Port and Harbor Structures
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Module-05 Lecture-30
Slipway, Drydock, Floating Dock, Shiplift

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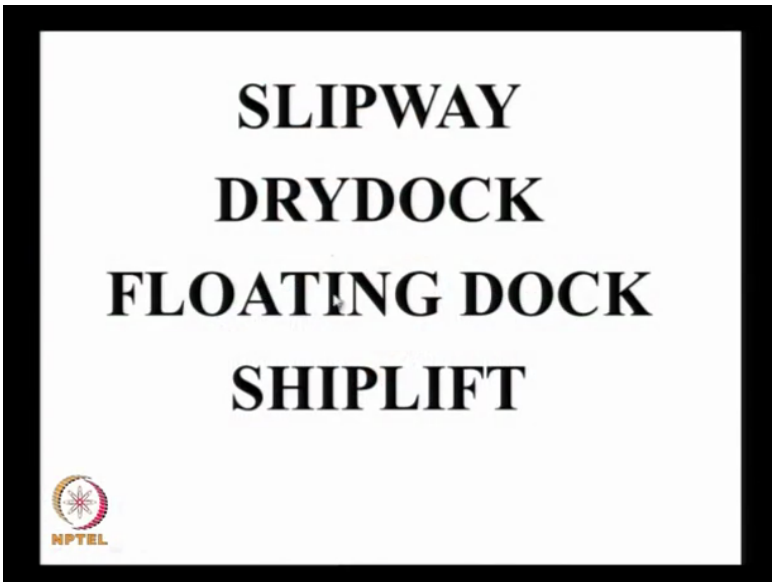

Today's class we will discuss about four typical structures that are built inside a harbor basin. This is not for handling of cargo, this is mainly for repair and building of ships. Yesterday I was discussing about shipyard. A shipyard will basically consist of any one or combination of these structures. They are slipways, dry docks, floating dock and shiplift. We have shipyards in Cochin, Goa and Kolkata.

In all the shipyards we have slipway or drydock. The floating dock is in Port Blair and recently we are commissioning a shiplift at Jaigad for Chowgule Shipyards Limited. And one has been recently commissioned in Kattupalli port by L&T near Chennai. And in Karwar also we had a shiplift system. So we have basically three shiplift systems. One at Karwar, commissioned maybe 10 or 15 years back. Another at Karwar, the third one is at Jaigad which will be commissioned shortly.

We will be discussing about the shiplift. Shiplifts are most commonly used nowadays because it is not very expensive and another thing is, very expensive means it is comparatively costly

compared to slipway and all. But operation-wise this is very convenient and period of construction also is very short for a shiplift system. Floating dock also are requirement for navy and it is the costliest compared to any of other systems.

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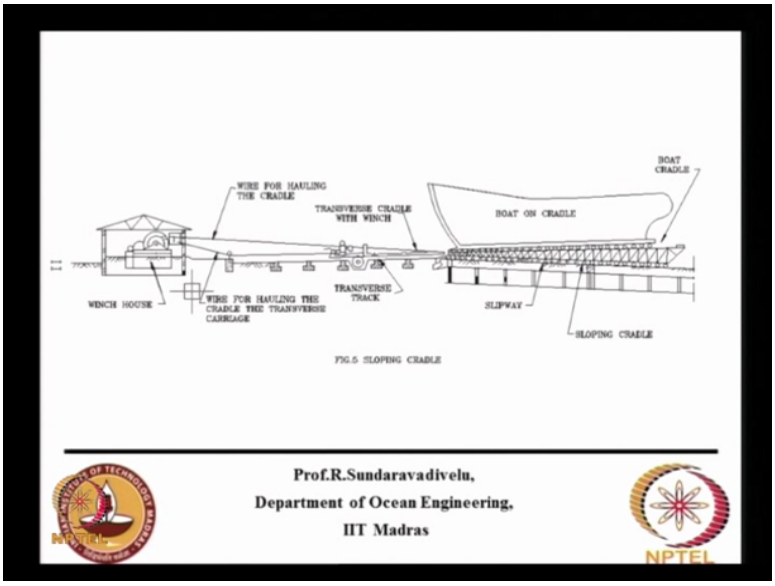

Slipway first, we will discuss. It consists of a sloping platform like this and then we have what is known as cradle. Cradle has a sloping phase on one side and horizontal surface on the top and sloping surface on the bottom inline in matching with the sloping surface here. Then we have a boat which is sitting on a cradle which will be pulled by winches by a winch house. And then it will be kept here and from here it will be either transferred or it will be kept at the same place for repair or maintenance. Sometimes they build the ship here, then push it down like this.

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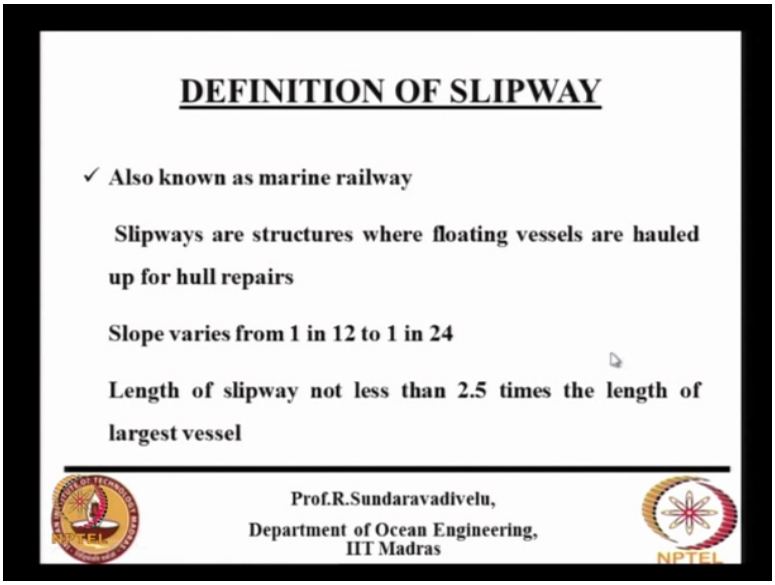

Definition of slipway, this is also known as marine railway. They are structures where floating vessels are hauled up for hull repairs. The slope varies from 1 in 12 to 1 in 24. So this slope is very important. A steeper slope, the hauling power required will be higher. Flat slope, the distance required into the water is larger. That is the length of the slipway, is generally about 2.5 times the length of the largest vessel that is to be hauled.

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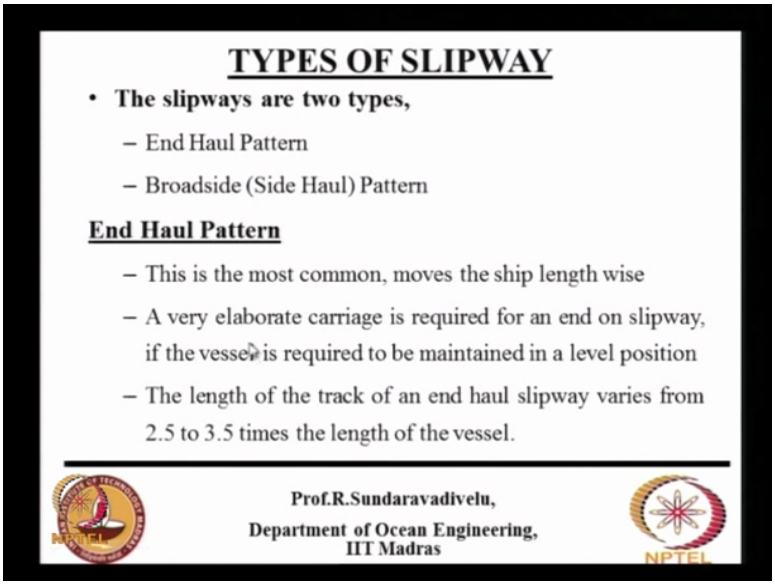

There are two types of slipways: end haul pattern and broadside or side haul pattern.

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End haul pattern, there is a ship like this, they will be hauling the ship like this. This is the end haul pattern.

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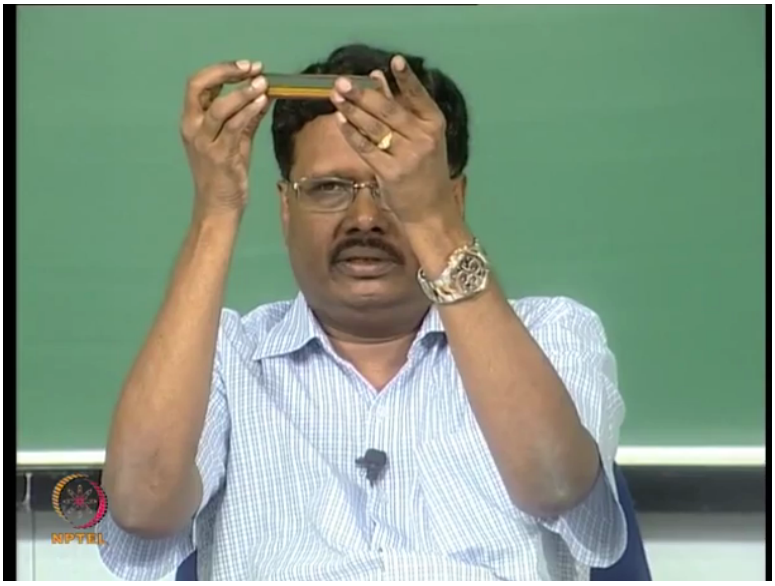

Side haul means ship will be like this. They will haul it like this.

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Similarly for shiplift also you will have end shiplift, that means they will raise the ship like this and then push it here. That is end haul.

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The broadside means they will lift the ship like this and then shift it like this. So both the options are there in shiplift also.

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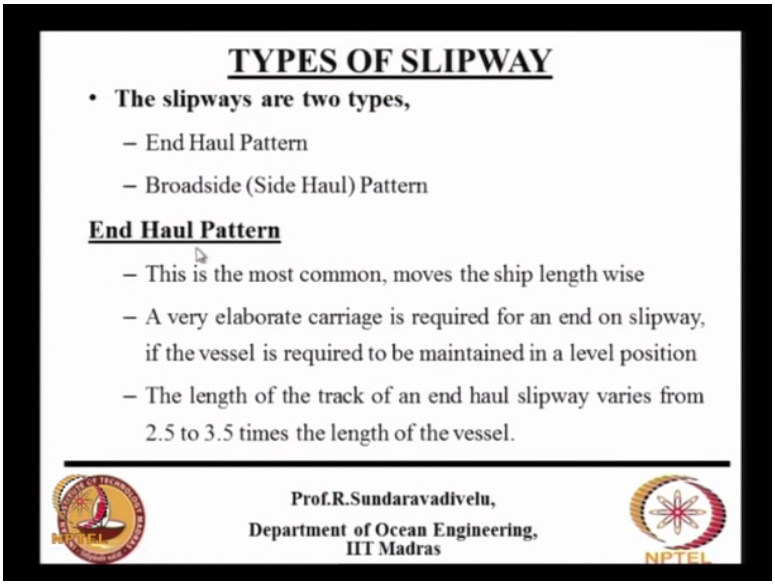

But most commonly used is the end haul pattern. This move the ship lengthwise. A very elaborate carriage is required for an end on slipway. If the vessel is required to be maintained in a level position, the carriage means nothing but the cradle. The length of the track of an end haul slipway varies from 2.5 to 3.5 times the length of the vessel. That is a length required. The length required is higher because for one length of the vessel the ship will be in water. For another length of the vessel it will be in land. That is why we need minimum twice the length.

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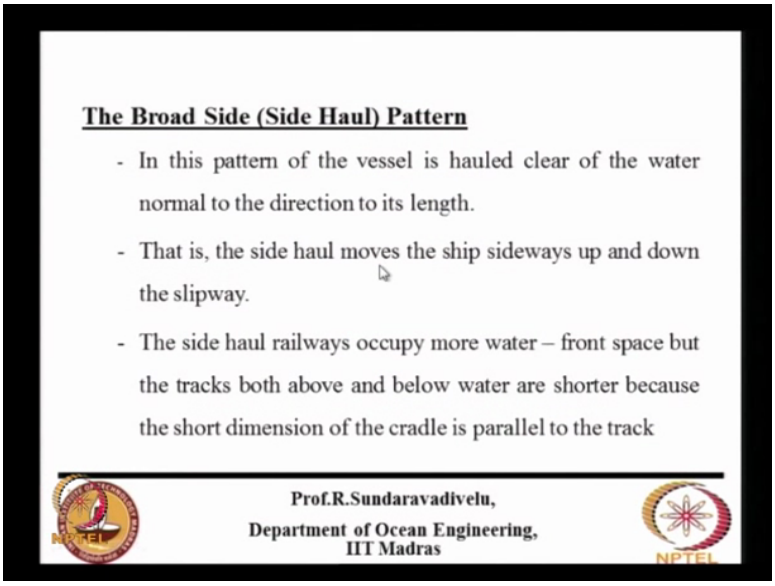

The broadside pattern, the vessel is hauled clear of water normal to the direction of its length. That is, for the side haul it moves the ship sideways up and down the slipway. The side haul railways occupy more water, front space but the tracks both above and below water are shorter because the short dimension of the cradle is parallel to the track. That is cradle width will be lesser.

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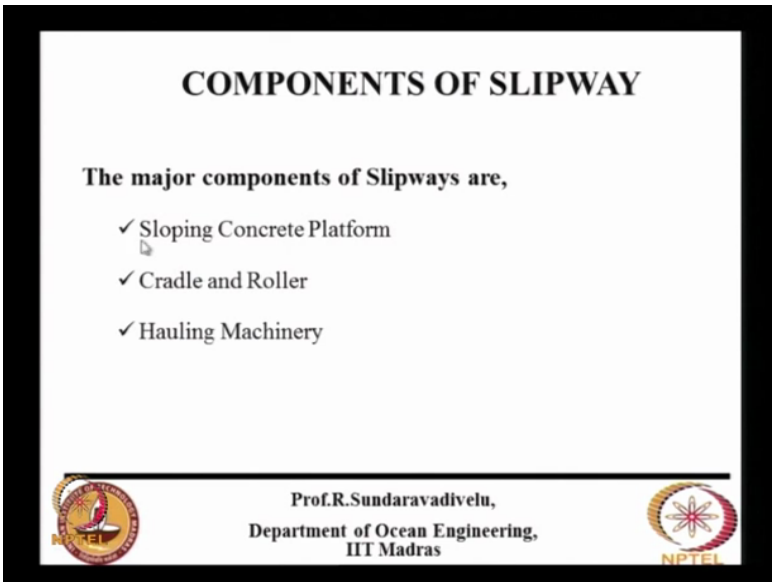

The components of the slipway, these are the three main components. One is a sloping concrete platform, that is a cradle and roller, then there is a hauling machinery. These are the three main components for a slipway.

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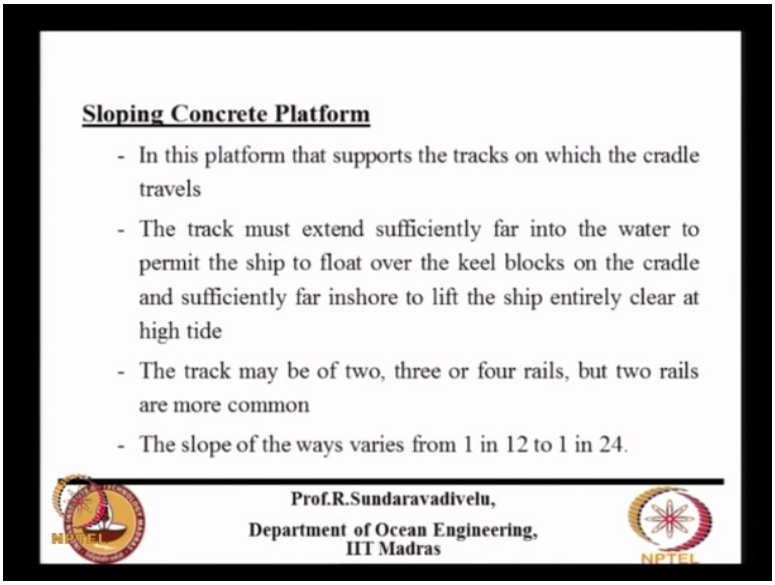

This sloping platform supports the tracks on which the cradle travels. The track must extend sufficiently far into the water to permit the ship to float over the keel blocks on the cradle and sufficiently far inshore to lift the ship entirely clear at high tide. That is one ship should float, one ship length of slipway platform is required where the ship will float. But another length is required where the ship will rest on keel block and bilge block.

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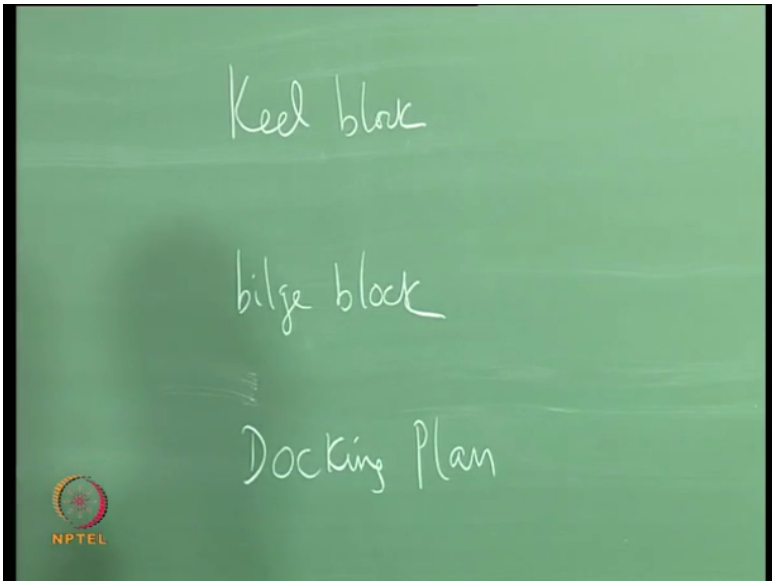

We have two types of blocks which are used. One is called as keel block, another is called as bilge block. These are the two types of block that are required. Then we need what is known as

docking plan. These are the requirements for any slipway or drydocking or shiplift or floating dock. These are the three main requirements that are required.

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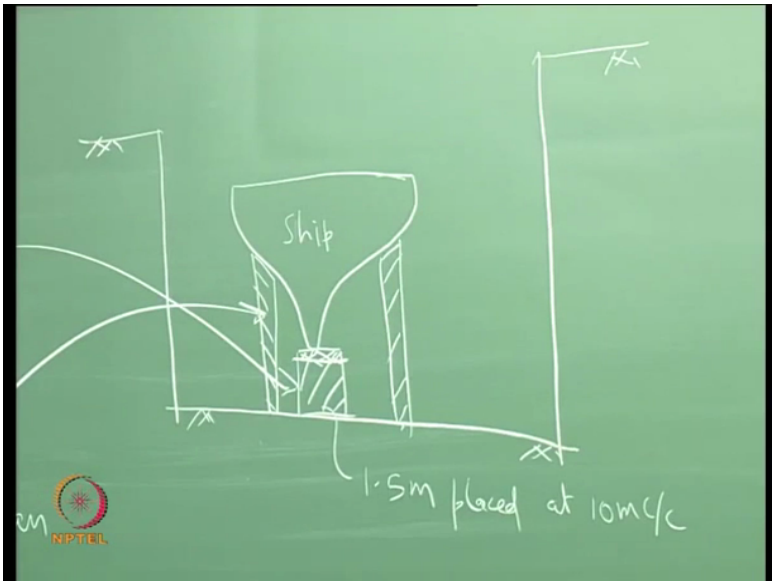

Keel block and bilge blocks are something like this. So when you have a block here to support the ship on the dock floor, this is called as keel block. The bilge blocks are to support the vessel at the ends. This is called as the bilge block. This is a ship which has to be resting on the drydock floor. So you may have, it is a dry dock or shiplift system, the distance will vary. Generally the ship will be resting on the dry dock. This will be the top level of the dry dock. This will be the bed level. We will have a keel block, it may be made of concrete but generally you will have some wooden strips on top of this.

Then to support the vessel at the bottom or the sides we will have the bilge block. Docking plan means in the plan at what locations these keel blocks will be kept. This height of the keel block is generally about 1.5 meter and this will be placed at depending on the size of the ship, maybe at 10 meters center to center or 5 meter center to center. We have been approached for one project to bring the submarine that is used submarine near Mahabalipuram. Most probably it will be done in March or April. They will be doing it spending about 2 crores or so.

At that time if it is convenient, I will take you there. They will bring the submarine from the sea to the land. It is there in Visakhapatnam. Similar thing they want to do, Tamil Nadu Tourism Department in Mahabalipuram for which we are designing certain aspects. So there also the

docking plan is required. There they want to support at every 10 meter center to center. It varies from ship to ship. It is not at equal spacing, it will be at different spacing.

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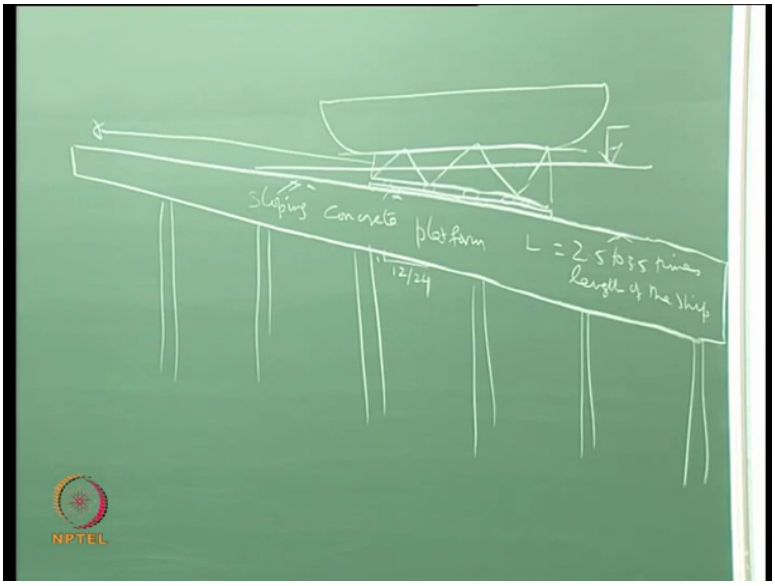

The slope what we are discussing is, suppose this is your slope of the platform and this is your water level, then on top of this we will have a rail. This will be the rail over which you will have the cradle. On top of it you will have the ship. So the cradle has to move down. It is not at this position. This one position of the cradle, this is your cradle which will be moving over rails like this. So the ship will be somewhere far away from here where it will be floating. At that time they will lower the cradle and then ballast the ship onto the cradle, then they will push this cradle clear of water.

So this length, from this it goes further down like this and you may have some piles supporting this sloping concrete platform. So this length should be 2 to 2.5 to 3.5 times length of the ship. And this slope will vary from 1 in 12 or 1 in 24. This rail what you are placing, this can be 1 rail or 2 rail or maybe 2, 3 or 4 rails. Minimum 2, sometimes they will have 4 rails also over which the cradle will move. Cradle is a steel structure which supports this platform.

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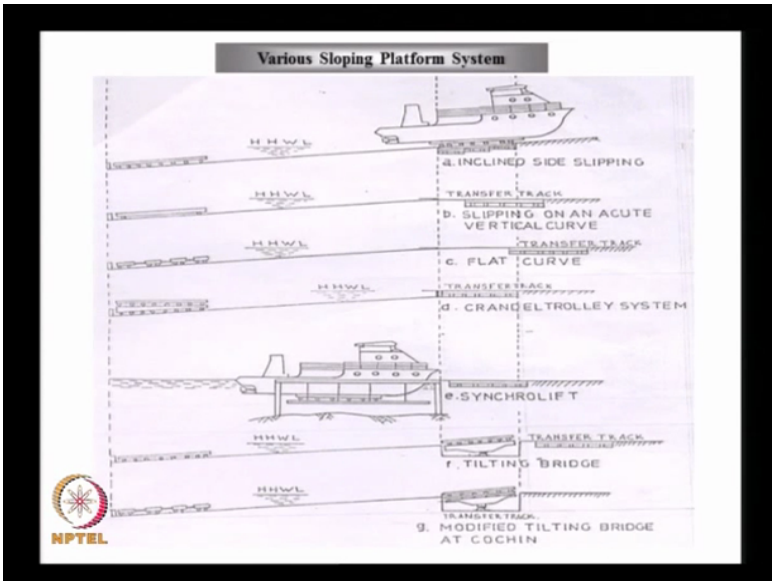

There are different types of cradle. So in this, this is called as syncrolift what you are seeing. So this is the high water level. Cradle is somewhere here, the ship will be sitting here, floating at one position, then they will ballast and then it will rest on the cradle. Then they will push the cradle here, then the ship will come clear of water. Some places we will have a transfer track through which they will transfer it on the sideways.

There are different types of slopes. One is inclined side slipping, another is an acute vertical curve. The third one is on a flat curve. Then we will have a cradle and trolley system. Syncrolift we will discuss later. Then they will have a tilting bridge. Then they will have a transfer track. These are the all different types of platform arrangements.

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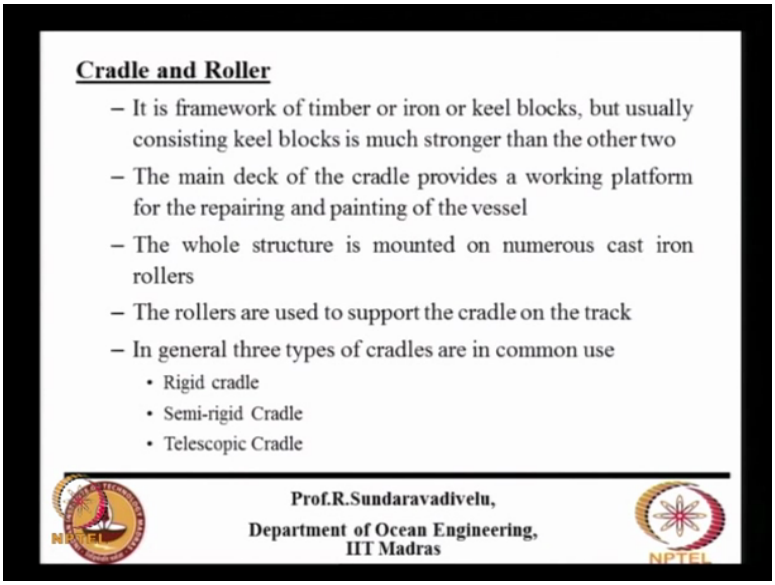

The cradle and roller is a framework of timber or iron or keel blocks but usually consisting keel blocks is much stronger than the other two. They can have cradle with a keel block also. The main deck of the cradle provides a working platform for the repairing and painting of the vessel. So when they take the platform with the, when they take the ship with the cradle, they will keep the ship in the cradle itself. So each ship will have a separate cradle.

So they will take it along with the cradle, repair and then take it, push it down to the sea. So each ship when they want to repair, they will have a specific cradle for that. The structure is mounted on numerous cast iron rollers. The rollers are used to support the cradle on the track. There are three types of cradle. One is a rigid cradle, semi-rigid and telescopic. Semi-rigid means is flexible, telescopic means they will increase the length of the cradle depending on the length of the vessel.

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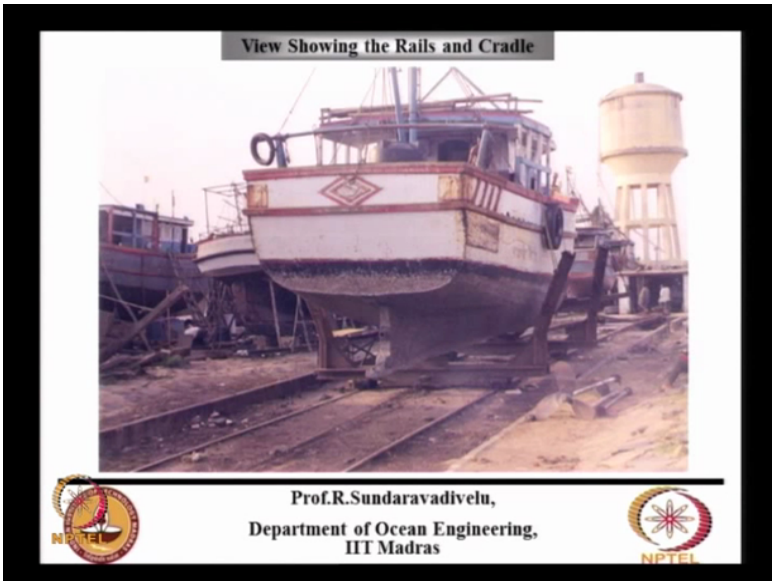

This shows a conventional ship repair. This is not a ship, this is for a floating vessel. This is in a place called Dhamra in Orissa. So here you are seeing the two rails. These are the two rails. I think these are the two rails I think. These are the two rails. This is another structure. This is what is I am talking about the cradle. This is a keel portion of the vessel. They will be pushing, this is a very simple structure because this is a very small boat facility.

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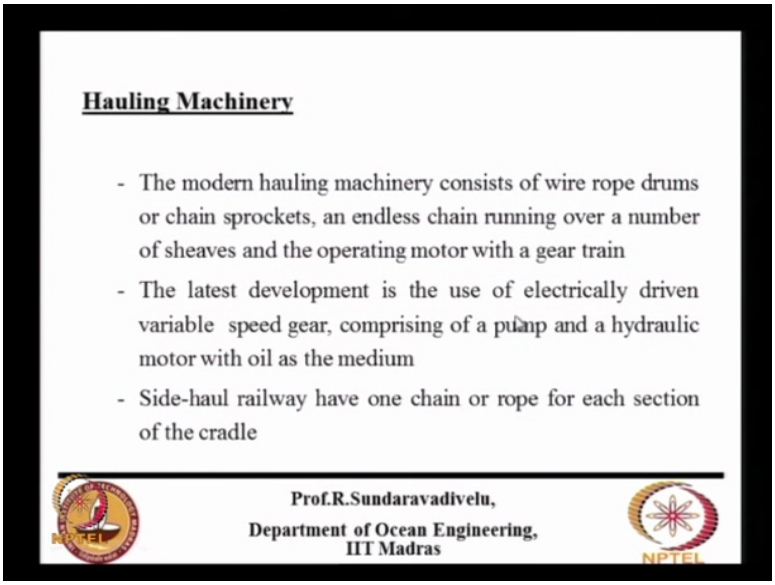

The hauling machinery consists of wire rope drums, (spine) chain sprockets, endless chain running over a number of sheaves and the operating motor with a gear train. Then we also use

electrically driven variable speed gear, comprising of a pump and a hydraulic motor with oil as the medium. Side-haul railway have one chain or rope for each section of the cradle. When you do a side-haul railway, there will be many cradles because the length of the ship is more. Each one will have a separate hauling system.

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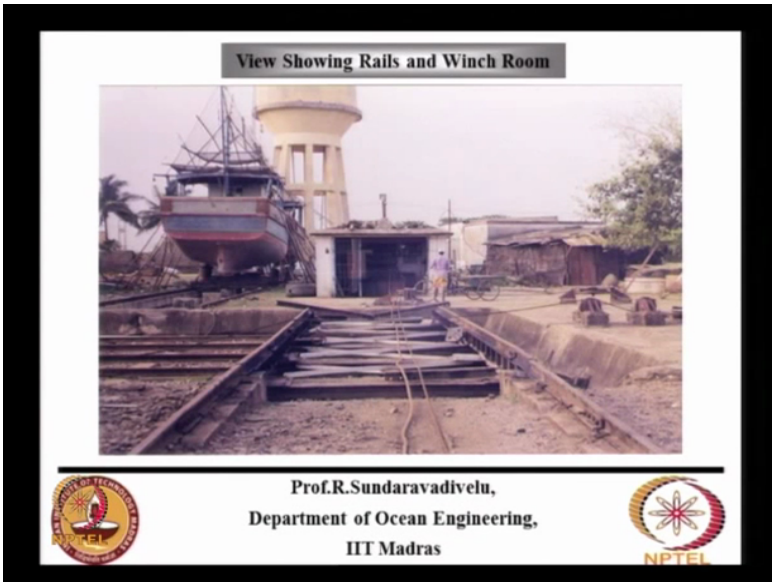

Hauling machinery means what you are seeing is this is the hauling machinery. This is the pump room, there is a wire which is going down. These are the two rails. Below this you have this sloping platform. Once the vessel comes here, they will transfer it to the side. That is why these rails are laid here. And then it is pushed back. Is it clear? Once you haul it, you do not keep it here, you push it down, then you further haul it towards this place. Then you do the repair, then you push it down, bring it here and then do the repair. I have video showing the shiplift where these operations are given. This will go to the other end below the water where they will be doing this.

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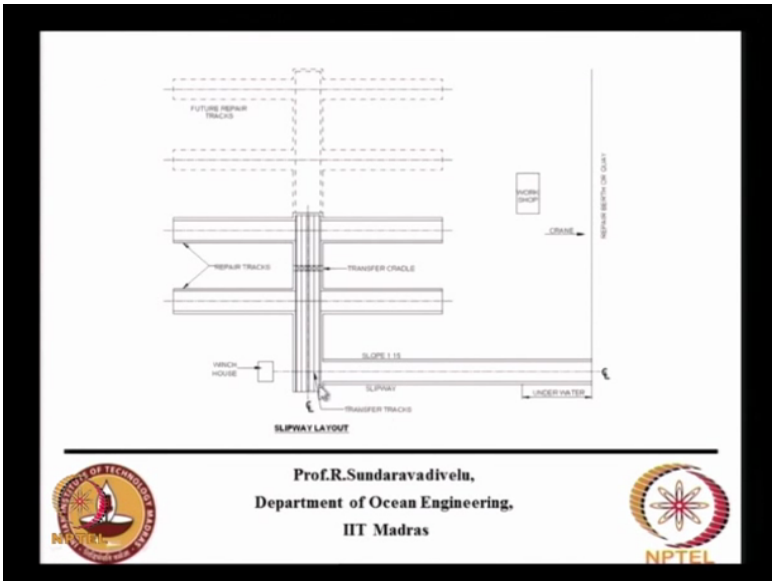

This is one typical system where the transfer cradle is used. So this is the main slipway. This is the river. This is land area. This is a winch house here. They push the vessel here like this, then they transfer it like this right up to the end. We have the tracks on either side of this, transfer track. And these are called as repair tracks. This they want to do it in future.

So advantage of this type of thing is you haul the vessel at any time and go to any of these repair tracks. Suppose this vessel is ready, then you bring it here, then push it back like this and then take it here like this. This is what they will do. Typically what they do is they rotate, the vessels will, wheels will rotate 360 degrees. I will show in the shiplift video how they are shifting, then only you can transfer it like this.

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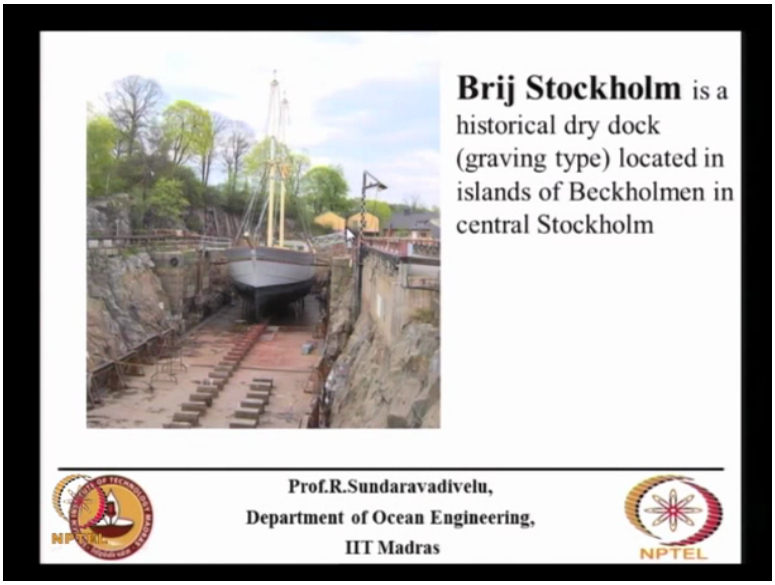

This is one of the dry dock what we are discussing. These are the keel blocks which are laid here. These are your bilge blocks which are positioned here. The difference between the slipway and dry dock is there is no cradle. This is not a slope. This is horizontal bed only. They have a gate here. So once they close the gate, then pump the water inside, keep the water level same, then they remove the gate and then take the vessel out. When they bring the vessel, they bring the vessel in, they close the gate, pump the water out. So a gate is required for a dry dock.

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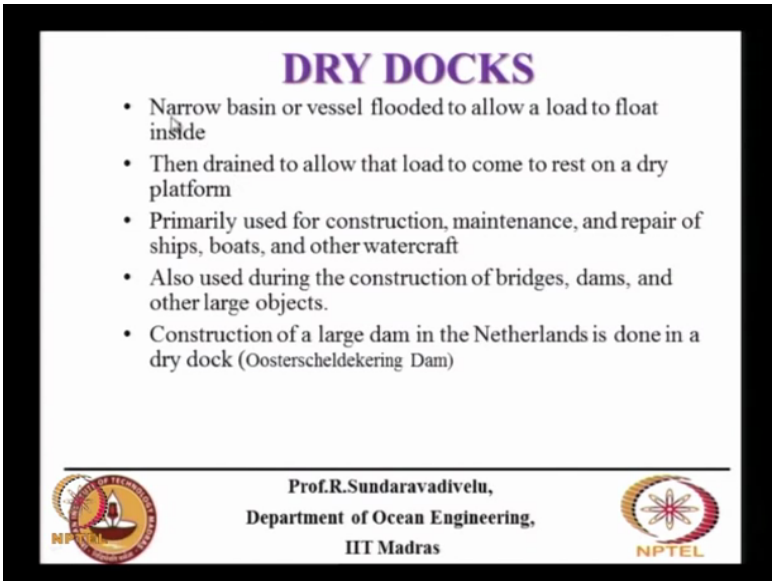

Is a narrow basin or vessel flooded to allow a load to float inside, then drained to allow the load to come to rest on a dry platform. That is first allow the vessel inside with water inside, then remove the water. This can be used for construction, maintenance and repair of ships, boats, and other watercraft. There is a regulation that once in 5 years the under keel of the ship has to be checked. For that reason we have to drydock the vessel once in 5 years.

You have to do some coating, anticorrosive and anti-biofouling coating. If the biofouling is there, the ship resistance will be higher, diesel consumption will be very high, fuel consumption. That is why we have to remove the marine biofouling also. Sometimes for construction of bridges, dams and other large object, we use the dry dock. At present there is a construction going on seawater in Tec Well for Hinduja project at Vizag for which the intake well is built inside a drydock. And one of the large dam in Netherlands they have done in a dry dock.

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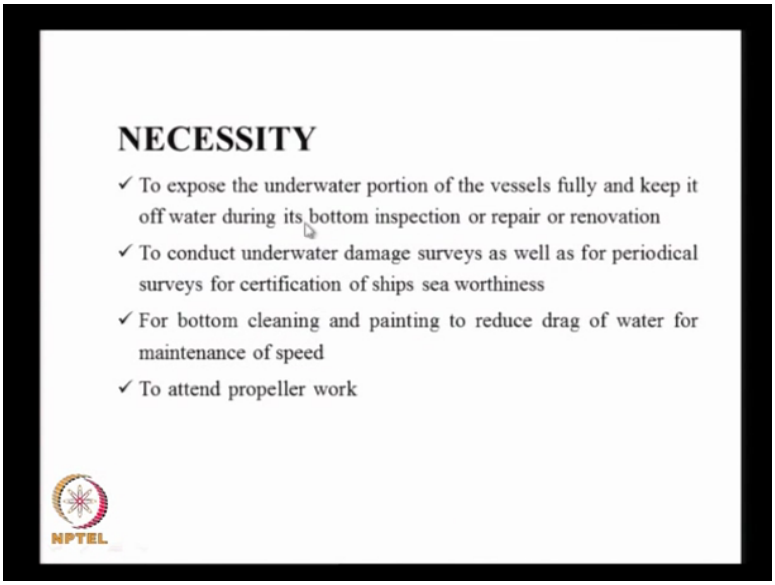

What is the necessity for a dry dock? This is to expose the underwater portion of the vessel fully and keep it off water during its bottom inspection or repair or renovation. Sometimes certain renovations are required in the vessel. For that also we have to drydock. We have to carry out this underwater damage survey, there is any damage that has taken place and as well as for periodical surveys. And certification is required. So we have to certify sea worthiness of the vessel once in 5 years. For bottom cleaning and painting to reduce drag of water for maintenance of speed, to attend to the propeller work, for these reasons we need the dry dock.

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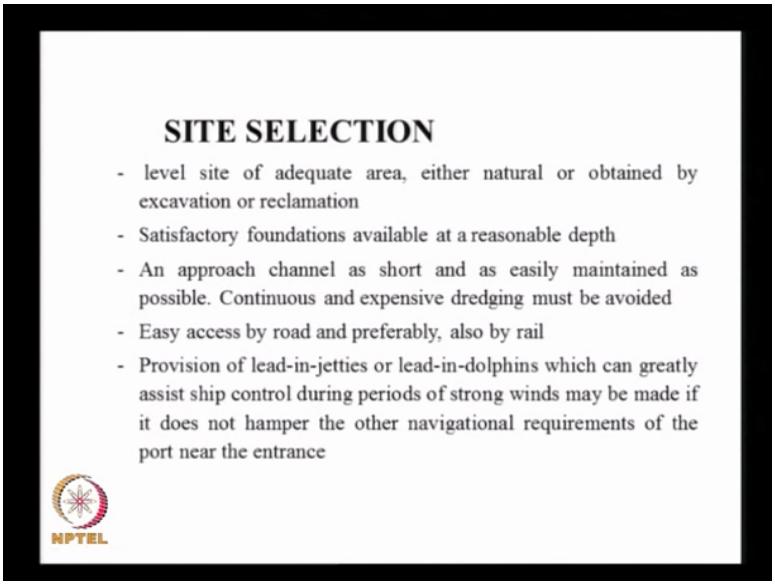

So site selection is very important and satisfactory foundations at reasonable depth should be available. A short approach channel is preferred. Dredging both capital and maintenance should be as minimum as possible. There should be easy access to road as well as for rail. You have to provide some lead-in-jetties, lead-in-dolphins which can greatly assist. Ship control during periods of strong winds and other navigational requirements, these are the requirements for a dry dock.

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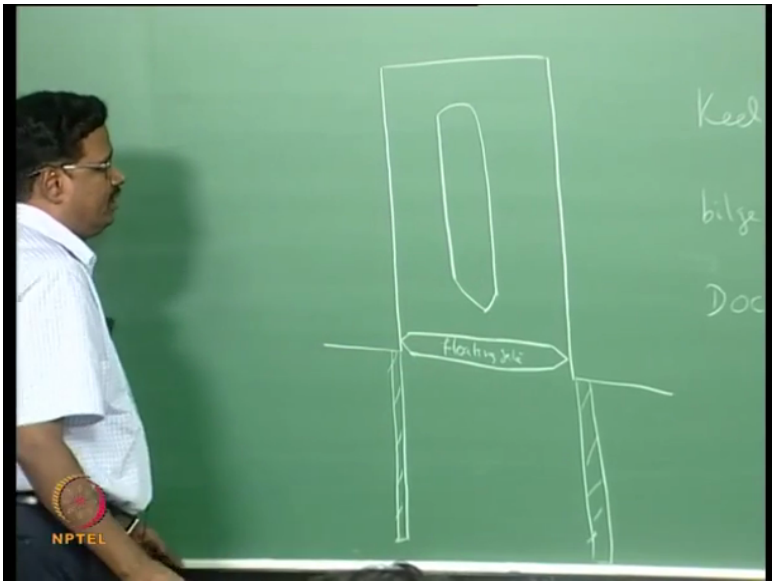

What dry dock, what they are asking is, I am drawing the plan of the drydock. So the vessel will be kept here like this. Dry dock, this is the plan of the vessel, then we have a gate. Gate is like this. What they are asking is a lead-in-jetty, there is a jetty here. On both the sides also it will be placed. So this is, there are different types of gate, this is called as floating gate. When they ballast, the gate will go and sit here.

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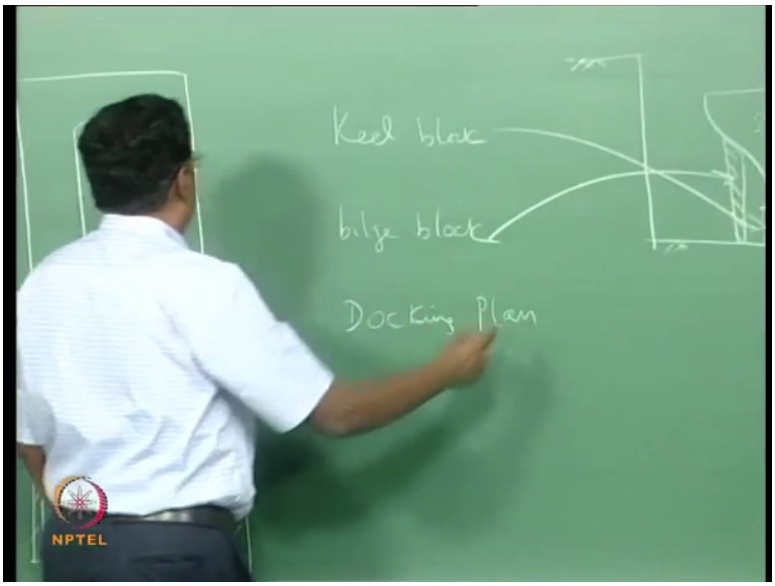

So if you see the, this is the cross-section.

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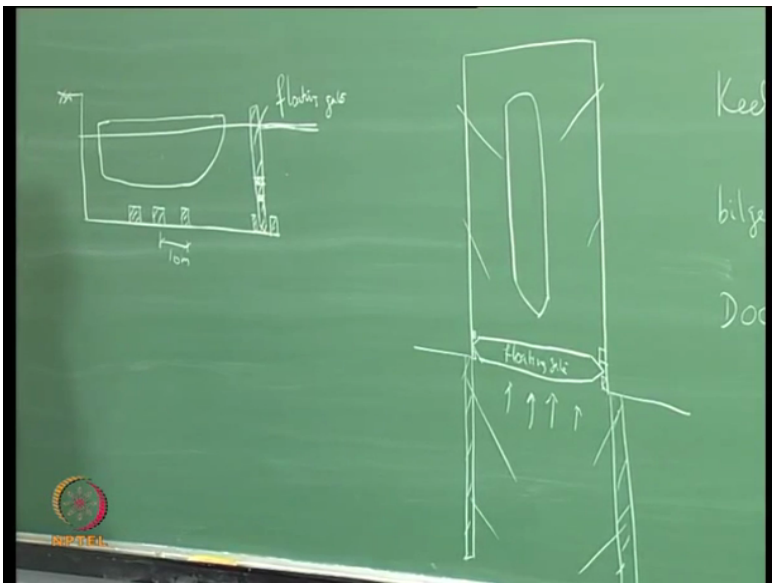

If you see the longitudinal section, so when the gate is not there, they will bring the vessel inside, then they will position the gate, then they will ballast the vessel or remove the water. Then the vessel will go and rest on the keel blocks. These keel blocks only I said this typical spacing will be about 10 meter in this direction. So this will rest here. They will remove the water. This floating gate has to be designed for.

So this will have the end grooves here like this. Like this there will be some grooves where it will go and rest so that the gate will not move outside. So there will be pressure from this side. And this side dock is empty, right? You have to design for this. And then once the repair is over, then they will allow the water inside. There will be some walls here which they open, then the water will enter from outside to inside. When the water level is same on both the sides, then they will float the gate and take it to the sides.

Do not talk. Hello, do not unnecessarily talk. They remove the floating gate and put it by the side also here. To bring the vessel inside when the vessel is somewhere here, they will have some aiding gate from here so that they can bring the vessel inside correctly into the position. They will take the vessel like this and then bring it inside. This is the operation for the dry dock.

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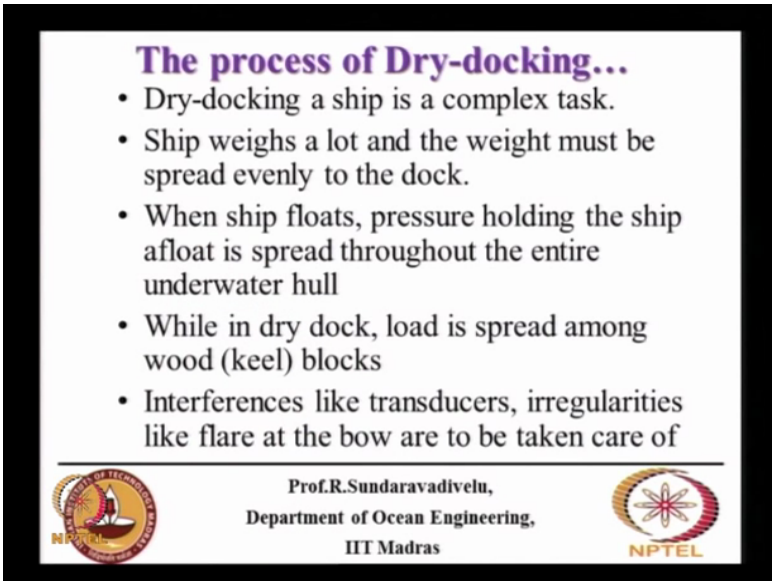

So very complex task. Ship weight is very high. The ship weight must be spread evenly on the dock floor. Hello! Who is talking there? Do not talk. When ship floats, pressure holding the ship afloat is spread throughout the entire underwater hull.

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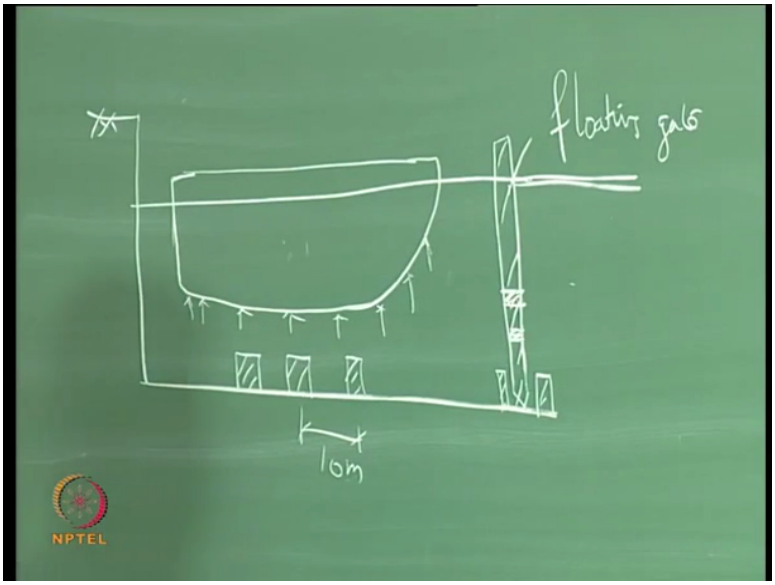

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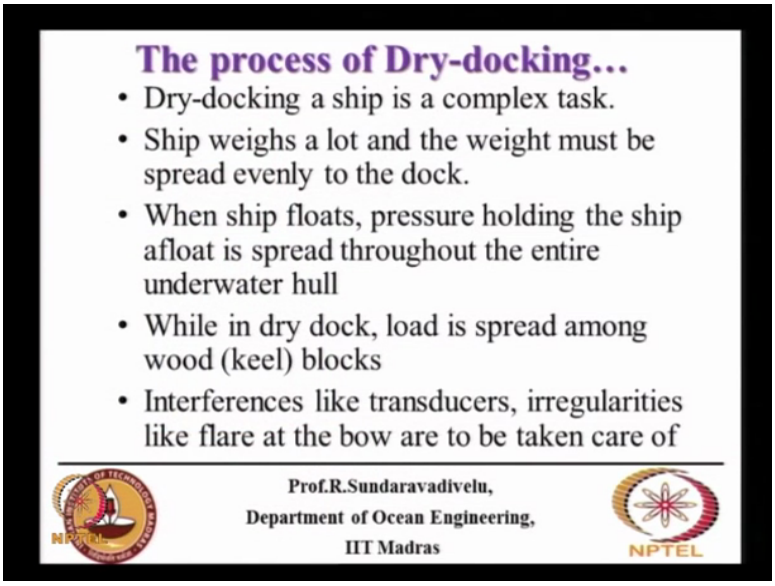

When the ship is floating, your pressure is throughout like this uniformly spread out. But when it is docked in the dry dock floor, it is at intermediate spacing. This will be on the keel blocks. There will be some transducers, irregularities like flare at the bow, they have to be taken care of. We cannot support this portion, bow portion cannot be supported. There may be some openings at the bottom especially for atomic nuclear submarines and all. There may be some locations where you cannot support.

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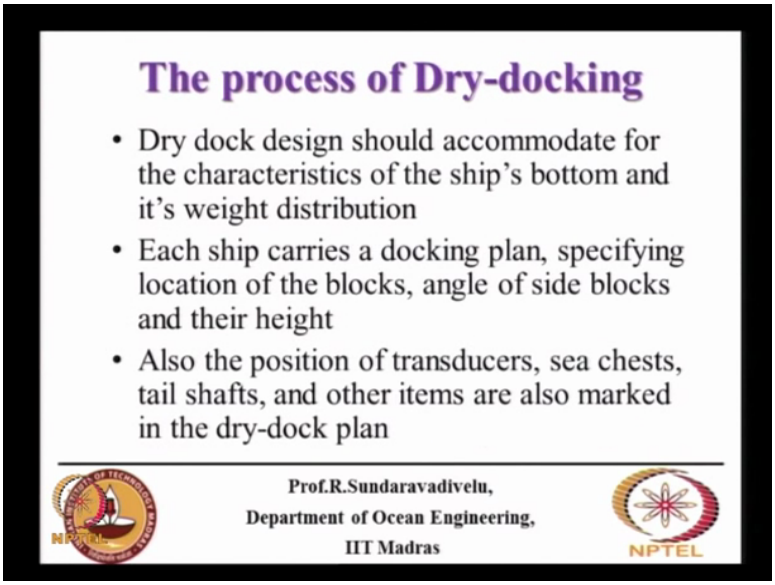

Whenever a ship is designed, the dry dock plan also is given along with the ship. Each ship will have a different planning. So it should accommodate the characteristics of the ship's bottom and the weight distribution. Weight distribution is not uniform, the weight of the ship. Each ship carries a docking plan, specifying location of blocks, angle of side blocks and their height. This angle at which it has to be supported, this angle also is given. Where it is to be supported also is given. The position of transducers, sea chests, tail shafts and other items also marked on the dry dock plan. You should not have a keel block at this location, otherwise this will damage the costly equipments.

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This photograph shows atomic submarine. You can see the space what is given here on either side of it. This is a dry dock. There are some cranes here which will lift some of the components from this side. There is a staging which is given here so that you can access any part of the submarine. Typically the height is about 1.5 meters, so somebody can go below and do the work also.

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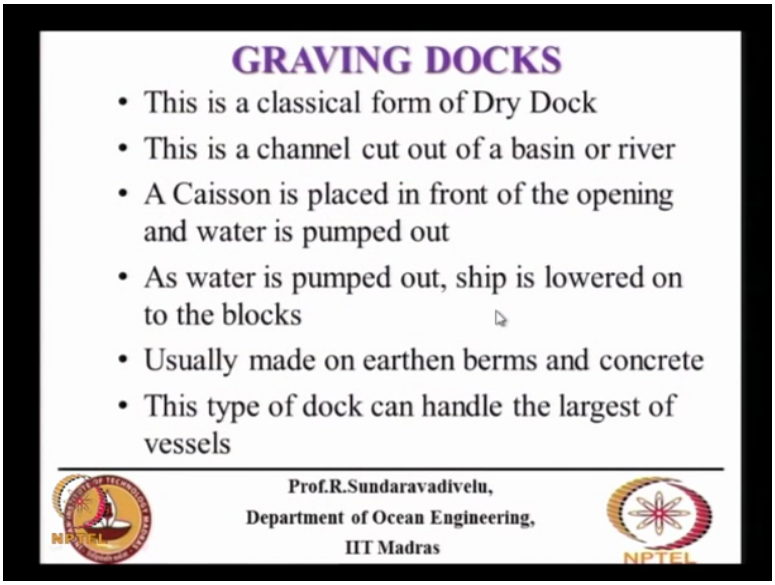

There is what is known as graving dock. This is nothing, this is a classical form of dry dock. You cut a channel from the basin of the river. A caisson is placed in front of the opening and water is

pumped out. As the water is pumped out, ship is lowered on the blocks. Usually made on earthen berms and concrete. This type of dock can handle the largest of vessels. So typically you cut a channel and put block between the channel and the river by a caisson. This can be a floating caisson which will arrest the water and side slopes and all are not required, side structures.

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One of the dry dock in South Africa, Cape Town. This is made of stone, all these phases. So they have put a stepped stone here. In Bombay dry dock also something like this only. This is the crane which is used to lift the structure from here.

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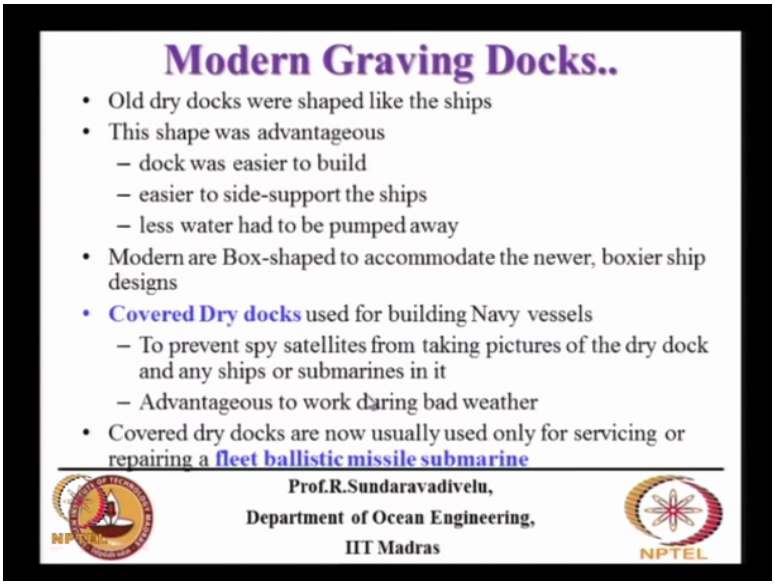

Olden day the dry docks were built like shape of the ship. The shape was advantageous because dock was easier to build, easier to side-support the ships, less water had to be pumped out away. But modern dry docks are box-shaped as they have done here. We use covered dry docks for navy vessel. This is mainly done to prevent the spy satellites from taking pictures of the dry dock and any ships or submarines in it.

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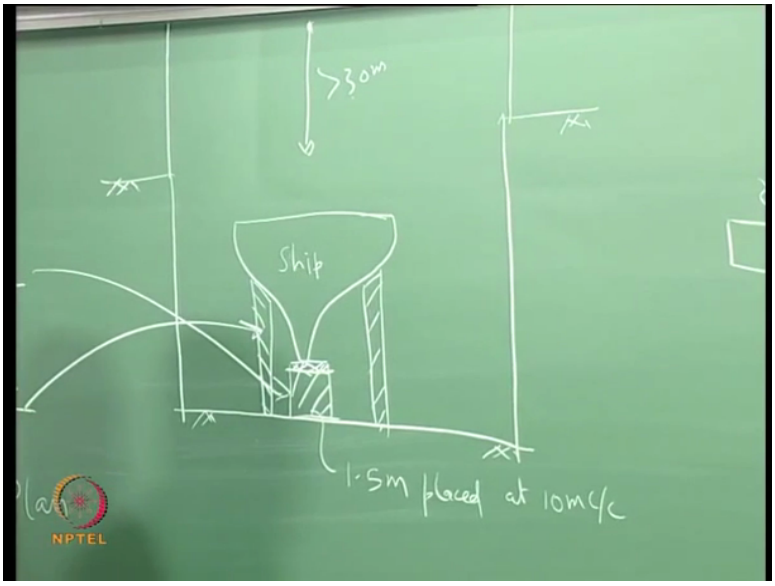

The advantageous to, say typically they put a roof over this. This is not simple because this height required is more than about 30 meters, about 10-storey building is required because some

of the nuclear submarines they have some antennas, so should not come and hit. So that is why they need these dry docks. I told you there is a plan to build a tunnel to take the submarines inside land for a wave place, that is also being done.

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Then we have what is known as floating dry dock. I was telling about lead-in-dolphin, this is something like a lead-in-dolphin only. These are floating dry docks in which the vessel is coming here. So this floating dry dock will be ballasted down, then the ship will enter, then they will de-ballast it. This another floating dry dock, smaller one without any vessel. These two are with the vessels.

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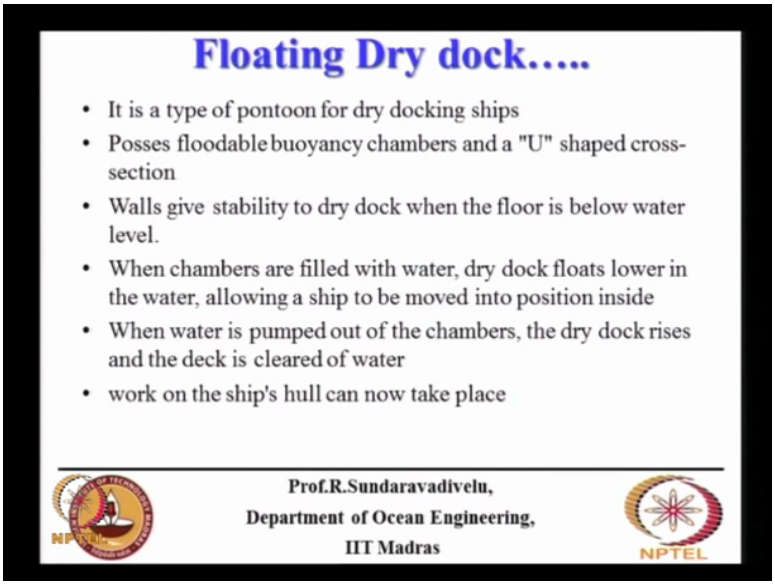

So it is a type of pontoon for dry docking ships. The chamber shape is typically U shaped. These walls give stability to the dry dock when the floor is below the water level. When the chambers, that is chambers are filled with water, dry dock floats lower in the water allowing a ship to be moved into position inside. When the water is pumped out of the chambers, the dry dock rises and the dock is cleared of water. Work on ship hull can now take place.

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This is general principle. It has multiple rectangular sections, this can be combined to handle ships of various lengths. That is you can handle single ship or two ships. Each section contains

its own equipment for emptying the ballast and to provide the required services. You will have about 5 or 6 typical sections. Each section will have its own pump and other machineries. The BOW section facilitates towing of assembled dry dock. Many shipyards commonly operate floating dry docks as means of hauling or docking vessels.

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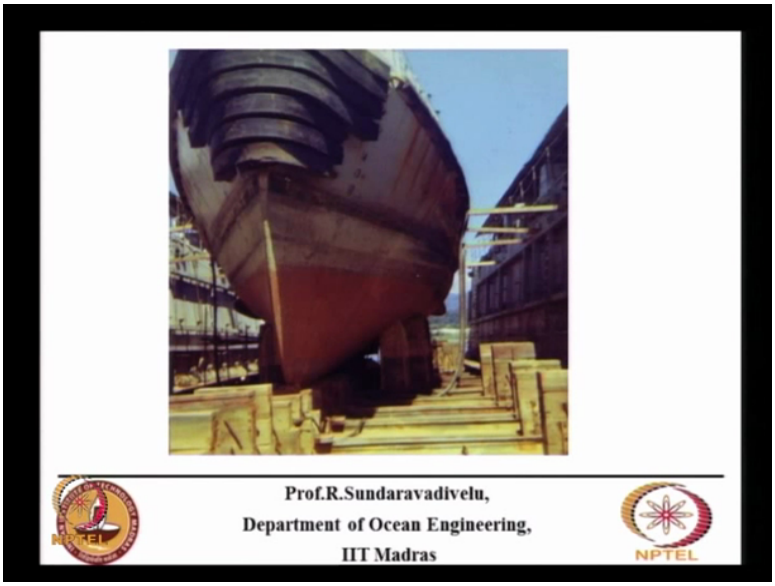

This shows a floating dry dock. There are some side supports which is given to the vessels here.

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This figure shows the floating dry dock. These are the side walls of the floating dry dock. This is the bottom chamber. You can see the person standing here. There are different sections. This is one typical section which will have its own machinery. Then like this there will be at least about 5 sections. And when you ballast this, when you put water into this, the whole floating dock will go down and then this vessel also will go down.

Once the vessel required buoyancy is reached, then the vessel will float above the keel block. There is no tying arrangement between the keel block and the vessel. Once the buoyancy is there, it will float, then they will take the vessel outside. Similarly the same process while bringing it in, they will ballast it so that it will rest on the keel block. Then they will pump the water from the side chambers. Then the floating dock will rise above, then they can do the repair. These are the twin propellers which are shown in this slide.

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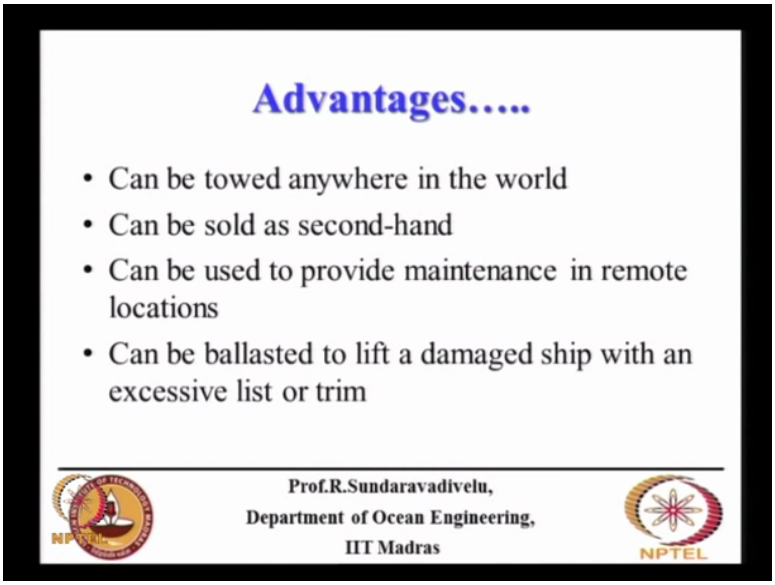

One of the advantage is the floating dock can be towed anywhere in the world. We can sell it as second-hand item. It can be used to provide maintenance in remote locations. That is what we need at Port Blair where we have the this floating dock. Can be ballasted to lift a damaged ship with an excessive list or trim. It can be used when there is vessel which is tilted, which is damaged, then you can take the floating dock there and do the mechanism of lifting it above the water for a damaged vessel.

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Shiplift for trial docking, this is the photograph from L&T Kattupalli project. They have commissioned in 18 months time. These are the haunches. This is the end-haul pattern.

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This shows the layout of the harbor. This is your breakwater. One break there is on the northern side, north breakwater. This is the south breakwater. You have the shiplift system somewhere here. What you are seeing is the container cranes, they have container facility here.

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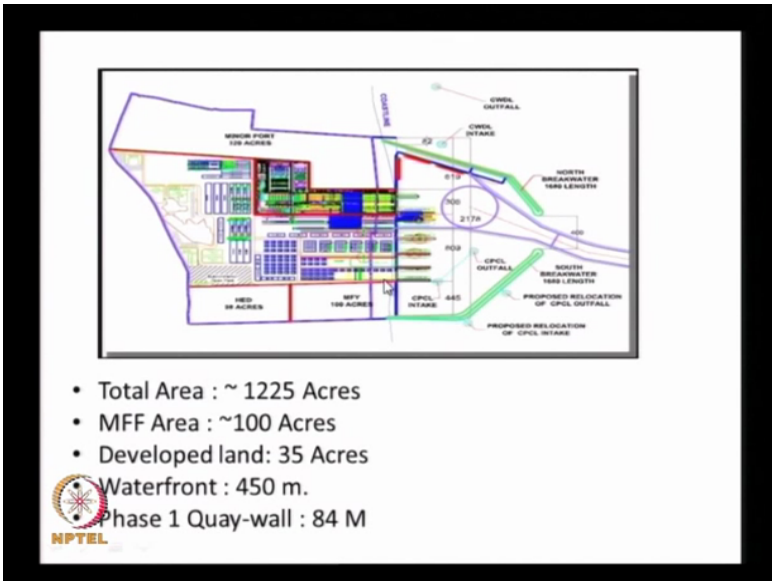

This shows the layout of the breakwater. This is north breakwater, this is south breakwater. This is a container facility. This is a shiplift facility. These are the other structures. Total area is 1,225 acres, whole area. That is called as modular fabrication facility, that is MFF, that is 100 acres. They have developed the land of 35 acres with very strong foundation. The waterfront required is about 450 meters. The phase 1, they have built one quay-wall also somewhere here.

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This can handle ships of size 260 meter by 46 meter. The light ship weight will be about 23,000 tons.

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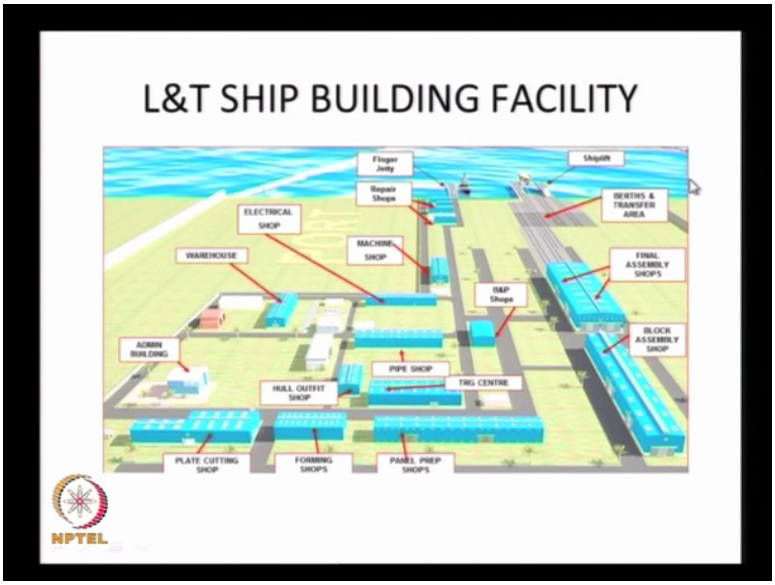

This shows the layout of the facility. This is the shiplift area. You can bring the vessel here and you can bring it here also or from the assembly shop you can take it here also. You can shift it here and go this side or this side and keep the ship. And these are all the other facilities that are required, hull outfit, administrative building, warehouse, electrical shop, machine shop, repair shops. There is a finger jetty where we can do the outfitting above the water level works, it can be done here.

Here you prepare the plate cutting, then forming shops, then panel preparation shop. From here it will go directly to the block assembly and then final assembly shops. This can be used for building of the vessel also.

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This shows the aerial view of the shiplift facility where we have the shiplift here. This is transfer bridges, these are the winches, then you can bring it back here. Then you can go this side. You can take it back or forward. You can keep 3-4 ships or you can go this side also. And these are the various facilities which are planned. From here it will go to the block assembly. From here you can bring the vessel also. So either you bring the vessel from inside and do the repair or get the plates from here, from there you make the modules and then assemble the ship here, and take it back here and then bring it to the shiplift.

Lower the shiplift and take it for trials, check the ship for all the parameters. If it is all right, then you can sail it. If there are any problems, then you can again bring it, then do the repair, then again bring it back. So some 2-3 trials are required for the ship before it is sailing out. Okay, thank you.