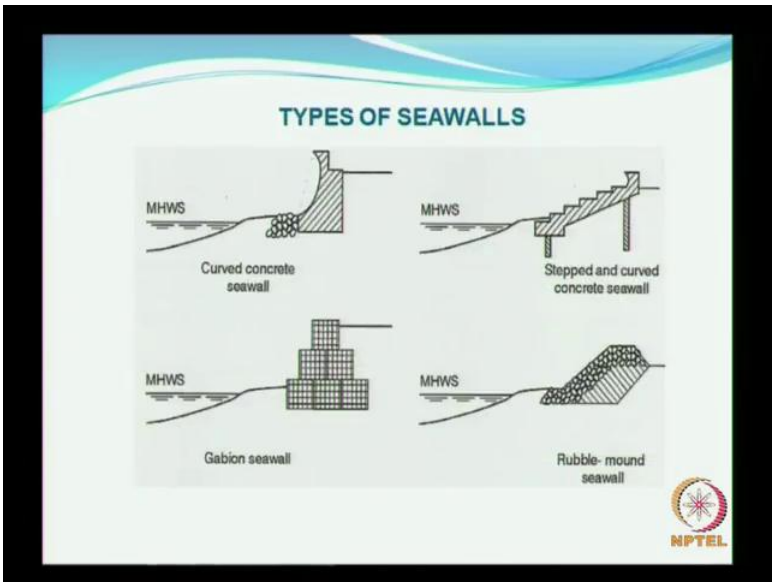

So, these are some of the type of sea walls where you have here this returns the flow back to the ocean. When it returns the flow back to the ocean you expect the reflection to be less and also the run up over the structure is less, where the run up over the structure is less the

anticipated over topping is going to reduce or you can have this kind of a sea wall wherein you have a number of steps and these are going to act as fix something like friction blocks where a continuous reduction in the energy is being offered because of its presence and because of its projections.

So, these are concrete type of walls and they are not rubble mound. Of course, this can also be constructed in terms of rubble mound a bit complicated, but it can be done and at locations where you do not have large size stones. When you calculate the stone size can be something like 2 tons or maybe even a very vulnerable coast it may be 3 to 4 tons and if you do not have a a proper quarry and if the quarry is located a very large distance to sit to get such huge stones, then you need to go in for what is called as gabions.

These gabions are something like net and it is some so it forms as a cube and then you put a smaller size stones, but make sure that it is not smaller than the size of the opening and then you dump it, dump and then you tie the whole thing and then this gabion will act as a single unit, but the material you use for those gabions should be perfect. What do you mean by perfect? Earlier they were using some some kind of cables and this cables used to get rusted and in due course it used to snap. Once this happens all the stones will come out and then this will be become pebbles and all this pebbles can easily be washed away. Now, these days we use what is called as geosynthetic ropes which are used for preparing the gabion and then putting the stones. So, I will show you some of the examples later. So, this is the conventional rubble mound sea wall which we have already seen.

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You look at this wall, this is a concrete wall. Now, you have a a toe protection here. The importance of toe protection will again be discussed later, after about 3 3 4 slides. In the rubble mound sea wall note that the drainage is also very important because when there is a monsoon the water which gets accumulated on the re le side and if if it starts penetrating, what will happen? There can be a settlement of the sea wall and the whole thing can be washed off that is the reason they use these days a geosynthetic material. So, you need to have a drainage in order to drain the water, storm water.

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So, this is another rubble mound sea wall. This is I think, it is somewhere near in Sri Lanka, along the Sri Lankan coast and you see that the protection has been found to be quite fruitful and, but only thing is they need to do frequent rehabilitation of the regular monitoring is a must.

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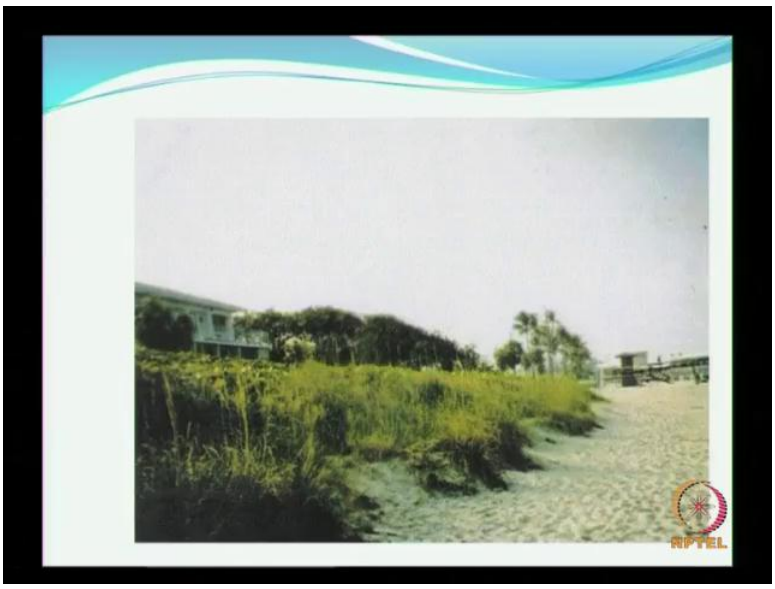

Plantation, this is also very important. All these things, I cover under sea wall because it is along the shore. Plantation also it will also act as a buffer. Later we will see how plantation

has made has played a very significant significant role in reducing the effect of tsunami on to the land.

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I said earlier that a vertical sea wall can also be made perforated and once such a such a you once you make a such kind of perforations, it can still be used. Although, we have seen the disadvantage of a vertical wall there is an advantage of the vertical wall because it occupies very less space and another another important thing is you will not, it is not an eye sore. When you go along the shore line and you see rubble mound sea walls all over it is nothing there is nothing, no charm in it. All the aesthetic value is lost.

So, this is a sea wall constructed in Japan where you look at this burms they have this is how it looks inside the ocean because we we will not be seeing and you look at here, you have lot of holes here so that the waves, when they penetrate they penetrate into the, into the holes into this rubble medium and the energy is dissipated and in plan, if you look these people have looks as if there are they have a direct access to the ocean. This is what is called as aesthetic way of looking at coastal protection. Of course, this kind of a structure is naturally more expensive than the other kinds of conversional structure. Hence, a coastal protection measure has also a bearing on so many other aspects like tourism for example, here this coast getting eroded they have saved the coast at the same time provided a beautiful place for the tourist and for the locals.

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So, this shows the use of gabions as we have seen earlier this is somewhere in in South Africa, in somewhere near Cape Town where you see the gabions and the stepped wall, as I told you earlier the stepped wall can be impermeable or it can be formed with the gabions. With the gabions it can be more effective because some amount of energy is dissipated because of the porous medium which we are having there, is that clear? So, this is a, this is in the case of reverse bank protection gabions are being used widely for bank protections. So, bank protection also are liable for cover, a erosion, erosion of the banks so they use.

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So, this is again under the sea wall wherein they have used what is called as geo bags, geo synthetic bags. So, these look like cement bags what we get filled with sand. So, they pump in slurry the water mixture of sand and water. The water comes out, but the sand retains and then it is placed like this and look at this, this is somewhere in Germany, island of Sylt. This is one of the usual common picture, you see when you look at the geo bag protection. So, this is again I am using it under the classification of sea wall.

This basically so probably the beach would have been here. Now, what is this? This is what is called as a irreversible act. So, the beach which is lost is lost, but now there is a desperate situation to save this. So, because if you do not do this, these vertical cuts can penetrate and then you see that this becomes the existence of that build building becomes questionable.

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So, this is in old Mangalore. This is a bit old picture now this scenario may be quiet different, but anyway I am using this picture in order to show you that the geo bags were also adopted, but has failed miserably. This is somewhere in Ullal, where you see the geo bags filled and it did not sustain the severe erosion that took place after the construction of the sea wall with geo bags.

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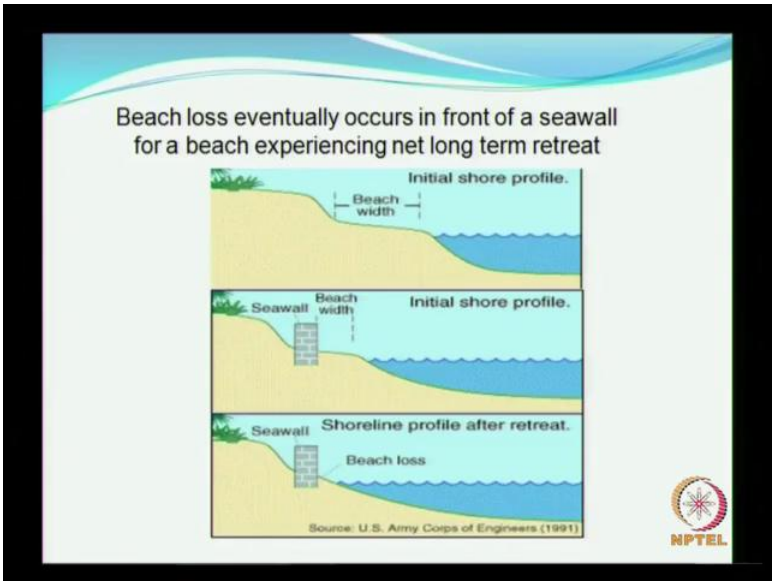

As I said earlier beach loss eventually occurs in the front of a sea wall for a beach experiencing let net long term retreat. So, this is the beach width. Now, you construct a a sea

wall, beach width is so much and then that beach also can be lost, but then this sea wall acts like a soldier trying to prevent further loss, but it has to be done carefully because the sea wall itself can be lost as we have seen in the earlier case. All these things are remains of an existing sea wall. So, sea wall if you do not do it properly the entire sea wall can again go into the ocean.

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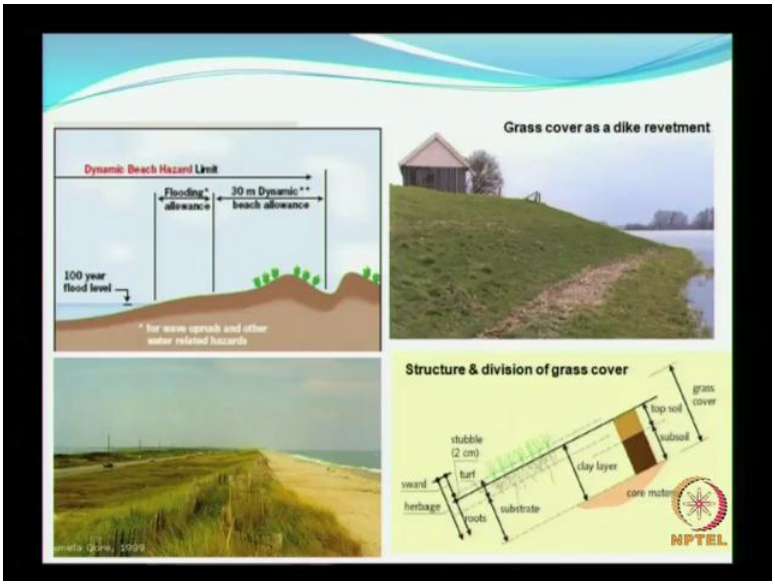

These are some of the views how you can protect the coast with the plantations. So, this concerning this picture I will again be covering under the tsunami. So, wherever you have scope for plantation it is better you go in for plantation because the roots have a property to act as a protection measure for by preventing the soil erosion which I will show you in the next class. With this I will conclude. Today, was it alright?