Dynamics of Ocean Structures
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Module - 1
Lecture - 5
New Generation Offshore and Coastal Structures

So, in the last lecture we discussed about the new generation offshore platforms.

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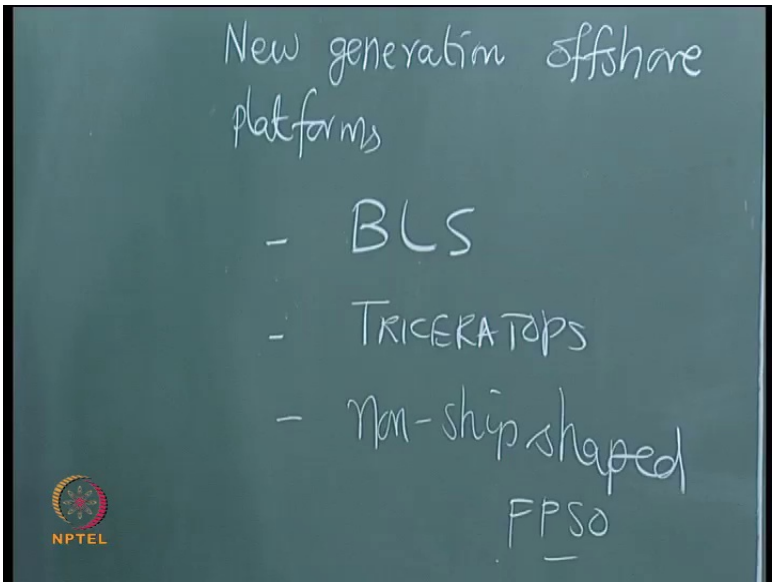

We spoke about buoyant leg structure. It is a form defined new kind of platform, we also spoke about triceratops. We spoke about non ship shaped FPSO and so on. So, what are the important aspects, which I have been discussed while these new forms of offshore structures have been generated? Let us look at that.

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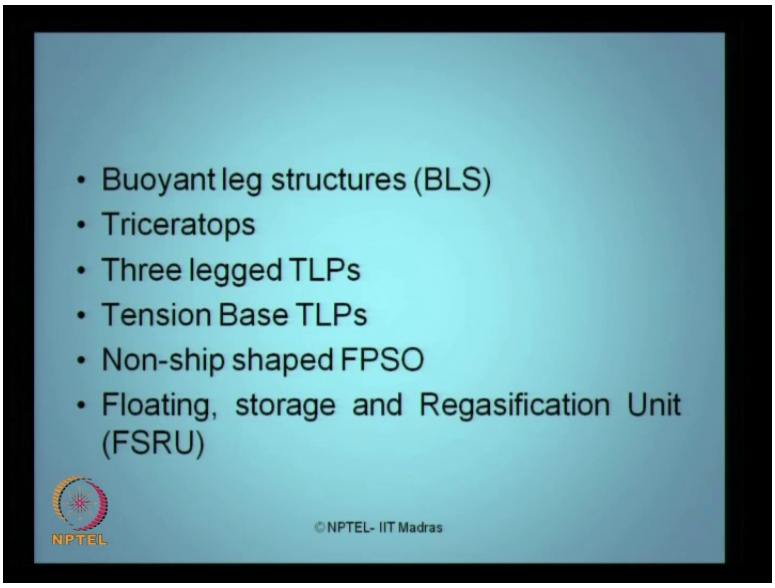

So, we spoke about BLS, triceratops. Of course, three legged tensioned platforms, tension based TLP's and of course, non-ship shaped FPSO, we will discuss each one of them separately about the dynamic analysis, when we move to the next module.

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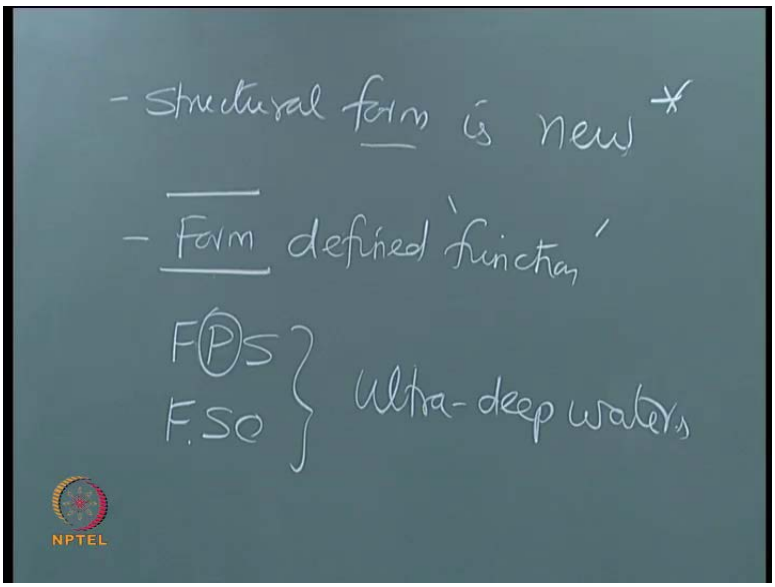

But let us here see these structures have innovative structural form that is very important the structural form is new. The structural form which has been generated developed is new; actually these forms have been selected in such a way that they can alleviate the loads and ultradeep waters may be a depth of above 1800 meters and so on.

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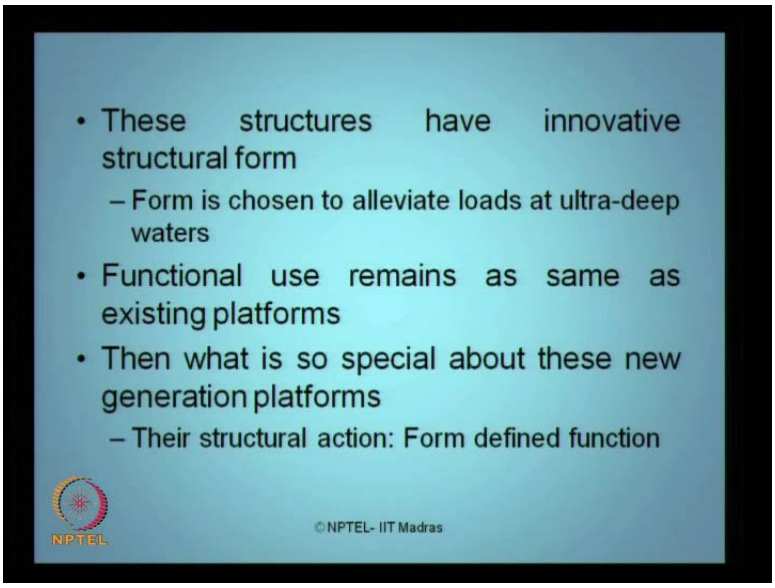

The functional use of these platforms remains same as that of the existing platform there is no deviation in the functional use of these platforms, when compared to any other conventional off shored platforms. They have got to maintain the similarity. Then what is so special about these generation platforms is form defined function. So, it based up on the form defined function, whereas in early generation platforms function was fixed and form was generated.

For example steel, jacket, platform. What was the function? Drilling, production, storage were the functions. They were fixed and platforms were forms were selected to accommodate all of them. Then slowly, for example, in FPSO there are very alternatives, there can be floating production storage there can be floating storage and offloading no production. So, these are all form defined function, because for that form production is not possible, is that clear?

So, there has been a complete deviation in the selection or design of an offshore platform based up on how to suit the different depth or greater water depths, what we call ultradeep water depths. What should be my form? which is comfortable for existence in these waters? For that selected form what functions can we have? I may have production, I may not have a production, so there has been a deviation, right? So, this deviation fundamentally occurred because I am selecting a form to suit my existence or stability or

survival of the platform for a different water types or greater water depths. Subsequently the maximum possible functions are accommodated in that chosen form.

So, obviously you will see there are certain platforms, which are meant or called as new generation platforms, may not provide all functionalities as you had in earlier platforms that are chosen. So, all these make them different from that of the conventional platforms. Any questions here? So, we have quickly seen different types of offshore platforms, their structural action and their growth or adoption to the design or modification of the existing design to suit various functions, various water depths etcetera. How the structural geometry was altered, you cater to different kinds of preferred structural actions under the given words.

That is the evolution what we saw in the previous four lectures. So, nevertheless in this lecture, we will discuss something about coastal structures also, because they also form as ocean structural systems. We must understand them quickly and of course, the structural action related to coastal structures. Then we discussed about the dynamics of single degree mathematical model systems. We go ahead with how to mathematically model these as a single degree freedom system, as a multi degree freedom system, how to identify the dynamic characteristics of these systems?

How I will use them for my dynamic analysis? Is that clear? That is what the provision what we have in the first module of lectures. So, we discussed a very important part in the first lecture. We spoke about mass of the platform. We also spoke about rigidity or flexibility or stiffness of the platform indirectly. We also spoke about material which is commonly used for offshore platforms, when I said material we quickly discussed about the damping characteristic of a material.

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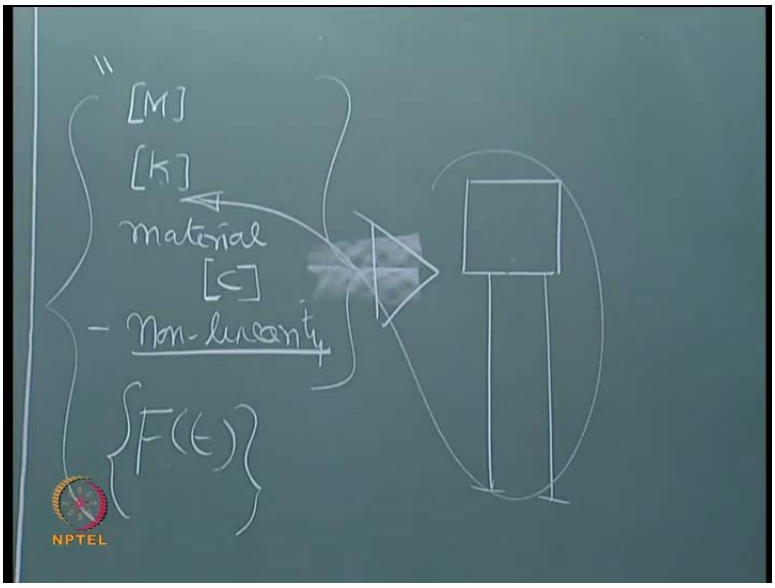

We also highlighted something about non-linearity, which can come from the material behaviour or it can come from the loading behaviour what we have not seen. So, far is very interestingly the right hand side of the platform. For example, I am, so far talking about all platform characteristics, we have not discussed about the extremecharacteristics which is nothing but force. What are the different kinds of forces? Why is it a function of time?

If the force is not the function of time do we have to do a dynamic analysis. So, that is a very fundamental questionwhich everybody has is dynamic analysis related to variation of the force coming on the system with respect to time or even for a static force. If the response of the system is respect to time, do I have to do dynamic analysis? Sothe answer will be it is very important all the time for all the structures for all the loading systems. You may not have to do a dynamic analysis. So, when do we do a dynamic analysis?

So, dynamics is a property which varies with time. So, the time characterization of any behaviour is what we call as dynamics, if the variation is not phenomenal. If it is marginal it is called quasi static if the variation is not there at all static analysis, is that clear? So, there is a path of analysis what people have followed in the literature. When do we do dynamic analysis? We will address this slightly later, but we must understand that can a mass stiffness damping and F of T contribute to dynamic analysis.

So, it is very important for all of us to understand all these are called essential characters of dynamic analysis. So, if you want to know what are the essential characteristics of dynamic analysis or dynamic loading. I must say mass of the platforms or mass of the material or the member should exist the stiffness should be there damping should be there and F of T should be there, instead of saying mass stiffness damping and force we will rename them slightly when I move forward.

I will call them as inertia of force, restoring force and damping force and forcing function. I will just rename them, but I will use the same concepts back again in the down the lectures on somewhere on the line, when I talk about mathematical modeling. So, we will talk about in this lecture quickly an overview of coastal structural systems and their structural action because this is also important for us to understand. But we will not talk about the evolution of coastal structural system as we did for offshore platform. So, the focus is on offshore platforms in this course, if you want to really know what has been the form evolution of coastal structural system.

Probably this is not the course which will address you that, anyway nevertheless we will talk about different forms and their functions and the structural action for our understanding. Any questions here? Any doubts on the previous four classes, whatever we have discussed? So far, any difficulty for anybody? So, do not have to be so serious; I mean you are not recorded lively we can edit it also there is no problem. They have taken it as a class, it is very important it is not that we are projecting or making movie; this is a class; you have got to pass the exam; you have got to get a grade on this. Remember this most important.

So, be casual and whatever doubts you have you can always ask. Now, do you have any doubt? Still if you do not have a doubt, either it should be extraordinarily clear or it is of no use for me, sir I am waiting for some more information of the same order, which is of totally useless to me, so I can get a good grade in this course, I can clear away my course. It is going to be mathematical based as I said.

PPT will be only about 10 to 15 percent supportive, 85 percent remaining will be mathematics. I do not want to introduce the dose in the first lecture, because I want to the last date of withdrawing the registration is I think the 19th or 23rd from 18th till that time. So, that we cannot withdraw. Then I will push mathematics into that. So, I will wait

till that time. Slowly we will move, show you some good photographs and videos and people may think this is all dynamics.

We can go add. Will that be the moment you say you have go ahead? A green flag is shown. Then we will you take you to the yellow red and etcetera, but be sure that what are we discussing will be to the best of my knowledge it will be transparent and clear. I will explain what the best I know and if you have not understood anything you can ask me, we will clarify it further. We will make it easy and simple that is very important. So, do not have to have a very high degree of seriousness, it is the class. So, be in that format as you have been otherwise in other classes.

So, we will talk about the coastal structural systems. Now, in coastal structures we are not addressing the evolution of this structural system the reason the basis. Nevertheless, we will talk about the purpose why are they constructed, where are they constructed not geographically, but physically. What do we mean by a sea wall or a die etcetera because these are all common terms, which generally come across to you, when you talk about dynamic analysis of ocean system. So, we must know this. So, what are the essential functions of a coastal structure?

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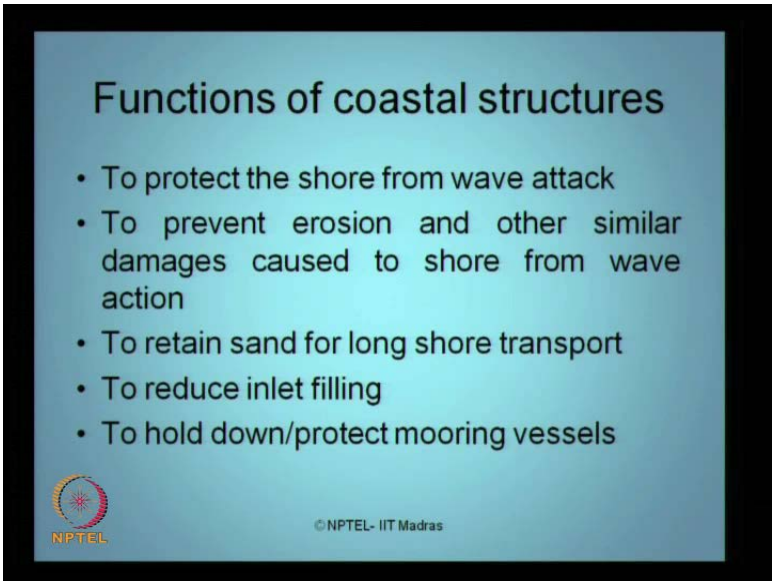

It is built to protect the shore from wave attack. In the previous case the functions were to either produce or explore or test oil from the deep sea, but here it is to protect the shore from wave attack. To prevent erosion and other similar damages cause to the shore

from the wave action, to retain sand for a long shore transport that is another function of a coastal structure. To reduce the inlet filling, because this will cause large amount of dredging, if you want to avoid that to hold down or protect the mooring vessels which have been housed along the seashore may be offloading vessels may be cargo vessels or passenger ships whatever may be the case I need a structure to hold them down or hold them. For example and so on.

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Coastal structures are also useful in coastal defense schemes it is very important because one of the strategic type of structure which is constructed for coastal defense or protection systems. Of course, to prevent flooding in many countries to provide sheltering of harbor basins, to stabilize navigation channels, it is a very important way of transport and communication beam different channels had been merged of every country. To protect importantly the water intake system, it supplies water or outfall which disposes water or any other effluent with the water body and so on.

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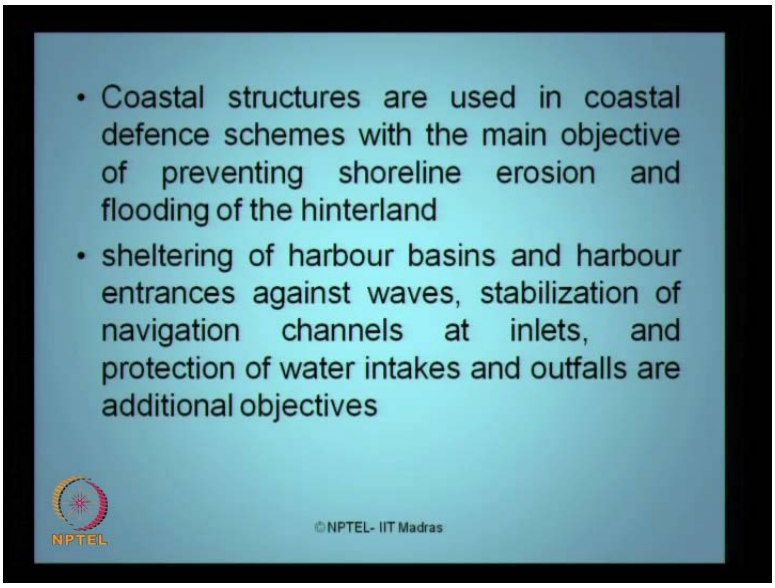

Coastal structures are generally used in coastal defense schemes, the main objective there is to prevent the shoreline erosion and the flood flooding of the hinterlands. So, sheltering of harbor basins, harbor entrance against waves, stabilization and navigation channels are also important as one of the function of the coastal structural systems, which are all the essential objectives of these kinds of structures.

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So, first type of its kind, is sea dike. The photograph what we see, both of them are related to sea dikes, we will talk about the important features of a sea dike..

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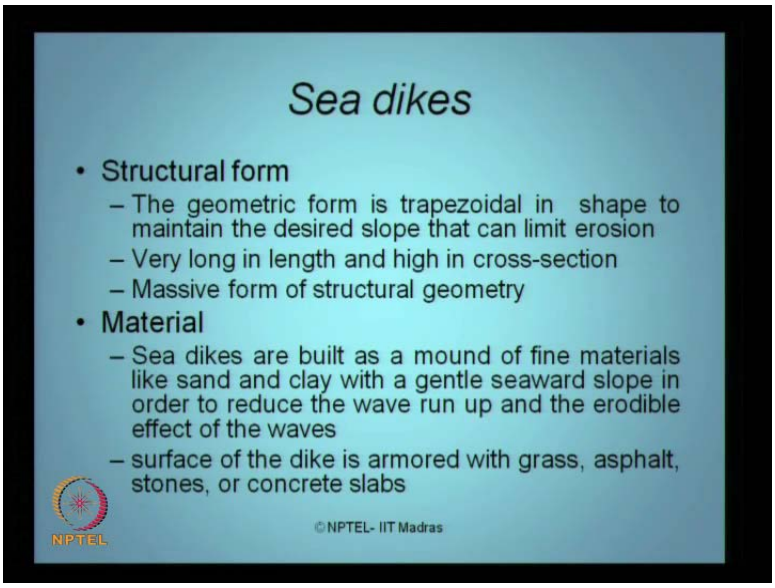

Sea dikes, the basic structural form is trapezoidal. The basic structural form of sea dike is trapezoidal in shape, it is essentially constructed to maintain the desired slope. So, that erosion does not take place that is the function generally sea dikes are very long and length and very high in cross section. So, trapezoidal cross section expected to be massive in gravity based systems massive structural.

So, the moment I say massive, what is the proposed material which comes in your mind when you talk about sea dikes boulders or stones boulders or stones or rocks of large volumes etcetera? So, the material essentially is fine material in clay over granites etcetera or larger boulders sometimes the surface also finished with grass asphalt etcetera or prevent erosion on the topside.

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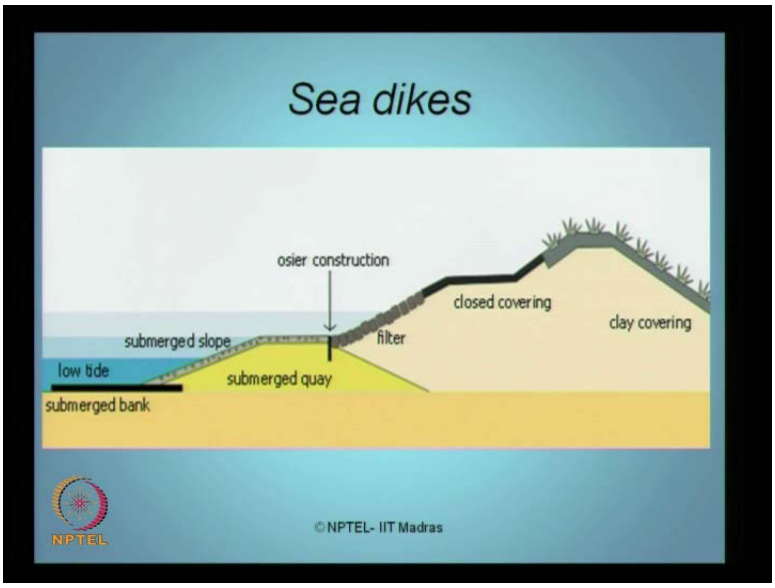

So, that is what you saw in the last photograph, this is a cross section you can see here. The slope prevention mechanisms can be of different vary, can have a filter, can have a closed covering layer, can also have gross or grains growing on the top, can have a submerged shape etcetera. If you have a low type you can have a submerged bank, this is what we call as submerged way. We can have different kinds of surface protection systems like asphalt covering like grass or vegetation like filter etcetera. All these are called sea dike surfaces. Sea dikes essentially a massive structural form which is used to prevent shoreline erosion.

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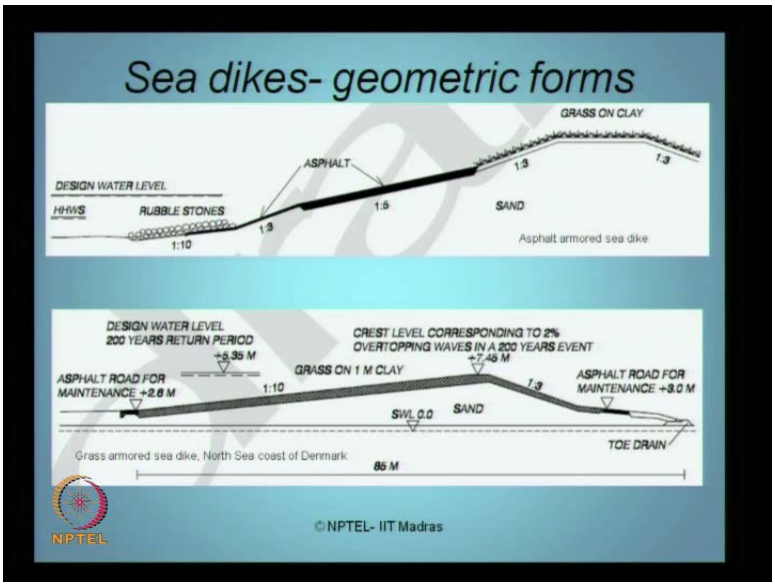

The different geometric forms of sea dike for different slopes can say the inward slope is 1 is to 10, the outward slope or the levered side slope is 1 is to 3 and so on. You can have an asphalt covering, you can have a rubble stone covering you can have a grass etcetera same thing what we saw in the last slide.

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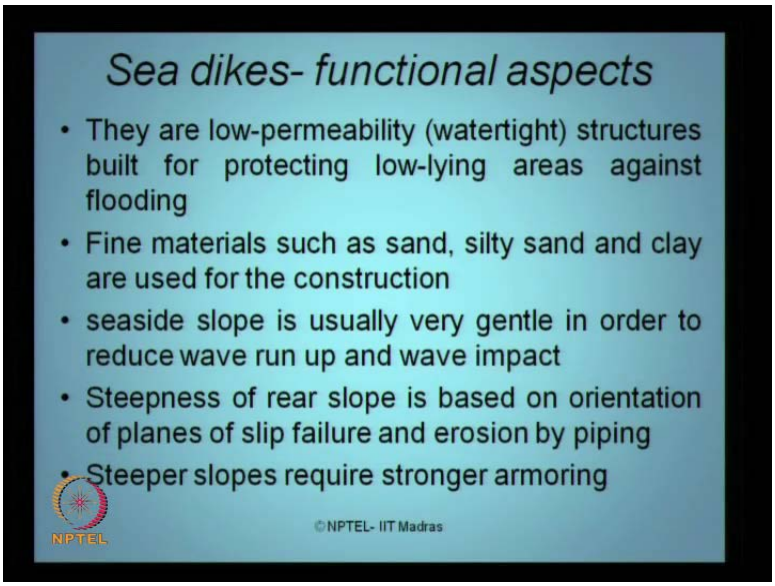

The functional aspects of sea dikes are the following, they are low permeability structures, they are water tight essentially, build for protecting low lying areas against flooding. That is the essential function of a sea dike. Essentially the construction material or sand silk and clay and boulders the seaside slope is usually gentle 1 is to 10, whereas the other side is 1 is to 3.

The essential reason is, it should avoid the wave run up and impact caused to the waves. So, the seaside slope is gentle 1 is to 10, 1 is to 15, the other side is around 1 is to 3, 1 is to 5 etcetera. That is the geometric form what we have for sea dikes. Any questions here? So, the material essentially is boulders clay, sand, minerals; the layer can be rubble stones, it can be asphalt, plane, it can be grass as well so one of the protecting system used for controlled flooding or protecting the lower land from flooding.

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The second type is what we call as the sea wall it is as similar to that of a retaining wall, but what is then difference between retaining wall which will be in soil with that of a sea wall? It is the two different kinds of pictures of sea wall what you see here; one is of course, having a vertical section other is having a sloped section or a stepped section. The one is having a stepped section here, one horizontal step and there is one more horizontal here. The width maybe lesser than this, but it is a different section whereas, this is purely vertical on one side otherwise it is completely sloped.

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Typical onshore structure with the principal function of again preventing flooding of the land and the structures behind the storm surges and waves that is the essential function of a sea wall again as you see the material. Essentially is rubble machinery stoned rubble machinery or random rubble machinery. It is generally constructed parallel to the shoreline wherever your shoreline is constructed parallel to it strengthens only certain part of the coast.

It is not constructed all along the coast, wherever it is weak, wherever the sediment transport is severe, wherever the erosion is very high in its volume, during that section only it has been constructed essential function is to prevent shoreline erosion. So, two geometric forms we saw, horizontal sloped horizontal or simply one way horizontal one way slope. It can be horizontal sloped horizontal.

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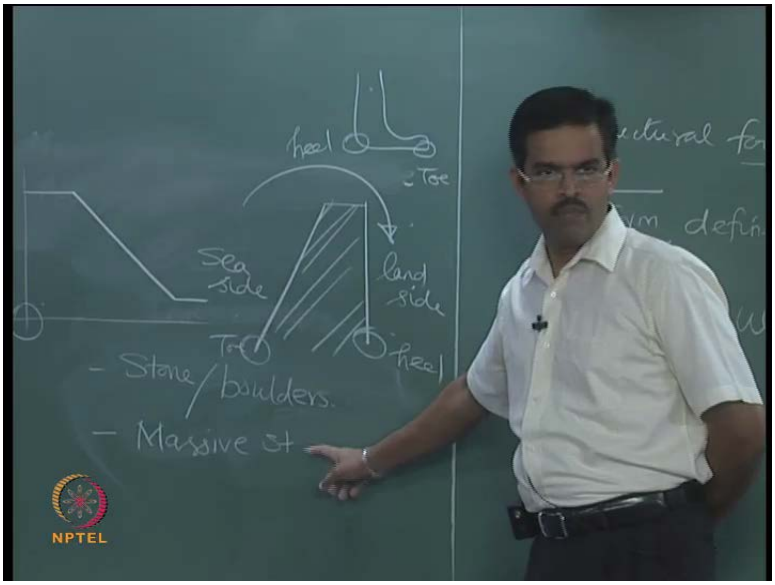

So, cross section can be vertical of course, with a horizontal in this type. So, this is the sea side this is a land side. So, this can be essentially a rubble machinery which is material essentially used is stone or boulders. So, we can also say it is a massive structure. So, it actually protects the natural beach profile that is an important function. Why these are constructed? It protects the natural profile of the beach from soil erosion.

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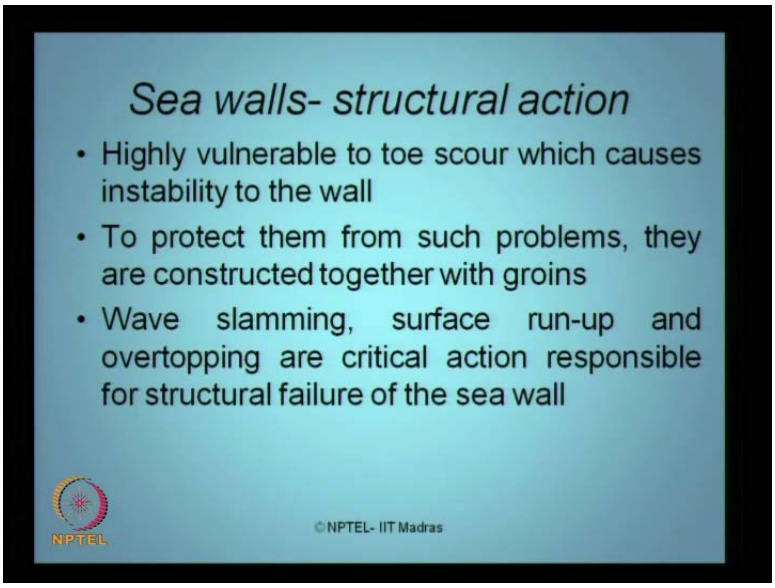

So, what is the structural action of this it is highly vulnerable to toe scouring. There can be a severe scouring at the toe of this in human leg, feet, toe. Similarly, heel, this is heel. So, this is heel. So, there is an enormous amount of scouring happening here;, this results in overtopping of this if scouring happens. So, this causes the wall to protect such problems.

They are constructed along with the groins. Groins is another type of structure, we will talk about this slightly down the line. Now, they are constructed integrally with the groins to protect them from scouring or toe scouring, so wave slamming, surface run up and overtopping are critical action responsible for structural failure of these sea walls. Sea walls generally fail, because of slamming, surface run up and overtopping. They are the failure modes or reasons why they fail. So, sea dikes, sea walls the construction aspects of sea wall.

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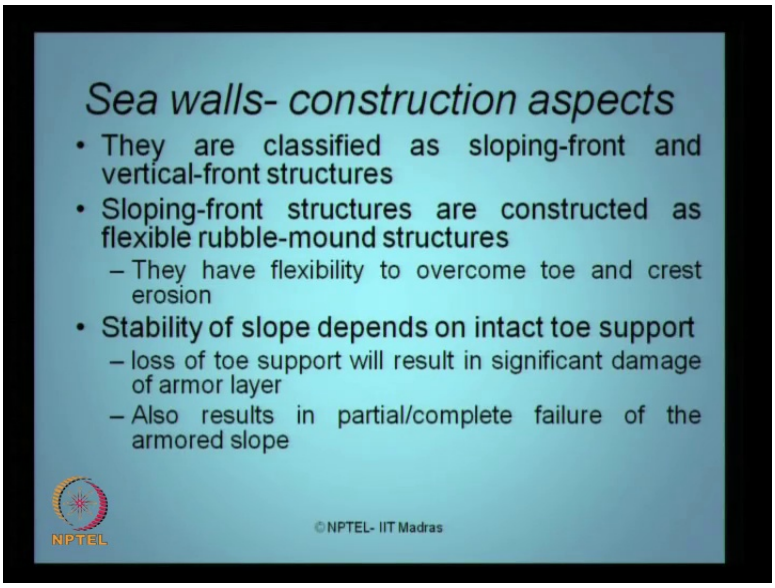

If you look at quickly, they are classified as sloping front and vertical front as we saw. Sloping front are constructed as flexible rubble mount structures, they have flexibility to overcome the toe and crest erosion. The stability of the slope depends on intact toe support. So, there are some toe supports also constructed along with this to prevent the erosion in the toe head, what we call as armored slopes, this is what we call as armored slopes. Armor is nothing but surface layer is strengthening, armoring means strengthening.

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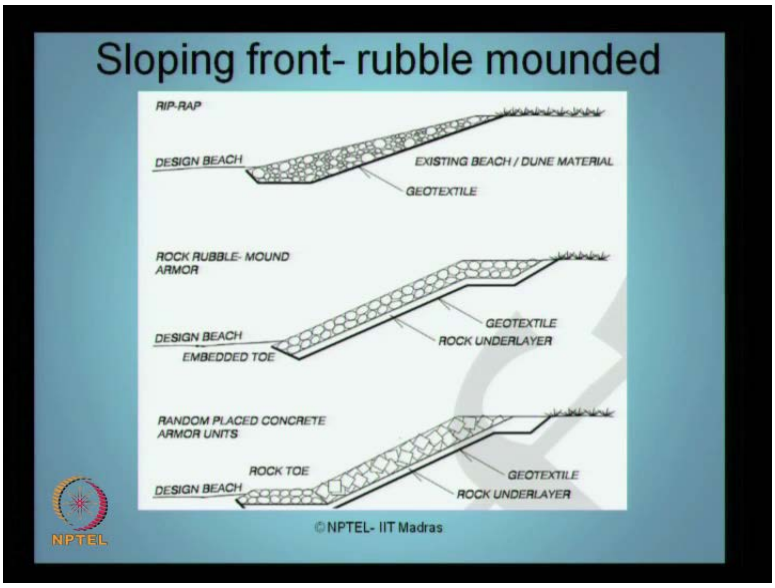

We are again describing the sloping front rubble mounted machinery structures. These are the different geometric forms which are available for sea walls. The beach side is in all the cases here it is a design beach, this is a toe area. You can also use geo textiles, can use rock under layer, over layer and etcetera. These are different methods by which the surface erosion on the sea wall area can be protected any questions here.

So, there are two basic geometric forms of sea dikes and sea walls. We had discussed them and we have quickly discussed what are the problems associated with the structural action of the sea wall on a sea dike, how they can be protected and what is the form of a structure? So, a massive structural form of a specific cross section the function. Already we know flooding and overtopping etcetera.

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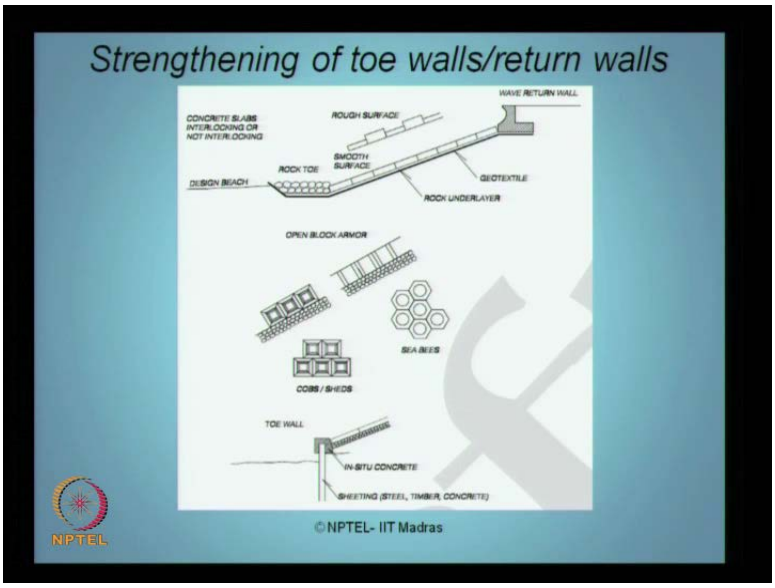

How do we strengthen this? What I said the return wall or toe wall, you can see here in this sketch, you can see the wave return wall being constructed to strengthen the crest area sometimes even at this area toe wall is additionally constructed to protect the toe erosion. That is another aspect by which this can be protected the most moment it is not coming you it is coming that is…

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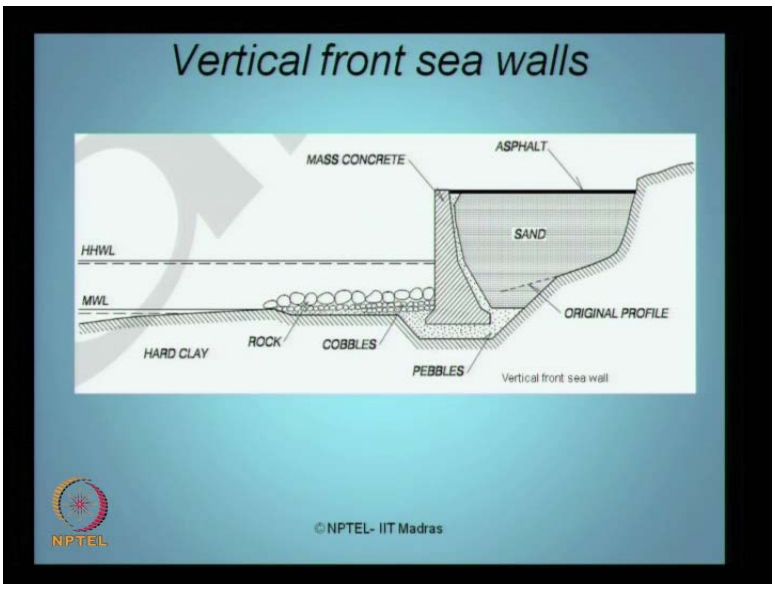

So, this is the vertical front sea, wall sketch what we have the mass concrete generally is on the front phase. Then the sand filling happens which prevents the original profile of

the beach and over this people sometimes do asphalt covering or a concrete covering to make it accessible and neat as we saw in one of the pictures in the models.

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The other type of construction, what we do for coastal protection is revetments. Revetments can be as porous as this, as porous as they are and you can also cover this layer from surface erosion using geo synthetics or geo textiles. Either way you can do that because the surface is essentially constructed for slope stability. So, to stabilize this slope either I can reinforce it in this design pattern or I can do it using a geo synthetic or a geo textile.

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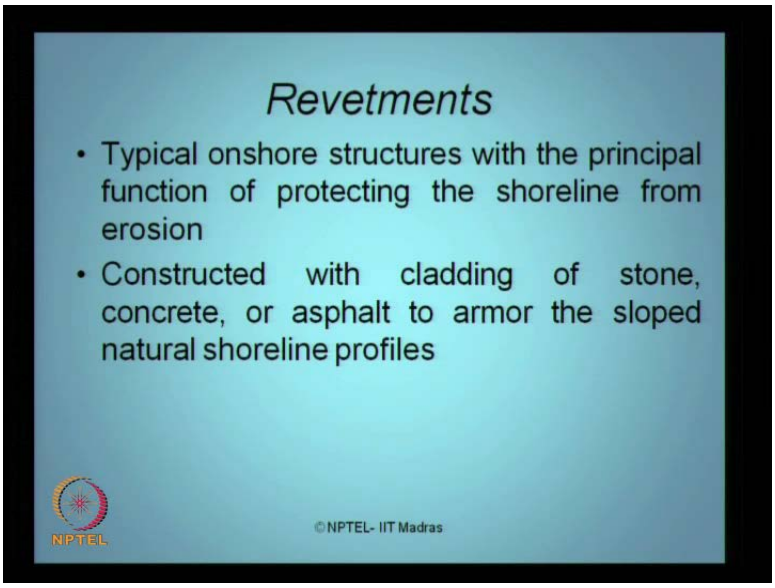

So, revetments more or less have a similar geometric form as that of a sea wall they are again onshore construction structures. The principal function is protect the shoreline as similar to that of a sea wall, it is constructed with cladding of stone concrete or asphalt. Then the slope is armor, we maintain the natural shoreline profile the armoring can be either a double line or can be a geo textile, geo synthetic dynamic depending upon the functional requirement of a day.

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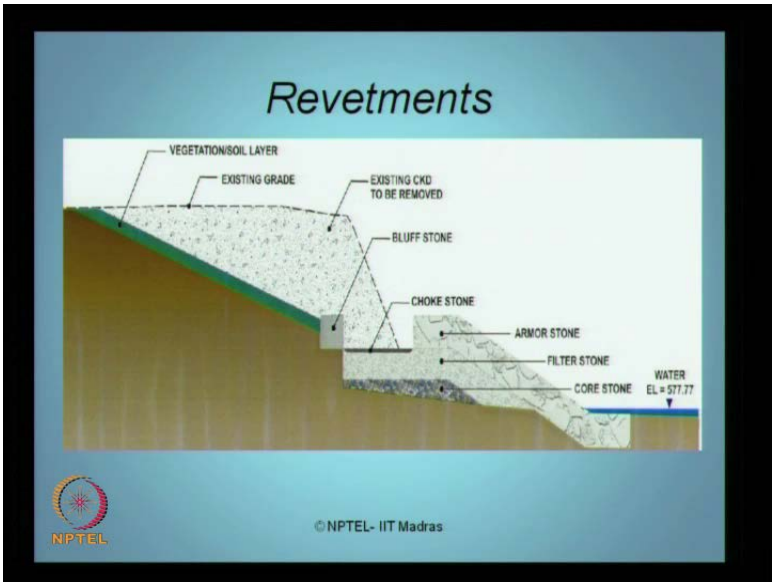

A typical cross section of a revetment, you can see here a vegetation layer is covered by this on the tip. There is a bluff stone, which actually protects the soil erosion in this segment, then there is a choke stone and then this layer is armor which we call as a armor stone and a filter stone because there can be some surface run off, which is coming from the surface, which can be collectedand then drained off; that is why we have a filter stone there. So, typical cross section of a classified revetment, which has been done for shore length protection, so the essentially the material is again rubble machinery or stone with the combination of concrete asphalt and vegetations.

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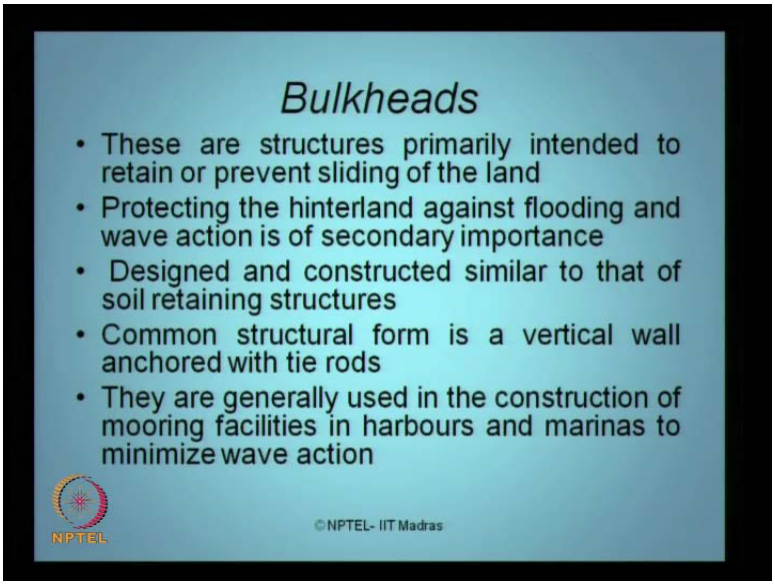

The other type of structure is bulk head. Bulk heads are structures intended to retain or prevent sliding of land actually on the beach side not to meet in the profile of the beach whereas, there is a possibility that land sliding may happen on the shoreline of the beach to prevent the land sliding one construct, what is called bulk heads. It protects the hinterland against flooding and the wave action is of secondary importance. So, it is essentially the retaining action coming from the soil its protecting the land from sliding.

So, the wave action is not a primary importance in this kind of structural action. This design and construction are similar to that of a soil retaining structure.The common structural form in a simple vertical wall anchored with tie rods is the four structural form what we saw for coastal structures. The functional aspects of the structures are different the geometric forms are more or less similar, but the size in terms of its length

dimensions cross sectional area or the surface treatment are different. So, they are generally constructed in the mooring facility areas. In the harbors bulk heads are constructed in that segment. So, it is a small segmental area where they are constructed, whereas in other cases they were on the large lineup along the shore, whereas here they are near the marines or harbor areas they minimize the wave action.

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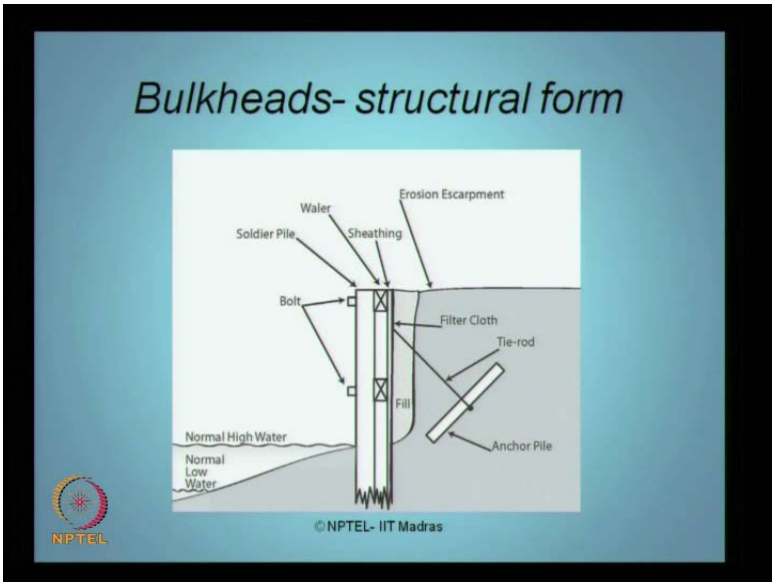

So, that is the structural form which is recommended for a bulk head. Essentially it comes with the soldier pipe, which is then sheet to the surface then use a filter cloth under a fill where you can collect the surface runoff water and drain it off. Then there is an anchor pile, which is connected to the sheeting which stabilizes or offers stability against the action in wave guide water. So, the primary function is to prevent the sliding of land near the marines or harbor sections. So, it is a simple rectangular form not for an infinitely for a specified length in the marines and harbors were land sliding is got to be protected or prevented.

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The other type of structure as we saw to protect sea wall also are constructed integrally, these are called groins these are some of the pictures of groin structures.

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Interestingly groins are built to stabilize the stretch of a natural artificial nourished beach against erosion. The functional aspect is as same as the sea wall against erosion. They are generally constructed where there is a net long shore loss of beach material is being seen there is a long shore sediment transport occurred. So, in those sectors groins are constructed functions effectively for long shore transport when it is being seen the

structural form is straight. But interestingly they are perpendicular to the shoreline not parallel and they are normal to the shoreline, whereas sea walls are parallel to the shoreline groins are normal perpendicular shoreline again.

The structural form is a rubble machinery trapezoidal in cross section and so on. Generally groins are constructed in series not a single groin is constructed. This is what we refer as groin field in the literature. Literature says we must not construct a single groin, you must construct series of groin. This referred as groin field in the literature, they are the most interesting difference between a groin and a sea wall is that one is parallel to the shoreline, whereas groins are normal to the shoreline the structural form is almost similar structural action is almost similar material of construction is almost similar functional aspects slightly differ.

So, we will quickly go through the slide, well designed groin systems can arrest the slow down rate of the long shore transport. That is an essential function of a groin building of material in a groin bay provides protection to the coastal and against erosion it is used to hold artificial nourished beach. Material sometimes as one of the additional function of a groin, if at you have any questions in this area, it will be only about the structural form and the function not on the name or any other activity.

Please do not be panic about because we are not discussing in detail about the coastal structures in this course; this what completeness we are addressing this as our essential topic is dynamic analysis, as I said immediately. Once I have a massive structural form the structure becomes stiff when the structure becomes stiff the response of the structure to wave action is lower. It may not be importance to study the dynamic analysis of the sort of, but there are structured stuff floating also for example, floating break waters.

Therefore, you must understand the coastal systems also parallely. That is why we are discussing this. So, do not panic; that is we are discussing about the different kind structural forms where we do not attempt to discuss the dynamic analysis of them. We quickly pass this, there are different shapes and etcetera rubble groins are most popularly used they have reduce a risk of scouring and formation of strong rip currents.

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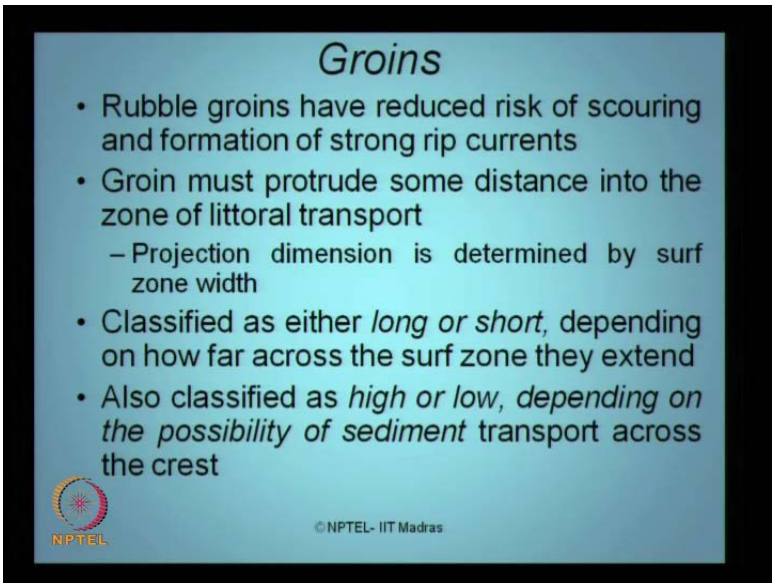

So, this has been identified by literature that rubble groins have been successful. So, we have also recommended series of groin field the along the marina coast Marina beach coast in Chennai, which are coasts. Tsunami study what our department did for government of India because Sundar and Sannasi Raj did this design. So, when you walk around the Marina beach extent near the Chennai porters you will see that lot of groins. I mean groin field has been established as a post tsunami effect of Indian coast. So, it is basically a rubble groin.

So, series of groins constructed for land protection against wave attacks the projection dimension is generally determined by the sub zone width. We are not talking about this in detail here because we are getting into coastal hydro dynamics. So, that is not the focus of this lecture any way. So, what we are interested is the cross sectional dimension the location purpose and structural action they are just looking at the glossary of these kinds of structures that is all there are many classifications. In terms of shared terms of height may be high and low etcetera depending up on the sediment transport etcetera.

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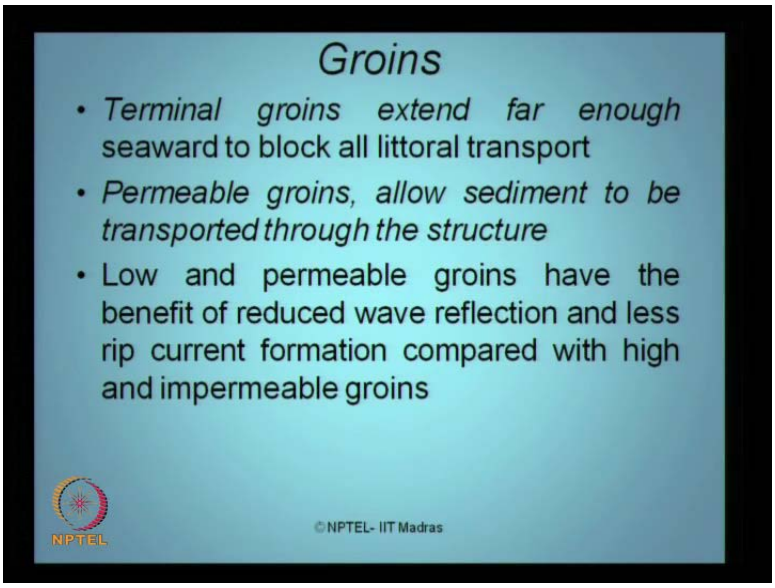

Terminal groins permeable groins etcetera are also different classification for different kinds of littoral transport as discussed in the literature we also have something called breakwaters.

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This is nothing, but a detached breakwater. There can be continuous break water detachment is here. You can see they are constructed with a gap in between them structurally, this gap should be not more than 50 percent of the length of the breakwater. So, if you do not want to have them continuous, can even break them. So, you can see

here these are all break waters constructed with gap, but interestingly when you construct the break water, which is detached you will have a specific form of sediment occurring which is there in all the beaches. So, that is a counter effect of construction breakwaters on the shorelines.

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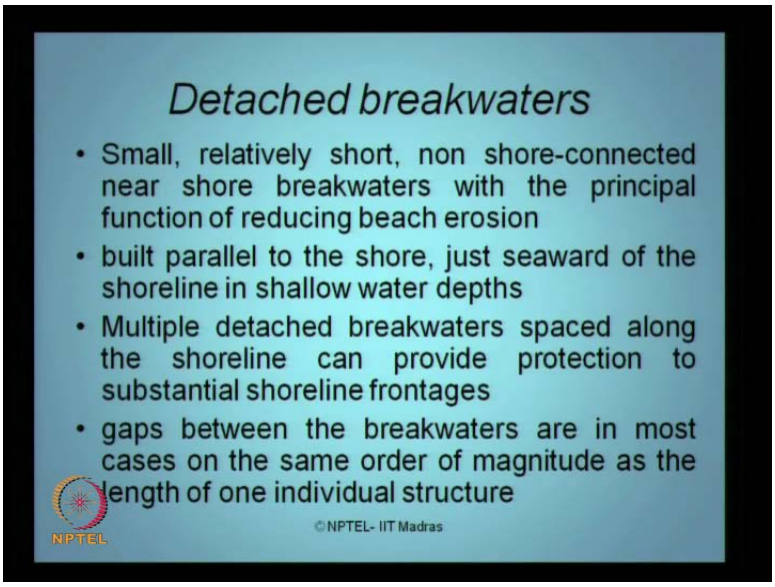

They are small relatively short non shore connected near shore breakwaters the principal function is reduce the beach erosion. They are built parallel to the shore just on the seaward side in shallow water depths. These are critical points which we must remember when we talk about break waters because we will talk about floating break waters now. So, there are multiple detached breakwaters spaced along the shoreline which can offer protection to the substantial shoreline frontages as seen in the literature gaps between the breakwaters are in the most of the case of same order of magnitude as the length of the individual structure maximum 50 percent of the length.

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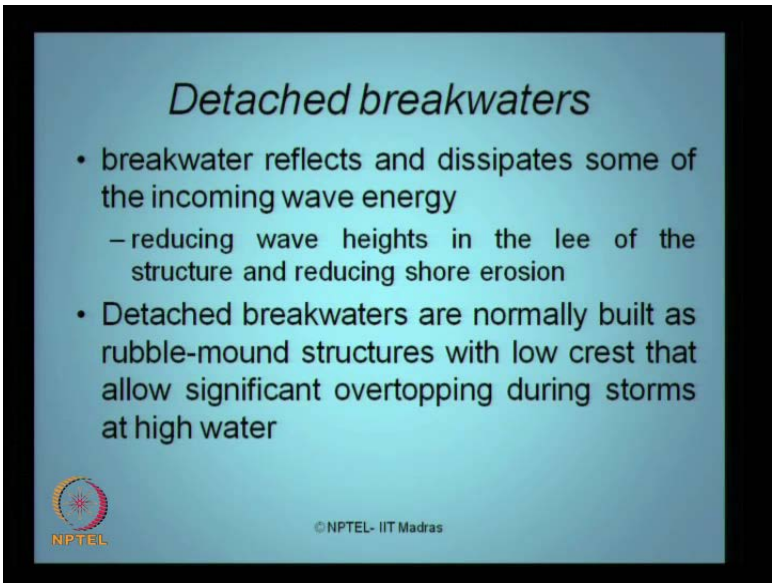

Or is equal to the span of the breakwaters itself breakwaters reflects and dissipates some of the incoming wave energy is very important. Because if we want to reduce the wave energy potential near the coast breakwaters, save that purpose as well it reduces wave height in the lee of the structure reduce shoreline erosion the material used rubble mound as we here rubble mound structures with the low crest, which allows significant overtopping. These are some examples and photograph of the rubble mound breakwaters you can see the material here.

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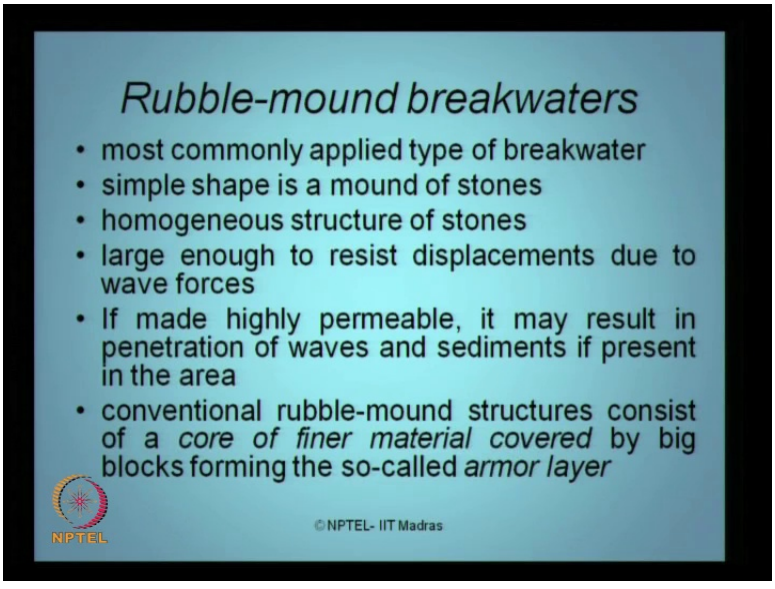

Most commonly applied type of breakwater in the recent past in simple shape is mound of stones. Homogeneous structure of stones or the general form of this construction, they are large enough to resist displacements due to wave forces. So, they have massive structure. So, the structural action because of the wave in this type of structures, if it is massive rubble mound it is insignificant.

If made highly permeable, it may result in penetration of waves. Of course, sediments if present in the wave area, so there can be a sediment transport possible. If they are made permeable, so there are problems associated with permeable breakwaters. These are functional problems, we are talking about the structural action here. So, our focus is not on the functional aspect terms conventional system is a rubble mound structures, which is constructing a consist of a core and a finer material then covered with an armor layer.

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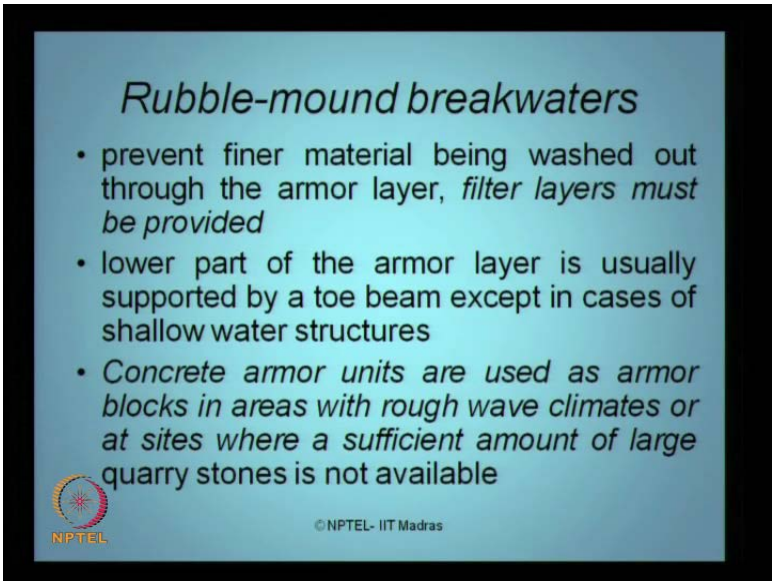

We will quickly skip as this not important sometimes the armor layer can also be a concrete layer where you have got a rough wave climate.

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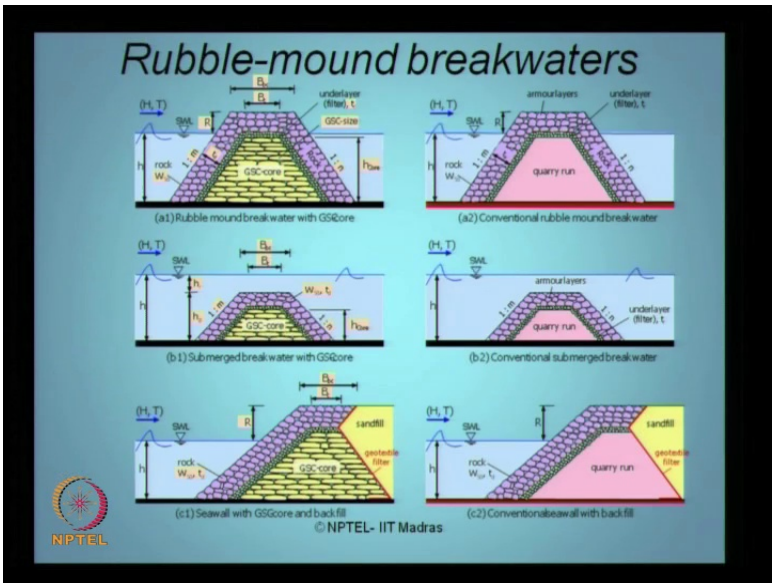

These are different structural forms in the cross section for different kinds of rubble mound breakwaters. So, what we discuss here is some important dimensions, which we will talk about slightly later. There is a wave action as w l level; these are my slope 1 and n. What should the value of n? What we must see here is the slope on the lever side and the other side are different this is m and this is n. This may top width this may crest width this is my base width etcetera.

So, one can have a rubble mound breakwaters systems with GS can have a submerged breakwater where the SWL the still water level is above the breakwater crest itself. It can also have sea wall with a GS core a back fill separately done can also have a similar type with the quarry run quarry run means the filling is of a different material. There is a GSC core level. So, the core that is different here is the rubble mound core, whereas, here it is quarry core nothing but a sand quarry sand. So, you can have different kinds submerged protruding or the sea wall convention the geometric form is more or less trapezoidal massive type of structure.

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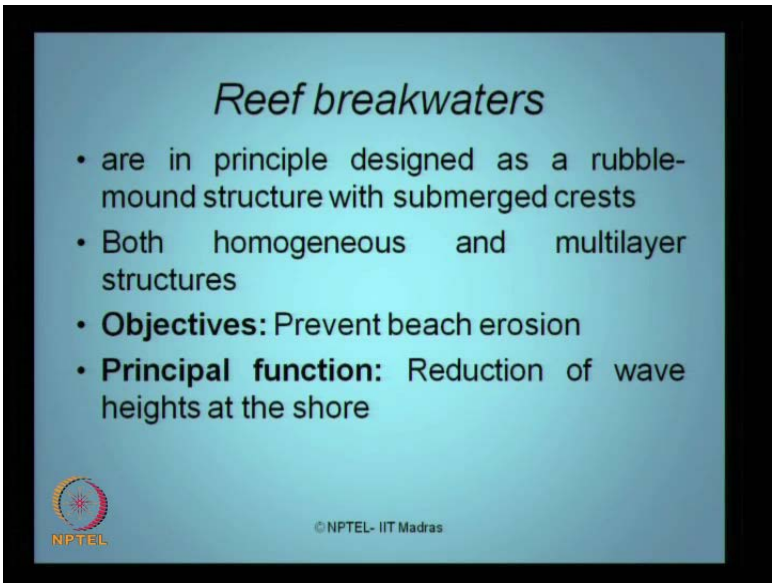

We can also have what we call as reef breakwaters. They are in principle designed as a rubble mound structure was submerged crest the crest is generally submerged both homogeneous and multilayer structures are constructed for reef breakwaters. The principle objectives is to prevent beach erosion, but the crest is submerged, but the principle function is reduction of wave heights at the shore two important aspects beach erosion is prevented and wave height is controlled when you construct this kind of breakwaters.

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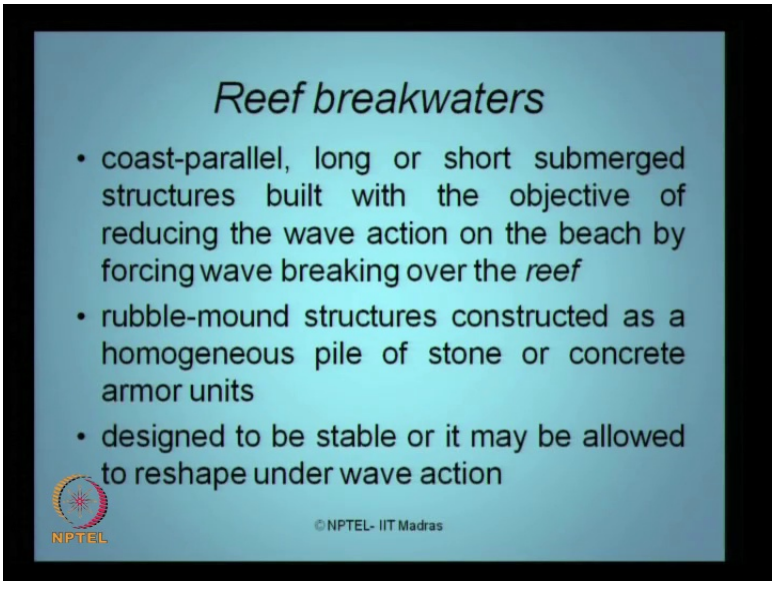

They are built coast parallel. They can be long or short, essentially submerged structures allow enough amount of overtopping the objective is reduce the wave action on the beach because the wave height is controlled, wave breaking is also controlled because wave breaking exerts force that is being controlled by these kind of breakwaters essential material is rubble mound homogeneous pile of stones are sometimes people use concrete armor units for surface lining of these breakwaters. The shape is itself is stable because the massive unit.

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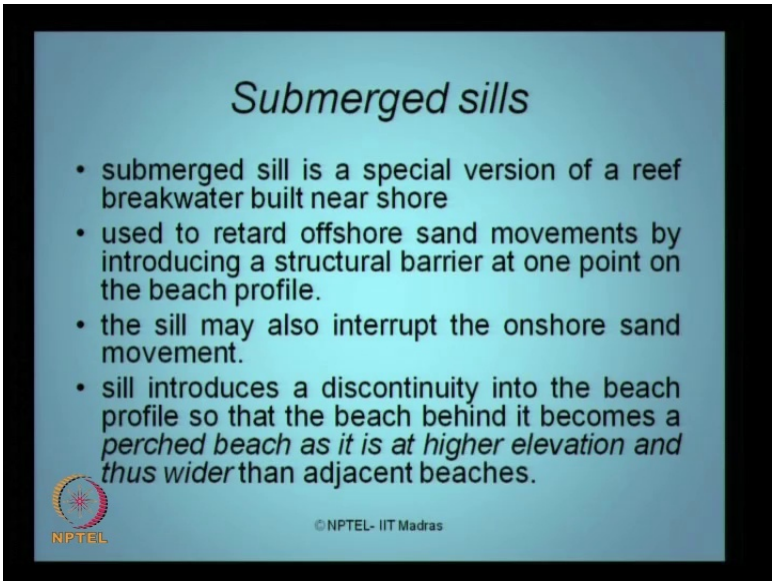

We will quickly escape this, we are not talking about this. We can have a submerged sills is another kind of structure; submerged sills is another kind of ocean structural system. Sill is a special version of a reef breakwater built near shore, so special version. So, classification of reef breakwater is essentially used to retard offshore sand movements by introducing a structural barrier at one point on the beach profile. The sill may also interrupt the onshore sand movement as well. So, this will vary the shore sediment transport when this kind of structures are constructed they form as a barrier. Sill actually introduce a discontinuity in to the beach profile, so that the beach behind it becomes what we call perched beach.

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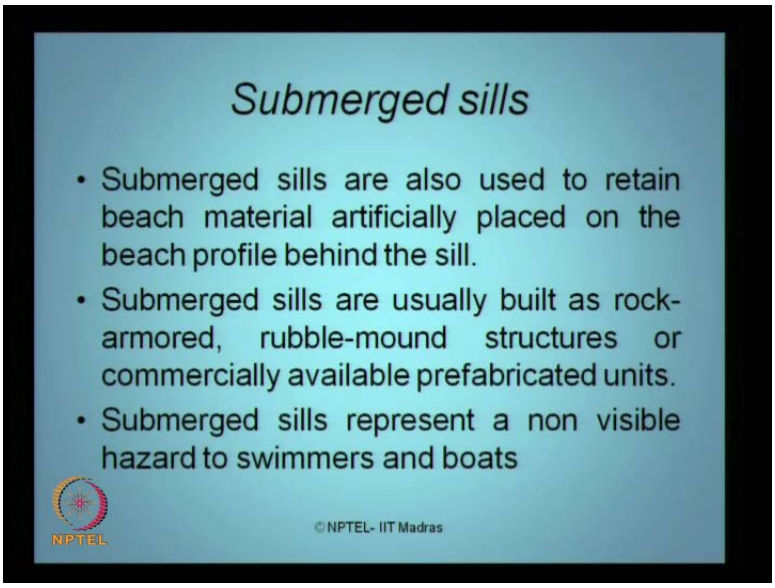

They are also used to retain the beach material artificially placed on the beach profile behind the sill sometimes. I will show you a cross section here they are essentially material is again rock armored rubble mound structures or sometimes these kind of structures are also available in a prefabricated formats. So, you can use prefab units for these submerged sills.

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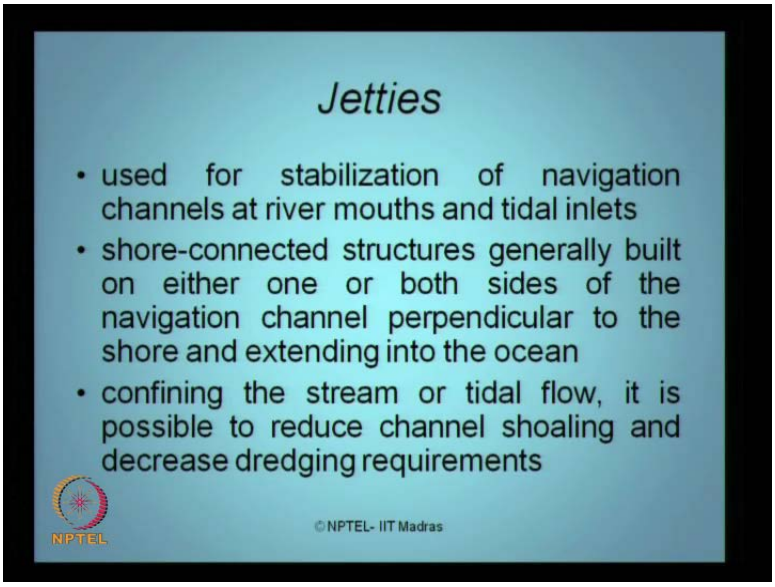

So, these are some of the next items of classified structures in ocean systems, which are jetties. The essential function is for stabilizing navigation at the inlet points. So, to

stabilize navigation jetties are constructed, they are shore connected structures generally on either side or both sides of the navigation channel. They are constructed normal to the shore, extending into the ocean they confine the stream of tidal flow at the inlet points.

Therefore, the possibility there is to reduce the channel shoaling and it also decreases, the dredging requirements. So, wherever you have got sand accumulation or sediment transport heavily occurring jetties can be constructed to reduce the sediment requirements or dredging requirements and of course, it reduces what we call channel shoaling effects.

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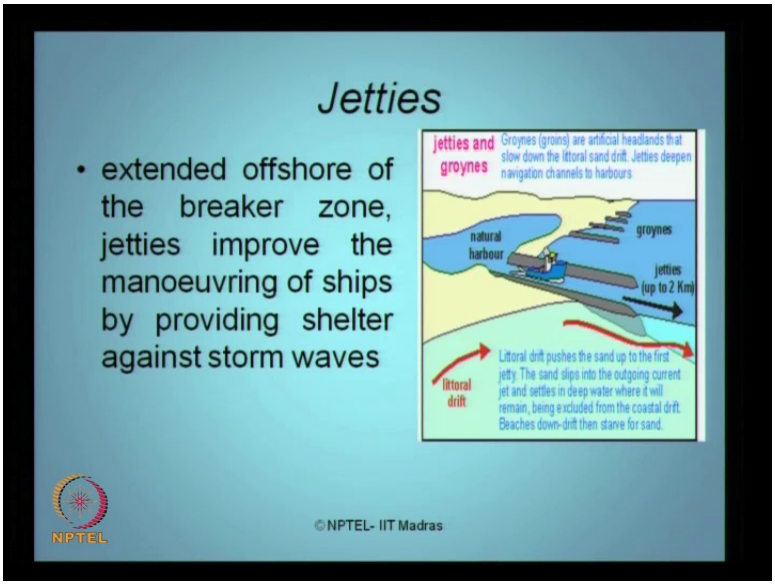

These are different kinds of geographic locations where a Jetty can be proposed extended offshore of the breaker zone. Jetties generally improve the maneuvering of ships also because they provide shelter to the ships from the storm waves. So, jetties have functional requirements structurally it is concrete material essentially is concrete resting on piles.

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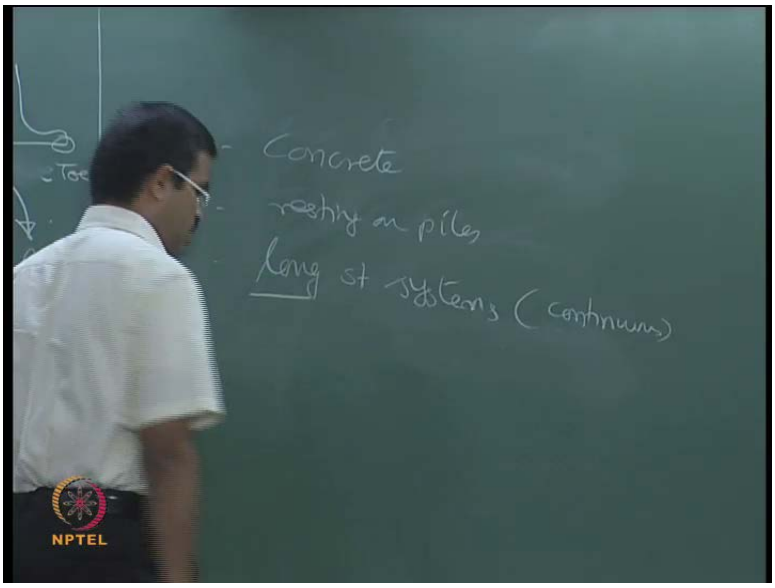

Essentially it is concrete resting on piles usually long structural systems. I should say continuous; not only long continuous structural system, there is no break. They are similar to breakwaters in terms of its functional aspects.

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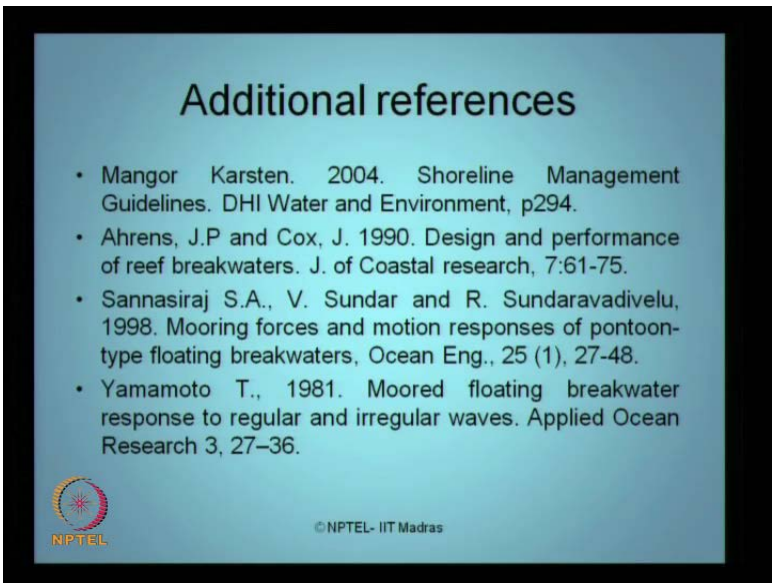

So, we have additional references, I want you to look at this. So, we can have more information because I slightly made this lecture faster. Mangor Karsten shoreline management guidelines DHI, Ahrens and Cox design performance of reef breakwaters there are papers by our own faculty colleagues Velur Sundar and Sannasi Raj ocean

engineering Yamato moored floating breakwaters response to regular and irregular waves. There are many interesting references which you can read now interestingly you quickly look at four tutorials. I want you to answer them as an offline for this class.

If you wish you can submit them, because remember all tutorials which have been submitted by you will be kept as a record with me. In case your performance goes bad in the quiz, we will use as a trump card to support your marks even if it is recording, we will eliminate this from the recording because then this talks about the evaluation system of IIT. So, that is not right.

So, some of you submit the tutorials to me. I will keep it aside; sincerely attempt your exams, we can substitute this because anyway this can be easily openly copied you have got lot of literature available. So, what best you can do is write it neatly; only hand written material will be accepted. All drawings has got to be drawn by hand. No copy paste of photographs, you have got to draw them. You draw them with or without color pencils that is up to you, hand sketch, draw them, explain their perspectives of these in terms of the questions is being asked.

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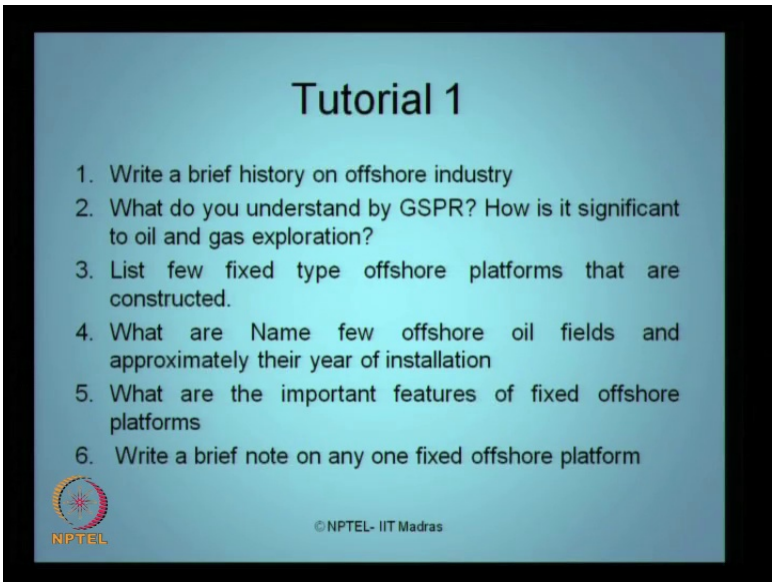

So, let us quickly look at the tutorial sheets, write the brief history on offshore industry? So, do not look this as a social studies class though the term sounds as history. So, what I wanted is a different history, which I think I explain. Write the brief history of offshore industry. What do you understand by the term GSPR? How is it significant in oil and gas

exploration? List few fixed type off shore platforms that are constructed. I want the name of the platform that can give additional information; name, year of construction, if you know more information about that it is good, but try to give the basically the name of the platform and where are they constructed and when are they constructed.

The name few offshore fields and their approximate year of installations and there is an error, we will correct that later. Name few offshore fields and the year of installations, what are important features of fixed offshore platforms? The structural action is very important for us to understand. What are the important features of fixed offshore platforms? Write a brief note on any one fixed offshore platform anyone platform pick up from the literature expand it and try to explain it in detail this is tutorial; one you got 4, we have got only 10 minutes more. I am not passing a copy of this; it is not essential. I think I have been talking about for 15 minutes, you can at least write for 15 minutes. So, there is no need for a copy of this. You may not even submit this. You have the full liberty of skipping this. So, you can take a challenge of a performance in the examination and then can skip.

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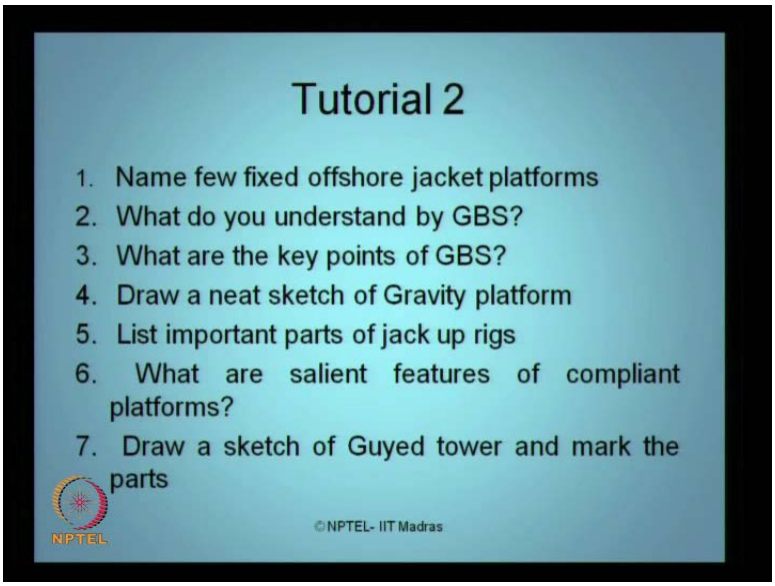

This second tut, name few fixed offshore jacket structures? Name few, what do you understand by gravity based structure? Do not expand it, do not abbreviate it, I want what do you understand by this? Why it is called gravity based system? What are the key points of a gravity based system in terms of its structural action? We discussed just in the

class of course, draw a neat sketch of a gravity platform, underline the word, neat list important parts of a jack up rig. We explained this type of platform as well. What are the salient features of a complaint platform? We elaborated in two lectures.

So, you must be having detail understanding of this. Now, in terms of its structural action someone can explain this. Can we move to the next slide? I want you to draw a neat sketch of a guyed tower and of course, mark the parts. I think you will understand what is the guyed tower? Why it is called as a guyed tower? What are the problems associated with the guyed tower? Talk about fatigue talk, about touchdown point, talk about the league fairly talk about the anchor drags etcetera.

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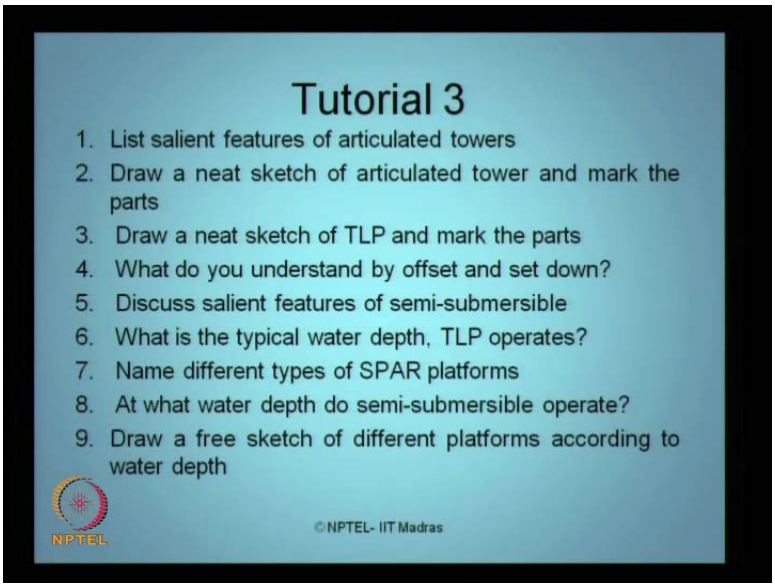

Next tutorial three. What are salient features of an articulated towers? What do you understand? The articulation is nothing but a deliberately introduced joint hinge pinned connection structurally. What are salient features of a t? How it restores, because the guyed where is now removed, but it restores under the wave action because of the buoyancy chamber and provision of velocity. I have introduced stability of this platform. How? Why we have discussed this?

So, what are the salient features of a t draw a? Of course,draw a neat sketch of this and mark the parts; draw a neat sketch of a tension leg platform and mark the parts. What do you understand by TLP mechanics offset and set down how does it restore its normal sea under wave action? What we call as a TLP mechanics? Then discuss features of semi

submersibles, what is the typical depth at which TLP operates? Look into the literature and then quote do not guess then discuss about spar platforms, different types of spars, sales spar, tress spar etcetera.

Though we skipped it first in the last lecture, but still is the open source literature different types of spar platforms. Then how about the water depth at which semi submersible generally operate? quote examples; then we move to the next sheet. Can I give comprehensive look out of different types of platforms at different depths? Just draw a line diagram, a line diagram starting from shallow depth to ultra deep waters.

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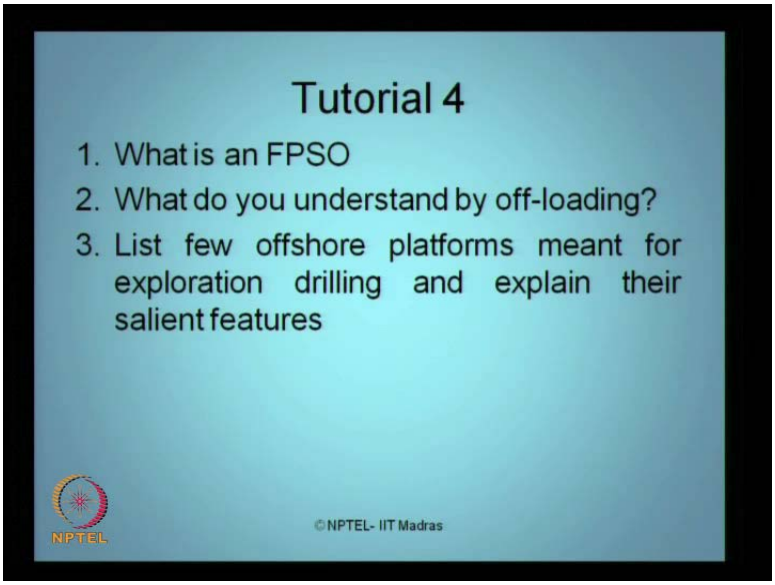

Last tut, what is an FPSO? Apart from abbreviating it, explain each part of FPS and O. What do you understand by off loading? List few offshore platforms meant for explorated drilling and explain their features? For example, drill ship. For example, which I meant for explorated drill, not for production close it here. So, I want you to answer these tut sheets at your own interest, off line. Then submit it to me, we will keep it as a record. If you have any questions on this lecture, please ask me.

So, the next lecture we will talk about the mathematical modeling, move into single degree freedom system. You want to write that is fine; I thought you are going to ask me a question; you are copying down the question; that is as long as you do not ask me, I have no problem with that. So, these initial 5 lectures, will give a comprehensive walk through of different kinds of platforms, their structural action, their functions and coastal

systems as well. So, with this as a base, we start now understanding dynamics of single degree freedom system models in the coming lectures for about 11 lectures, more down the line possibly. We will stop at that point, for this one.

Thanks