Port and Harbour Structures
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Module 01 Lecture 03
Vishakhapatnam Port

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This class we will see Vishakhapatnam, tuticorin, Mormugoa, paradip in a new port that is to be developed Gopalpur port, the layouts and the significance of each port. We ill first discuss about the Vishakhapatnam port. The latitude and longitudes are given here. They have both imports and exports, imports are coking coal, steam coal, fertilizer, LAM and pet coke and export is CP coke. These are different types of cokes, steel products, finished steel products. There are many a steel making units industries vaishakh (())(0:57) steel plants. So they need to export the products what they are manufacturing POL, alumina and thermal coal. Many power plants are there for which we need the thermal coals, which are being exported from Vishakhapatnam to other ports along the coast.

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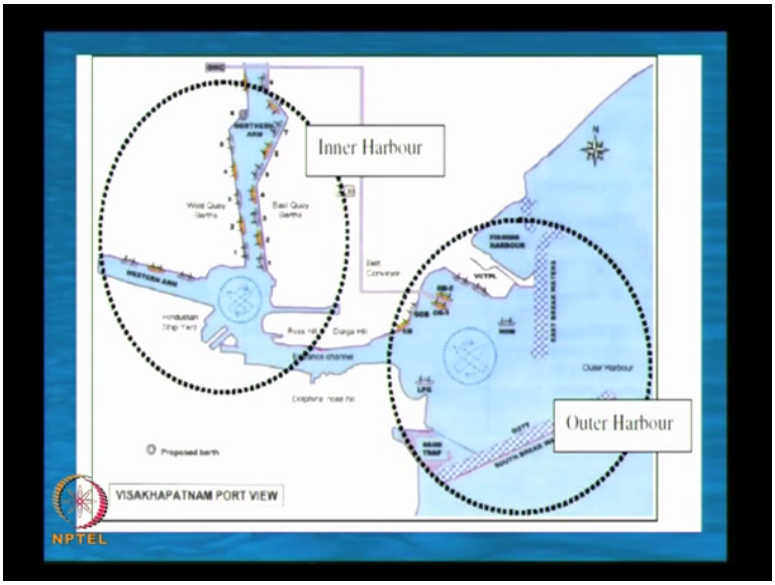

This shows the schematically the details of 2 harbours. One is called as the outer harbour which is built subsequently. Originally, we have the inner harbour, we have (())(1:46) who first asked to create the clear opening at the entrance channel. What he has done is? He has (())(2:00) one ship here so that the sediments will not pass through this and clock the entrance channel so that it can be done very quickly and this shows the entrance channel through which the vessels will go and this known as the northern arm, in which we have berth on either side. This side is known as west quay, this side is known as east quay.

Then we have this arm western arm, we have a Hindustan shipyard also, which is used for building of ships, repair of ships and we have what is known as a dolphin nose hill, which is protecting the entrance channel and creating calm climate inside this. This is the turning circle where the vessels will turn, we have the berths number west (())(2:59) quay 1,2,3 like this. Originally the draft in this northern arm is about 9 meters. Now IIT madras has been asked to retrofit the structure. Retrofit means strengthen the structure so that deeper draft can be created.

This shows the outer arm. We see the outer arm, there is a south breakwater and this breakwater is not shore connected. One of the special features of the eastern coast, if we remember Chennai port, this opening was not there. So there is lot of sediments settlement, Ennore also it was like that. Once you create a opening here whatever sediments that are suppose to accumulate here, it will come and deposit in the sand trap. This sand trap means it will be dredged.

Let us say about 500 meters by 500 meters to a depth of may be 10 meters or 12 meters and the whatever sediments are coming, it will come and settle here, then a dredger will come and this dredger, how to dredging this material will deposit it on the northern side either by pipelines laid along the shore or the dredger will come out of the harbour and go very near to the coast and then they will deposits the dredged material by what is known as rainbow method that means they will pump the sediments along water so that this is called as Ramakrishna beach, which will be nourished.

This is one of the soft measures, soft measures means we are not building any (())(4:59). Fines means a structure built for particular to the shore line which was done in Chennai port. This is a soft measure by artificially nourishing the beach using the sand deposited in the sand trap is called as a artificial nourishment. We have a fishing harbour adjacent to the main outer harbour. There are plans to build one more outer harbour to cat up a bigger vessels and we will see the details of this harbour in the next slide also.

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It shows the satellite imagery showing you the various details of breakwaters as well as the entrance channel and different arms which are used for berthing of vessels.

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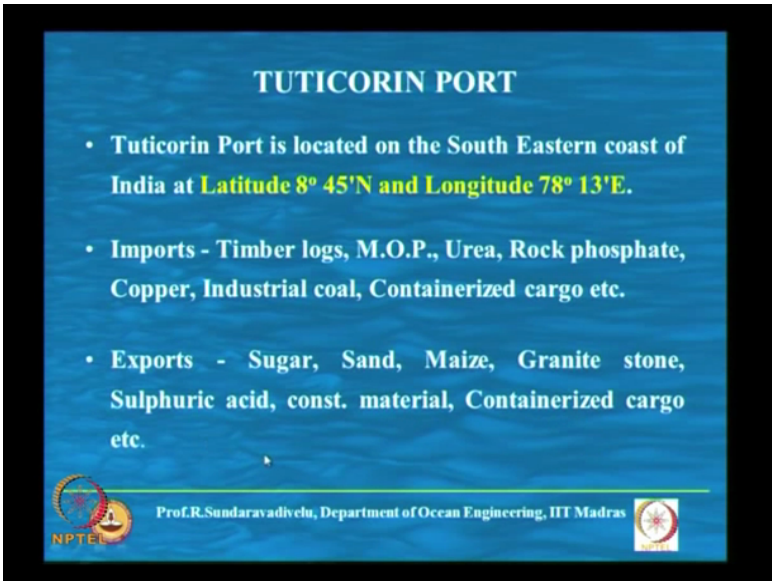

Next we will see the tuticorin port. This is located on the south-eastern coast, latitude and longitudes are given here. It is also has both imports as well as exports. Imports are timber logs, MOP, urea, rock phosphate, copper, industrial coal, containerized cargo etcetera. Exports are sugar, sand, maize, granite stones, sulphuric acid, construction material, containerized cargo etcetera.

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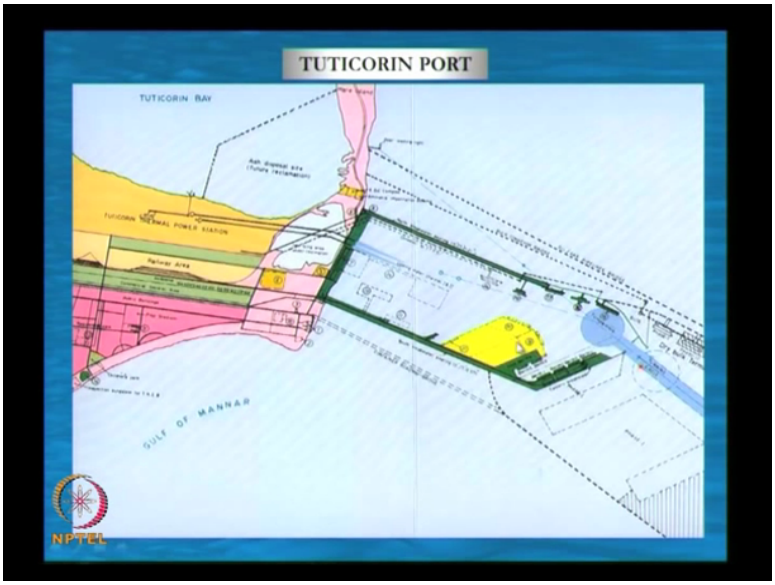

This is artificial harbour having very long breakwater both south as well as the north breakwater. They have the entrance channel, the turning circle. What is shown here in this dotted line are future expansions that are being proposed, you are seeing these two blue colors. These are the intake channels for the thermal powerplant. The water requirement for

the thermal power station depends on whether they want the ones through system or make-up water system. Ones through means, they will not have any cooling tower in the thermal power station. They need huge quantity of water.

The quantity of water required for a 1000 megawatt plant for a ones through system is about 200 thousand cubic meter per hour. It is a very huge quantity. Make-up water is one 10^{th} of that about 20 thousand cubic meter per hour. So we need a channel for a ones through system to take the water. So inside the harbour creating the entrance channel is intake channel is very easy. There is a place called as Haar Island here. This island is being used as a stackyard for coals and we will have the coal berths being planned here and the coal will be taken through a conveyer system through the Haar island. From there which will be taken to many powerplants located here.

This area what is shown in the yellow color is the container storage ar. Port of Singapore authorities are operating this berth; one more berth is also being planned in a PPP mode. Here we have very soft rock in the surface; we have to do dredging of this rock. The dredging of the rock cannot be done as it is. We have to pre-treat the rocks. Pre-treat the rocks means we have to drill some holes and we have to lower some explosives and we have to create weakening of the rock then we have to remove it by a special type of cutter section dredger. So it cost more than about 1000 carores so far to dredge this area. The advantage of having a rock very close to the sea bed is the berthing structures what is being built will be having very good foundation. The cost will be reduced whatever rock that has been dredged out of this has been used to fill up this area. We will show this in the next slide.

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So this is the area which is being filled up using the rock material and this whole area what is reclaimed to be used for container storage. These are the two cranes which are used for loading and unloading the containers.

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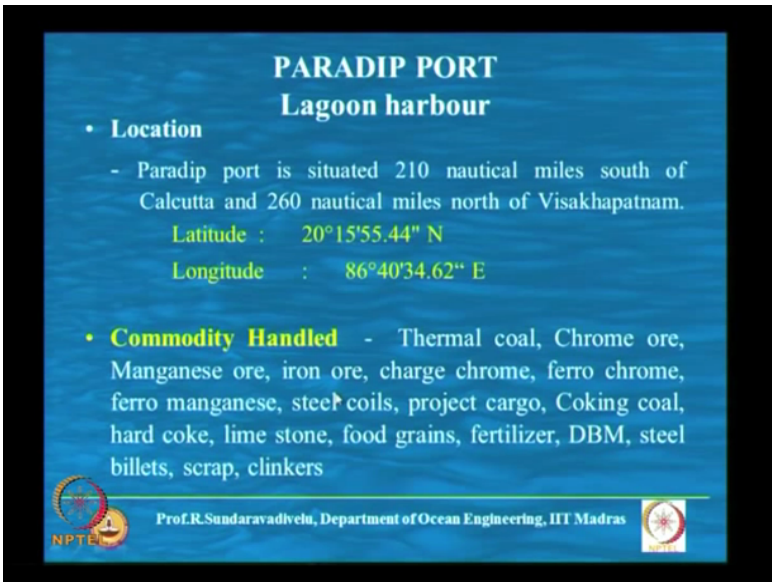

Next we will go to the paradip port. This is a port created in the Orissa state after independence is called as a lagoon harbour similar to Mangalore which we have seen. This is located at about 210 nautical miles south of Calcutta and 260 nautical miles north of Vishakhapatnam. Almost between exactly between Calcutta and Vishakhapatnam. Latitude and longitudes are shown. The commodity handled are thermal coal, chrome ore, manganese ore, iron ore, charge chrome, ferro chrome, ferro manganese, steel coils, project cargo, coking

coal, hard coke, lime stone, food grains, fertilizer, DBM, steel billets, scrap, clinkers. What you can see from here is we have very good minerals available for the hinterland of paradip both in Orissa state, Bihar, Zarkhand and all of them are being exported through this paradip port. We have many industries also in paradip port.

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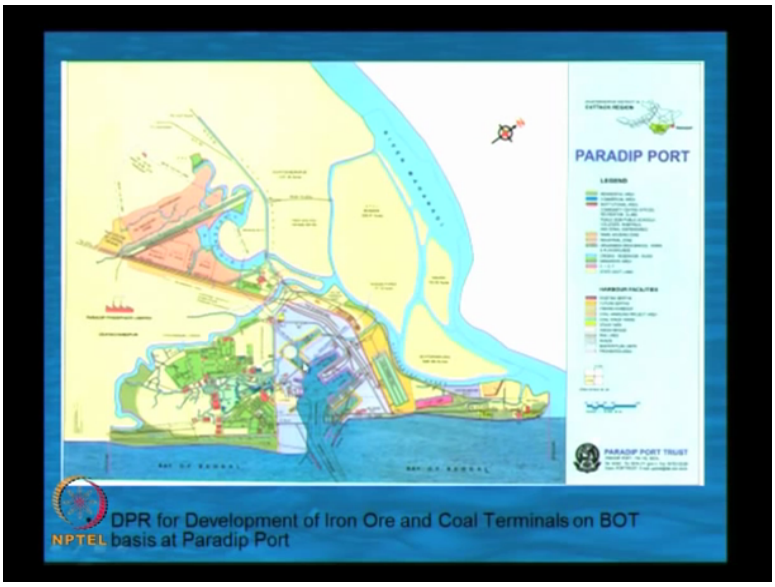

This shows the layout of the lagoon harbour. This is the Mahanadi River, which is draining into the sea here and we have two breakwaters here, which are only protecting the entrance channel. The original shore line was somewhere here. After construction of these two breakwaters from the original shore line, there is so much of accumulation of sand on this side from the original shore line here is so much of erosion may be more than about 100 meters erosion has taken place here. Lagoon means we create a artificial harbour basin inside the land.

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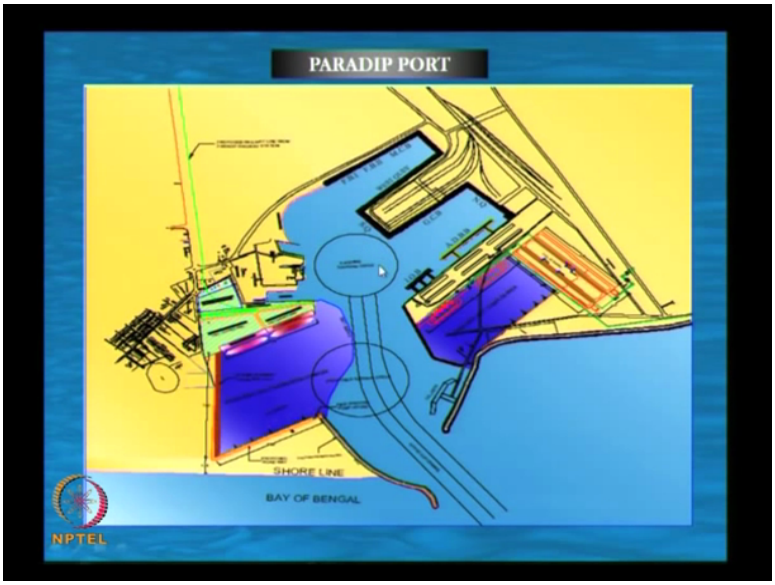

This shows in detail, the entrance channel. This breakwaters. This is the oil berth which is very close to the entrance. Originally shore line was somewhere here, so much accumulation in this side and erosion this side. They have a two docks. This is one dock, another dock, this is a third dock. What is shown in light blue color is already existing. What is shown in this dark color is the ones which are being proposed. Originally the turning circle was somewhere here subsequently, they have shifted the turning circle to this point, as I told here the engine of the ship will be stopped somewhere here we need about 7 times the length of the vessel for the engine to stop and take it, for this reason they have shifted the turning circle from here to here. Originally they were handling smaller vessel for which the length is less. So this turning circle was sufficient whereas for a longer length of the vessel we need longer distance. So a smaller vessel when it comes, it will turn here for a longer vessel you go here then turn.

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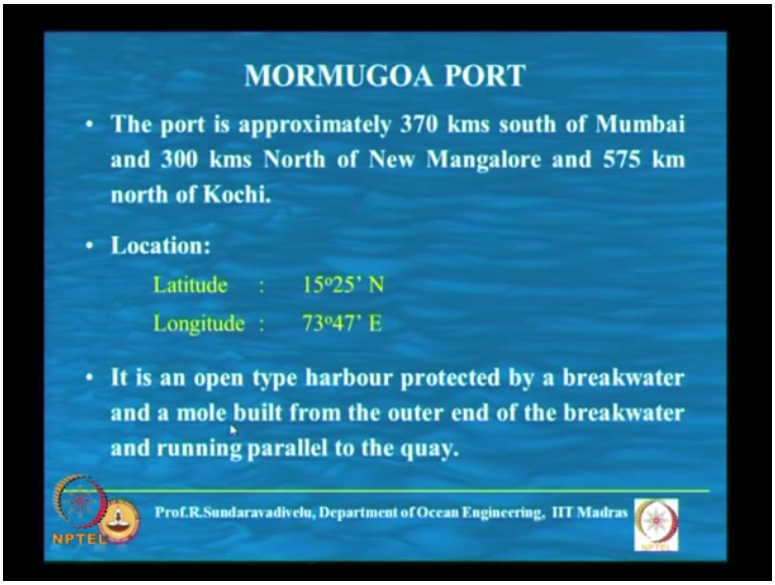

We will see the Mormugoa port. This is one of the best location that can be there for a port. This is in between Mumbai and the new Mangalore 370 kilometers south of Mumbai, 300 kilometers north of new Mangalore and this is about 575 kilometers north of Cochin. In India, if we see approximately a very 300 kilometers we will have about one major port fort in the east coast and west coast. This is called as this latitude, longitude are shown here. This is a open type harbour so a natural harbour protected by a breakwater and a mole built from the outer end of the breakwater. This because of this small breakwater which is built, it can be called as a semi-natural harbour; it cannot call it as a natural harbour like Cochin, because we have a breakwater. Mole is a construction; it is not a solid construction. I will show it in next slide about this mole.

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This is a satellite imagery. This is one side we have the breakwater. There is no breakwater from the other sides that is why it is called as a open type breakwater. Basically iron ore export terminal, all these berths are placed here. Here we have a shipyard, which is called as a western India yard limited and here we have this mole, which is built here. The rubber mound breakwater is a solid structure from the sea bed to the top whereas this will have openings for water exchange between here and here. Now we have planned one structure here, parallel to the breakwater. This is used for offshore supply vessels for ONGC to get the required materials from Mormugoa to the platforms in the bombe highway.

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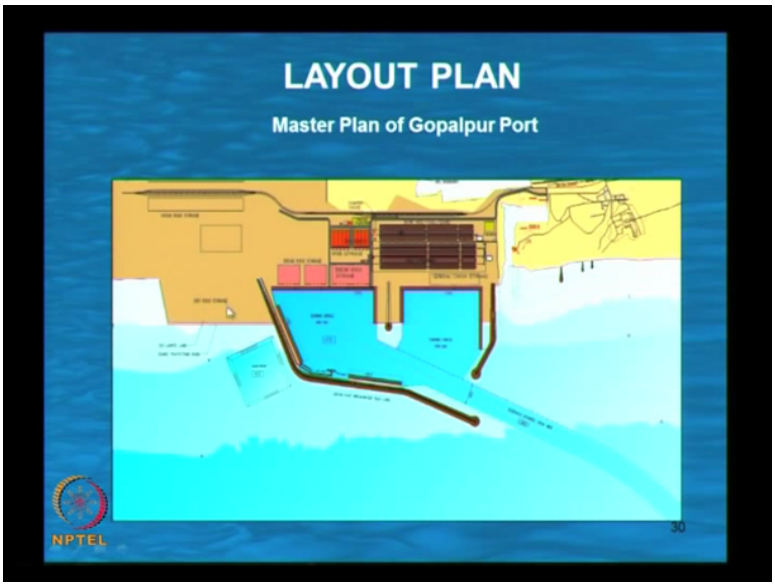

Next we will go to another port which is called as the Gopalpur port. This is being planned now and this port originally as a lagoon port what is shown here is a lagoon and is called an anchorage port originally. The ships will be standing somewhere here. The barges will go inside and out and we have Indian (())(15:51) limited factory somewhere here to export the Indian the (())(15:56) outer processing and uh those (())(16:00) will be loaded into small barges 200 tone barges and then they will come out like this and when the ships are anchored here. These barges will transport the rarer (())(16:13) to the ship.

The ships will be of small size may be about 20000 DWT and this is called as fire weather anchorage port that means this will not operate throughout the season. It will operate only in the fire weather. The fire weather season start sometime in October and it goes right upto April only during this season the operation will take place and this operation for a 20000 DWT vessel when you are bringing the cargo by 200 tone barges you can imagine so many barges have to come here, 200 20000 ton vessel when we are loading, it may take about 4 to 5 days and after operating this (())(17:03) export in order to distribute the fertilizer. They started using this port for import of fertilizers also.

One of the important requirements for any port is what depth you will have? What distance you will have the deeper contours available. What is shown here is the contour lines. This is one meter contour, 2 meter, 3 meter, 4, 5, 6, 7, 8 and 10, 11, 12, 13, 14 and 15. This 10 meter contour is available at a distance of about 900 meters from the shore line to varies from 700 to 900 meters all along the coast. This is the nearest 10 meter contour available all along the east coast. If we take Chennai the 10 meter contour may be available at about the 1200 meters or 1400 meters, whereas here it is available very close.

The advantage of having a deep contour very close to the shore is the length of the breakwater that is required to be built will be less and this is a master plan for the new port that is going to be developed in Gopalpur in a public privet partnership scheme and we have two breakwaters. This is one of the breakwaters. This is another breakwater. It is going to be developed in two phases. This portion will be developed initially and this portion will be develop subsequently and we have a sand trap here. This sand trap will be dredged for about 10 meter so that whatever sand that is coming will get deposited here, then a dredger will come fetch (())(19:07) sand and take it to the northern side and then dump it on the northern side.

Here we are using both the soft and hard measures. Soft measure means the artificial nourishment of and along this line taken from the sand trap plus grinds (())(19:24). This grinds are built in numbers not one one is not built we have 1, 2, 3 actually what we have finally decided is to have about 10 (())(19:38) each (())(19:41) length will reduce as we go towards the northern side which is called as a transition (())(19:47). There is numerical studies required to find out what should be the length of the (())(19:54). What should be the spacing between the drawings?

Here, we have the entrance channel and then we have the turning circle, we have the berths parallel to the breakwater all along this line. We have the berths along the shore line here then we have the areas where air mark for storing the cargo. The complete landside development is not shown in this figure only part of that is shown. So this is not in the scope of the present lecture the layout of the port to decide how much area is required will not be discussed detail in this course, we have a separate course for this port planning. Once you have built the port with the breakwater, we will have the accumulation of sand. They want to use this accumulation, if we see the shore line here, it is here and here the shore line is here. So this area they want to use for the purpose of development.

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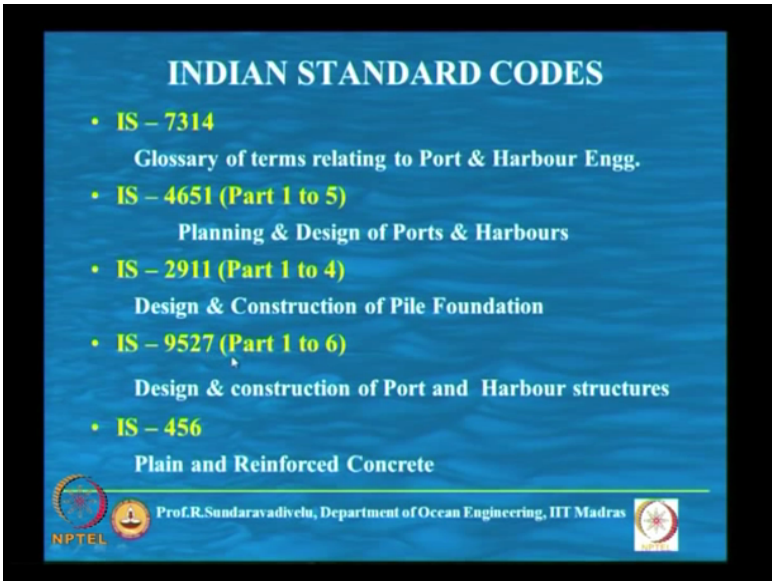

So we have completed the different layouts of ports. Now I will tell you what are the Indian standard codes that are being used for the design of the port and harbour structures planning and design, you please get the code. It is available in our library you can download it. First you please read this port, IS-7314. This code gives glossary of terms relating to port and harbour engineering. The glossary of terms means they will explain what is a meaning of

each word technical word used in port and harbour engineering, technical terms is the better English than technical word like breakwater, fender, bollard, approach channel, beam breakwater. So all these terms you can get the meaning. So you please go through this code.

Then the main code that is being used for port engineers is IS-4651 part 1 to part 5 is planning and design of ports and harbours. I will be describing about the 5 codes that are being used part 1, 2, 3, 4 and 5. The part 4 code is modified in our department only; we have given the various modifications required. The code was last modified in 1989. So subsequent to the modification of IS-456. This is a plain and reinforced concrete code in 2000 and IS-1893 seismic code we are incorporating all the parts in part 4 and we have modified.

The other parts also are being modified. For any subject to learn you have source material in the form of books, in the form of ports, in the form of conference paper and in the form of journal papers out of all these forms is uh if you want to be a professional designer, you should be very thorough with the codes, because whatever is to plaited in the code as to be followed and if we are deviating from that there should be sufficient analytical and the modeling background experimental studies so that we can change certain parameters give in the code. If certain things are not available in IS code we can follow European code or American codes.

Mostly in port and harbour structures, we will be using pile as a foundation and for this pile foundation we have the code IS-2911 part 1 to part 4. These parts are different for different types of piles like a bore to (())(24:14) pile precast piles like that. So it gives both design and construction. One of the requirements for an engineer to learn is not only the design but also the construction aspects that is why these construction aspects are given give the importance for pile foundation, I will be discussing some details of IS-2911.

Our course consist of essentially 3 parts that is estimation of loads, analysis and design. These are the 3 parts; I will repeat again load estimation, analysis and design. The load estimation is given in IS-4651 for analysis for the piles we use what is known as fixed depth that is given in IS-2911 and design aspects are given both IS-4651 and IS-2911. When we go for design, there are two designs, one is called as a structural design another is called as a foundation design. For structural design you have to go for IS-456, for foundation design you have to go for IS-2911. To compliment IS-4651 which does not deal much with construction, we have IS-9527 part 1 to 6. This gives both design as well as construction. In port and harbour structures we have basically berthing structures, but in addition to that we have (())

(25:55), dry docks. So those things are given in IS-9527 in different parts.

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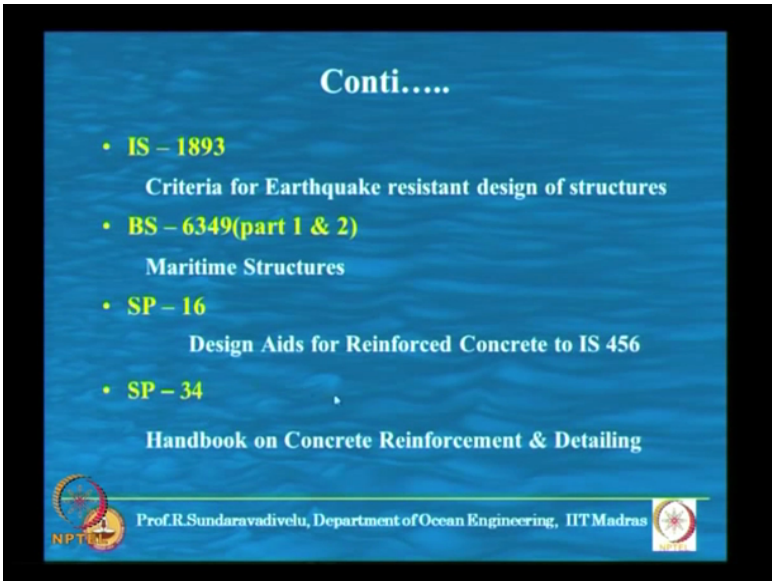

Continue the ports we have IS-1893. This was revise in 2002 is a criteria for earthquake resistant design of structures. So we have to study this structure IS-1893 study this code, because most of the structures are govern by the seismic codes especially the structures in kandla, Mumbai (())(26:40) that is Andaman group of islands, because both kandla as well as forblayer (())(26:47). They are falling in seismic zone pile. Tuticorin port is in seismic zone too that is not govern by the design is not govern by earthquake.

Then we have the British code if certain provisions are not there in IS code, you can refer this code British code maritime structures. When you go for design, there are two parts of the design one is the design another is the detailing. So keep proper design is not sufficient unless you do proper detailing, the structure may fail. If you analyze the structural failure of structures, it is not by improper design, but it is by improper detailing specially reinforced concrete structures even for steel structures, we need the welding details properly otherwise that also will fail. So the Sp-16 will give design aids for reinforced concrete to IS-456. We will not go into much detail about this design aids, because a separate ports is required for the complete design, but I will discuss some silent features of design of piles for this course (()) (28:11).

We will also discuss few important points for detailing of concrete structures especially port and harbour structures, because the construction methodology in port and harbour structures

is totally different from land based structures, we use both precast and forecast (())(28:36) structures and the joining between them is important and the structures are built under water. So a special provision is required for this.

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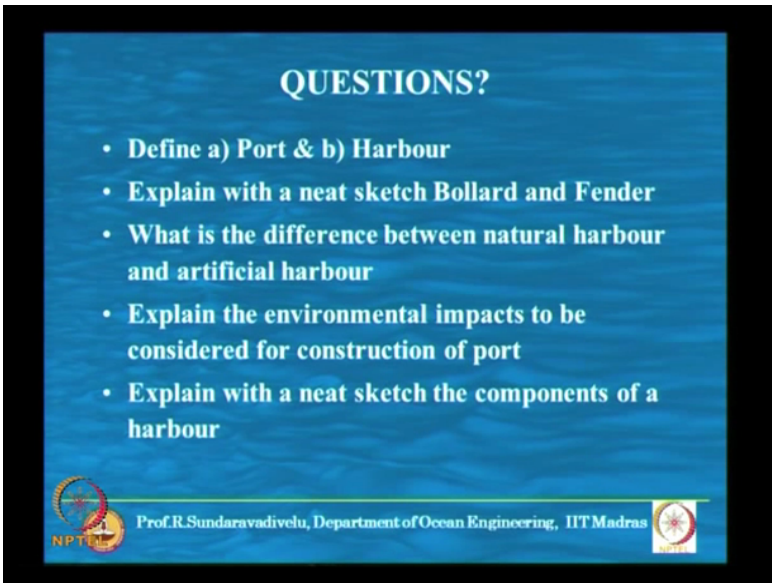

Now we will discuss the questions that is likely to be asked in this particular subject what we have discussed. I have written down here what is a port? What is a harbour and I want you to draw a sketch showing the bollard, fender, berthing structure as well as the ship, you please practice the sketch do not see the sketch and come to the exam and start drawing the sketch, you want to draw a ship it may look like something else. So whenever you want to draw a sketch please draw the sketch with the sketch in front of you, try to copy the silent features, a good engineer should be in a position to draw a good sketch. If you cannot draw a sketch properly then you cannot be a good engineer. Then after a drawing the sketch seeing the sketch, what you have to do is, you have to close the sketch and redraw it once again.

Whatever PowerPoint you have seen here try to draw this sketch for artificial harbour. Draw the shape of the bollard properly. Draw the shape of the fender properly mostly when the answer papers are corrected, the teachers normally will spend more time your sketch then what your write it. Then you have to explain the difference between natural harbour and artificial harbour. If you want to answer this question, you try to give it in a tabular form two columns, natural harbour and artificial harbour, for example natural harbour means no breakwaters, artificial harbour means breakwaters will become essential like that you can say that there is a less environmental impact in natural harbour and more environmental impact in artificial harbour and only dredging is required in natural harbour whereas we need the

breakwater as well as dredging in artificial. Try to write some 3 or 4 points side by side in the columns.

Next question is likely to be asked is what are the explain the environmental impacts to be considered for construction of port. I have discussed 3 points in this class, one of the point the first one is likely about the shore line is changes because of construction of breakwater. The second one is dredging and disposal of dredged material that will come. The third point is if you are dredging in rock if you are using explosives, what is a vibration cost. The vibration cost I told, it may impact the heritage structures nearby JNPT in addition to that, it may also impact the berthing structures which is closed to it, for example in tuticorin port we have seen there already structures and if you are dredging in front of the structures when you are using the explosives, the structures also will get vibration that also you have to (study) (())(32:09) see.

There are two parts in environmental studies, one is environmental impact assessment, the other part is environmental management plan. This we will discuss separately. in this class one of the environment management plan, you have discussed is create a sand trap and allow the sediment to settle in the sand trap and every year periodically remove the dredged material nourish it on the northern side that is one of the management plan. Then I have writtturn here explain with a neat sketch the components of a harbour. The components of a harbour, if we see artificial harbour, there will be breakwaters, there will be entrance channel, turning circle, then we will have berthing structures, then we also have the mechanical handling systems, conveyer systems, then we will have customs building, we have parking area.

All those things you please go through this, I will give you the lecture notes later where we have given some of the textbooks you can go through the textbooks. One of the requirement for any course is that you have to study one textbook cover-to-cover and one of the textbook that is being recommended is by one Mr. (())(33:39) that book is available in our library. Those details I will give it to you please go through this. Any questions, I have to writtturn the questions, you have any questions in this, because we are going to next slide next topic. Any dought you have? Okay.

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Next I will explain about this vessel type and size. This class consist of people studying from M. Tech ocean engineering, B. Tech civil and B. Tech mechanical. This M. Tech ocean engineering students, they have some basic knowledge about the vessels as we have studying a subject on statics and dynamics of marine vehicles. They also have basic knowledge on wave height dynamics which the civil and mechanical B. Tech students do not have.

So I will be giving certain details of this vessel type and size, but what I will be concentrating on vessel type and size is related to only the design of port and harbour structures where is the much more is required to learn about the dynamics of marine vehicles. This shows the photograph of a vessel container vessel and we have the containers which are stacked here 1, 2, 3,4,5,6 and the containers would have been stacked below this level also. So we have container above the deck and the below the deck also. When you talk about vessel type, the vessel type is basically whether it is a container vessel or is a POL vessel or it is a bulk-cargo vessel like that. So size means it can be the length of the vessel or beam of the vessel. The width of the vessel is called as a beam of the vessel and the draft of the vessel. So what you are showing the red color below that is the draft. So if it the red color is completely in the water, it is called as fully loaded draft that means you can still load on to this some more conveyers containers, here it is not loaded so that the full draft will be realized.

Then we can have partially loaded draft that is what is shown here. Then we have light draft. Light draft means when you have no containers here. The light draft is less than 50 percent of the fully loaded draft and what is shown here above the water level is what is called as a free-board. Free-board is different at different locations. Here the free-board is less and here the

free-board is more that is one size. The another size that is being discussed is DWT of the vessel that I will describe later.

The another one is what is number of container boxes it is taking, I have already defined about TEU that is 20 foot equivalent units, 20 foot means the size of the container is 20 feet long, 8 feet height and 8 feet wide that is 20 feet by 8 feet by 8 feet. Normally the containers are used in civil engineering sites as air conditioned office space. So you can get into the container, because it is a height of 8 feet and you have the width of 8 feet, you can put a table and discuss. So for you remember I have telling that this is 8 feet by 8 feet and length is about 20 feet. It is almost double the size of your room, your room size is about 10 feet by 9 feet, 19 square feet given for a student in (())(37:55). So this will be about 20 feet by 8 feet that is 160 feet square feet is there.

We have a double the size also is there 40 foot container is also there 40 feet by 8 feet by 8 feet is also there. So these 20 feet by 8 feet by 8 feet is called as 1 TEU and mostly we use the panamak size vessel, which will contain about 4500 boxes here that is called as 4500 TEU and we have first generation, second generation containers vessels that we will describe towards the end of this lecture.

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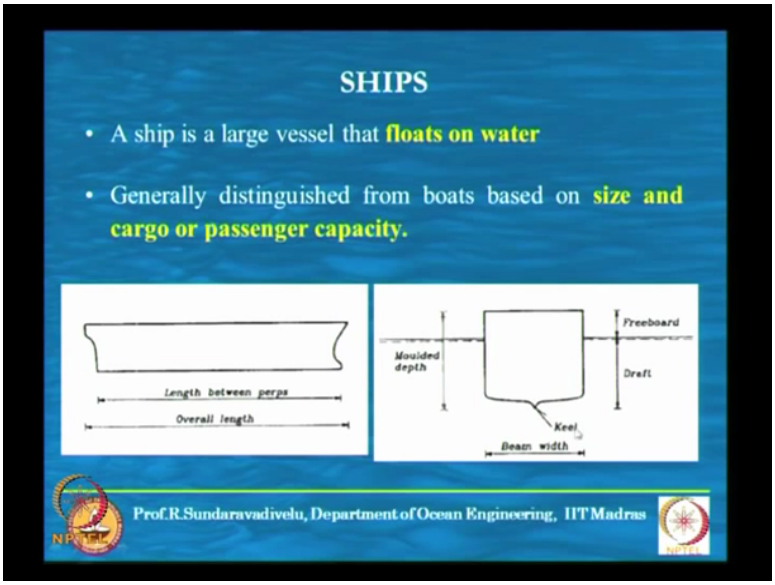

For example I am giving what is a ship definition. A large vessel that floats on water. It may look simple, but we have to define means not define like this only. We are defining compare to a boat. It is distinguished from boat based on the size and cargo or passenger capacity. So we have the sketch showing the ship and you try to practice the shape like this. This is the

longitudinal section. This is the cross section of the shape; we have the length between perpendiculars that is from this point to this point that is length between perpendiculars from the aft end to forward end. This is overall length. This called as LOA overall length. This is called as LBP.

Then we have the molded depth from the top of the vessel to the bottom of the vessel which is called as a keel that is called as molded depth. Then we have the draft from the water line to the keel, then from the water line to the top of the vessel that is called as the freeboard. So this is a definition of the ship and we will discuss about their features of a vessel in the next class. Thank you.