Port and Harbour Structures
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Module 8, Lecture 43
Detailed Project Report

So last class we discussed about this approval from MOEF to get the approval we have to prepare a detailed project report. A detailed project report shall contain all these parameters what I am going to tell today.

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The first parameter is the Ship size it is the Design ship size there will be various ships that will be coming to the berthing facility. What are the different types of ships? Hmm? panamax, kape size, any other type of classification? Containers and tankers. So you have to decide suppose you are using general cargo container and bulk cargo and tanker for each one of them you have to give the size of the ship whether it is a panamax or;

I told one of the classes crude oil will be coming in one size and refined petroleum product in another size what is the size crude oil will be transported. Hmm? What is it crude career what is the size? Is it panamax size or what size it is? Kape size or more than kape size VLCCs that is a cargo that will be transported for crude whereas for refined petroleum products it is panamax or less than panamax.

So depending on the cargo whether it is import or export based on that the size will vary. The expected cargo details means what is the volume of cargo? How much a berth will handle traffic? How many million tons it will handle? Suppose you are building one berth in a port

facility, how much cargo it will handle? How many million tons? How many vessels it is approximately it will receive in a year? Hmm? 5 million tons, how many vessels it will receive?

How many days are there in a year? How many days are required for a vessel to be berth and evacuated? 2 to 3 days, and how many vessels it is approximately? 100 days about 100 days, there are 365 days the port may not operate because of some cyclones and other things so 100 vessels if it is panamax size it will be 6 million tons it is what the cargo that will evacuated. The expected cargo details used to study how many berths are required.

Suppose you want to handle 12 million tons of bulk cargo in Indian scenario we generally give (4) 3 berths because you will be handling only 60000 DWT vessels we are using a cape size or bigger size vessel 2 berths will be sufficient. So that is what is given here what is a berth requirement? What is a cargo handling rate? The end of the course you should know how much cargo will be handled in a day or in an hour. This has been told to you earlier also.

Who are mechanical engineering students raise your hands? Mechanical Engineering hmm how much cargo they will handle? How much cargo they will handle? Guess some value do not keep quite, 2000 tons per hour that means how many tons per day? Into 24 is not correct into 20 generally we take 20 hours only. 40000 ton per day it is a handling rate.

If you put a more conveyers more cranes then you can increase the rate. That is what is coming here about the cargo handling equipment, operation time , berth occupancy in Indian scenario it is more than 70 -75 percent, in Singapore it is 50 – 55 percent, what is desirable is 50 – 55 percent, the berth has to wait for the ship, the ship should not wait for the berth. There is so much congenstion in Indian port it is required that we have to reduce the berth occupancy. You should not increase the berth occupancy.

The berth requirement for master plan also you should give. Master plans means whenever you design a port you should not design based on today's scenario. You have to design based on 20 years 25 years or 100 years. So for a master plan you should always position some berths which are required. Another important parameter is the storage requirement of different cargo that is how much storage is required.

Generally they say for one million ton about 1 and half acres are required as a storage requirement. But sometimes it may be higher also depending on the type of cargo. Fertilizer, wheat and other things we may need much higher area karla porters gives about 8 hectares for

million tons. Then we should know about this building requirements. Then receipt on evacuation of cargo you have to know about the port access road, railway system, water and power requirement.

Generally we have to provide this desalinated water as well as water for the ships power requirements also and we have discussed about the master plans of the port. And there are two parts in master plan one is a inside the port harbour basin another is on the shore landside facilities.

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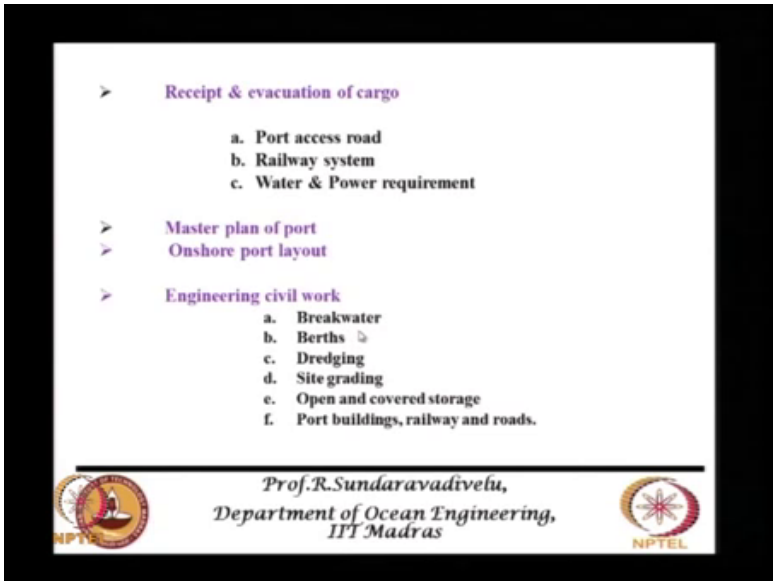

Then we classify the works into two categories Civil works and Mechanical works the civil works are generally break waters berths, dredging, side grading, open and covered storage shed, port buildings, railway and roads. These are the major components of Engineering Civil works.

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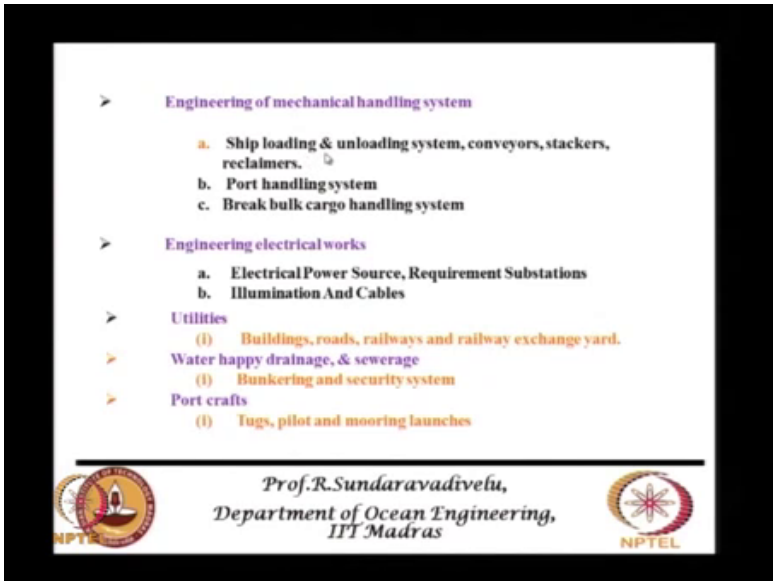

And Engineering and mechanical handling systems ship loading and unloading system, conveyers, stackers and reclaimers port handling system, break bulk cargo handling system. These are the various handling system that has to be done. Then we also need to have a engineering electrical works electrical power source requirement, substations elimination and cables. So we have Civil Mechanical and Electrical works in a port.

Generally these Civil works and Mechanical works almost equal cost. If you see major port facilities the civil works and mechanical works the cost is almost equal. Electrical works and utilities that will be around 25 percent of the total cost of the project. Utilities include buildings, roads, railways and railway exchange yard. I do not know there is a mistake here water drainage and sewerage, bunkering and security systems, port crafts like Thugs, Pilot and mooring launchers.

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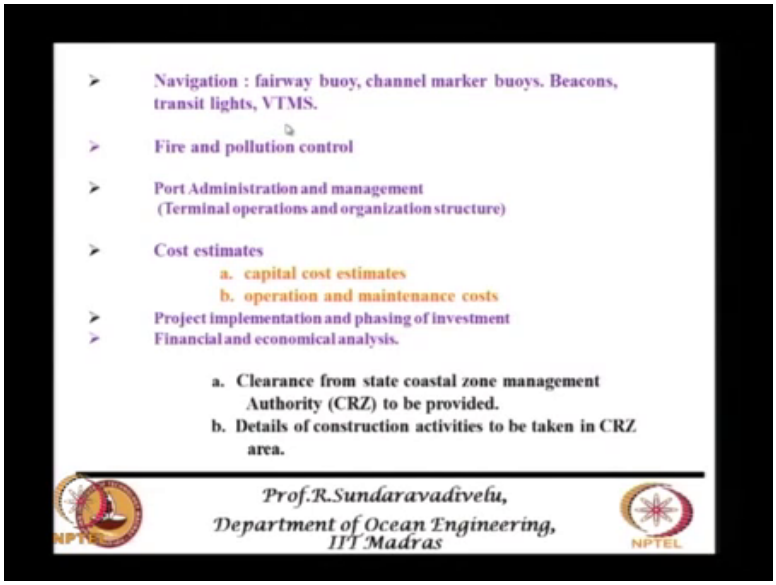

Then we have navigation where a buoy channel marker buoys beckons, transit lights, VTMS. Now what is VTMS any idea vessel traffic management system. This moves just like air traffic controller there will be a vessel traffic controller will be there it is not in place in Indian ports but this is very much required. So every day if you are getting around 10 vessels, you have to manage how to bring these vessels and take these vessels out.

Then Fire and Pollution control is also important fire control you have to provide adequate systems for water to be pumped in. Pollution control if it is a dusty cargo you have to sprinkle water you have to put some barriers these are all the pollution control system. Then we have a port administration and management for terminal operations and organisational structures. So finally the deep yard should consist of two parts one is the capital cost other is a operational maintenance cost.

I told you earlier one million tons of cargo if you want to handle you want to create a facility it will cost between 60 crores to 100 crores that is a bandwidth of cost that will give you a rate of return which sufficient for bankers to enhance the project. Generally most of the port infrastructure project are financed by banks 25 percent only is put by the developer balance 75 percent the banks are financing unless there is a internal rate of return which is about 12 percent on the capital cost estimate.

It is very difficult to get the sanction from the banks. Then you have to also write about the operation and maintenance cost. Some of the operation cost are not or some of the capital cost are included by leasing equipments I told you about this navigation tugs pilot and

mooring system. Sometimes the cranes sometimes some small feeder cranes are fortlift tracks all of them are leased, then it will go into the operational maintenance cost. It will not be in the capital cost estimate.

Then you have to also give what is the project implementation and phasing of investment. That means when you want to implement the project how much time do you think it will be required for developing a Greenfield port. What will be the duration? Hmm? Greenfold fold 2 to 3 years that is a usual period. Then you have to give what is the phasing of investment also.

So this financial and economic analysis we have to give internal rate of return and things like that. Once you complete all these facilities then you have to get the clearance from state coastal zone management authority then you have to give the details of construction activities to be taken in CRZ area then we have to get the consent to establish then you can sort carrying out the project these are the various steps involved in getting the clearance.

So there are certain basic designs that are required that we will be seeing in today's class one is navigation channel design one part of the navigation design is it can be either single in traffic it is called as the one way traffic another is called as a two way traffic. You should know what traffic you are carrying out. So this is a natural bed level this is the lowest water level. So the depth available is not sufficient.

So you create a dredged pit here. We should find out what should be the width of this lane for one way traffic and also you have to find out what is the depth required. The width required consist of 2 parts one is the maneuvering lane another is the bank clearance. So this should not go very close to the bank there will be some section effect from the banks. So you have to provide a bank clearance then you have to provide a maneuvering lane.

Because when you are moving the ship it will not go in a straight line it will go this way that way for that you have to have a maneuvering lane. In the case of two way traffic you have a bank clearance you have a maneuvering lane and navigation to that you have a ship clearance because between the two ships maneuvering lanes there should be a ship clearance. This is basically what is required in a navigation channel design.

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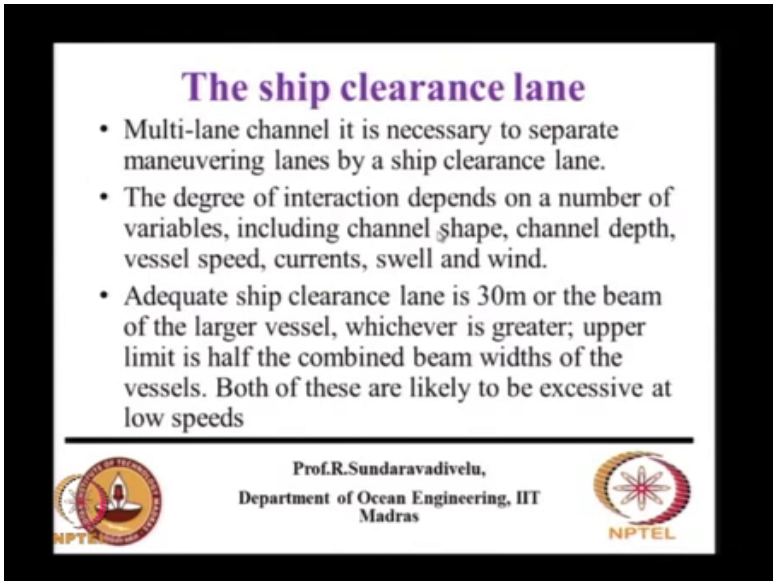

So for multi channel you have to separate maneuvering lanes by a ship clearance lane. So this degree of interaction over matured provide it depends on the channel shape it can be straight or it may be curved what is the depth of the channel? What is the speed of the channel? What is a current? Swell and wind. What is a vessel speed normally inside a harbour basin when you want to bring in.hmm? how much?

Normally it is about 2 to 3 knots. So about 1 metre per second. They sometimes switch off the engine and the tug boats will bring it in currents are very serious consideration of the current is perpendicular to the direction of the ship. What is the difference between swell and sea? Ocean Engineering students what is swell and what is sea? Hmm? Both are waves what is the difference?

Hmm triples, Due to wind if the waves are created at the same location it is called as a sea. Suppose it is created near Bengal and comes to Chennai it is called as swell. So the waves are created elsewhere then it comes here. So swell is generally a long period wave. It is more critical than a sea. Sea is generally about 3 to 6 seconds what you call as a ripple sometimes it can be more or low. Generally it is between 3 to 6 seconds where is swell is more than12 seconds.

So the ship clearance lane is about 30 metre or beam of the larger vessel whichever is greater upper limit is half the combined beam widths of the vessels. Both of these are likely to be excessive at low speeds. Suppose the speed is less whatever you are providing 30 metre or one width of the ship or half of the bigger ship is half of the smaller ship width it is excessive

it is a low speed. Bank clearing is when there is a suction do not have symmetrical flow of water round the vessel you have to provide the bank clearance.

Generally we provide a trapezoidal section this will produce lesser section then a steep sided canal section. So this is a glove this slope is steeper section of it will be more it is trapezoidal it will be less. Under keel clearance sometime called as UKC which depends on bank section increases as under keel clearance decreases. So this bank section also is a part of under keel clearance. How much we provide a under keel clearance generally? Hmm? It is not in metres it is percentage of something, hmm? What is it? 10 percent of a draft if it is inside a harbour basin, if it is outside a harbour basin it is 20 percent of the draft.

So this gives the total channel with requirement with of all the other three all the three lanes then permanent international association and navigation congress this recommends the total width of the channel for single lane it is between 5 to 7 times the vessel beam depending on the sea wind condition that is between 5 times the beam of the vessel to 7 times the beam of the vessel. The double channel is about 9 times of width of the largest vessel.

So this is some approximation normally the length of the ship is equal to (5) 7 times the beam of the ship. So the width of the channel also you can same approximately as equal to the length of the ship. Why you should be worried too much about this navigation channel what are the implications? Hmm? You are designing something I am teaching you how to design. If you do not design it properly, what will be the consequences?

You have to answer when you are designing something. Suppose you have to provide beam of the vessel suppose you provide only three times the beam of the vessel what will happen? Hmm? What will happen if the width is less? Not getting wrong it may go and hit the sides, then it will get grounded. Possibility is that the ship will not come inside.

Instead of 7 times the beam of the vessel suppose you provide 14 times the beam of the vessel what are the implications? What is the impact of dredging? One is cost another is environment. So this is a so you have to provide a design which will be, there is one more thing which I do not expect you to answer that is there are two aspect in the port design one is called as the tranquillity another is called as the Ship maneuvering.

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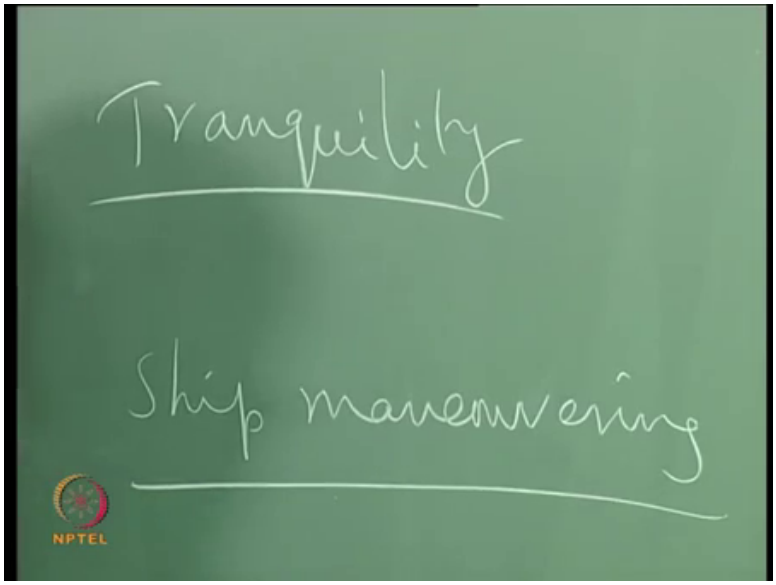

So navigation channel it is wider it has a problem on tranquillity. So in a DPR we need these two studies Tranquility and Ship Maneuvering. So these two aspects are to be studied carefully, tranquillity means what will be the waves inside the harbour basin. So if you provide more width the wave shall pass through the width of the channel and more depth also will transform more waves inside. So that also has an impact.

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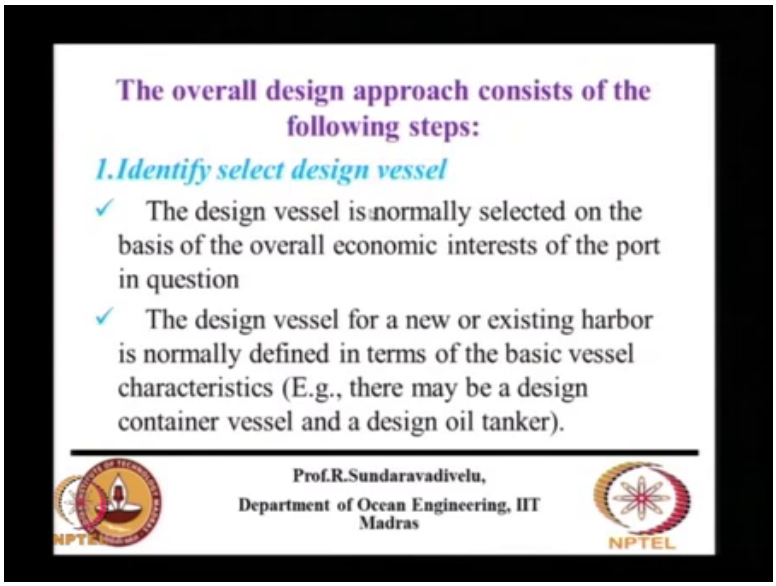

So what are all the design approach for this channel design. First you have to select the design vessel. So design vessel is based on the overall economic interest of the port in question. So when we want to select the design vessel you should see for a type of cargo what is a majority of the maximum share of the cargo in what size of the vessel it is being

transported. So you have to design for that vessel. So this basic vessel characteristics you have to design whether it is a container vessel or oil tanker or things like that.

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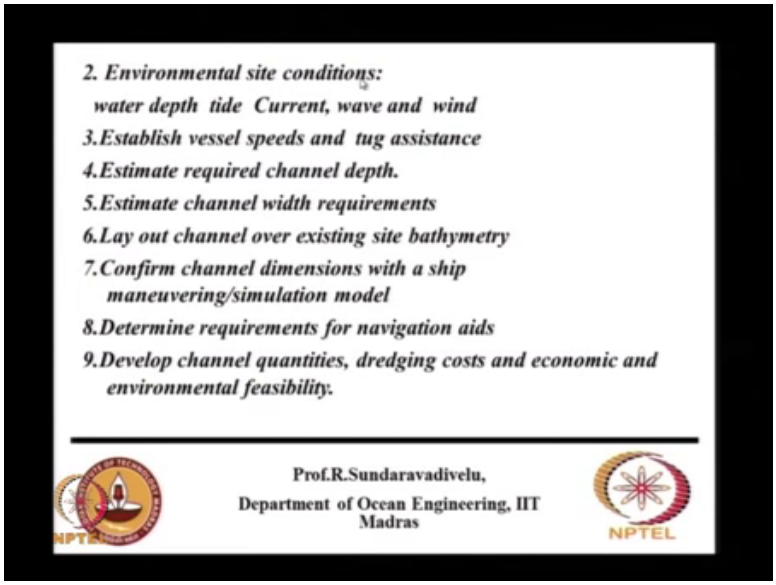

Then you have to find out the environments like water depth, tide, current, wave and wind. Also you have to establish the vessel speed and tug assistance. So if you provide a better tug assistance then you need to provide lesser width maneuvering becomes more easy. You have to estimate the required channel depth. So to estimate the channel depth you have to find out the under keel clearance What is told is approximate but we have to calculate it depends on various parameters like trim, squat, type of c bed.

If it is a rock you have to provide more under keel clearance, if it is a clay soil less you have to estimate a channel width. This can be done by a maneuvering analysis. You have to put the channel over the existing side bathymetry. Then you have to do a simulation with the channel dimensions. You can have a real time simulation. This real time simulation is just like aircraft when they get some training.

Similarly the ship pilot will do a simulation in it is there in Indian maritime university the real time simulator. One more private Engineering college also has simulator. There they will mark the layout of the channel and bring in similar different types of vessels and put different environmental conditions and see whether they are able to bring the vessel inside. Then also you have to find out the requirement of navigation aids.

There will be some marker buoys which will show where the channel is. That is a navigation aids. The vessel traffic management system VTMS that also will give lot of aids. Navigation

aids is not only the buoys on the entrance channel there will be a navigation tower which is a tallest building in a port from there just like air traffic controller now where he sits and see all the vessels coming. From this tower also they will be giving.

There will be some light house kind of thing in the navigation tower. The ship can see and there will be two towers so we can align the ship with reference to the if it is one tower we cannot align. So there will be two towers. So you have to calculate the dredging cost and economic and environmental feasibility. This we have discussed just now.

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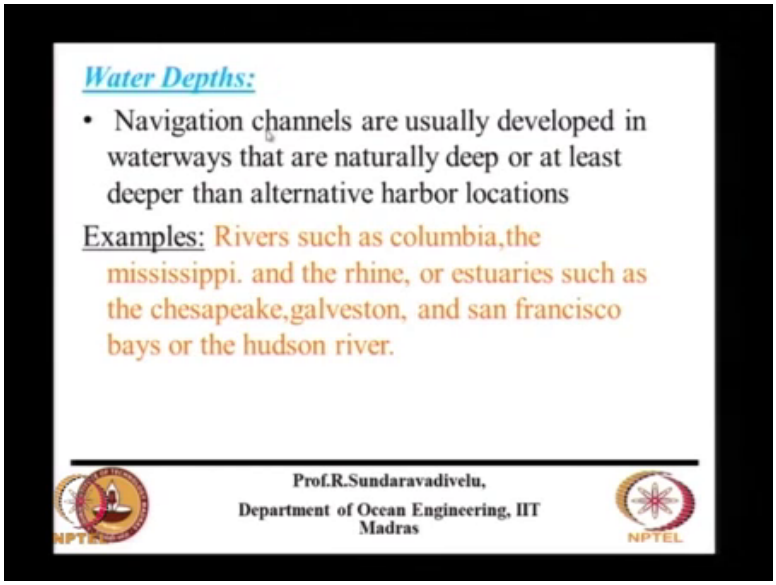

So we have to develop the natural channels and waterways that are naturally deep or atleast deeper than alternate harbour locations. This is how you have to decide that means suppose now a days we have to bring the vessel about 12 meter draft and 14 meter depth is required. Normally what we say is about 10 meter water depth what distance it is available from the shore, because 4 meter you can reach.

So 10 meter depth is available at a distance of about 600 to 800 meters in Gopalpur port. So you can select at that location. Whereas paradeep which was developed long back the 10 meter counter was available more than 1 and half kilo meters that was not a correct location, location depends on where deeper contour are available closer to the shore lane. So for rivers also they are giving some of the details which rivers are better.

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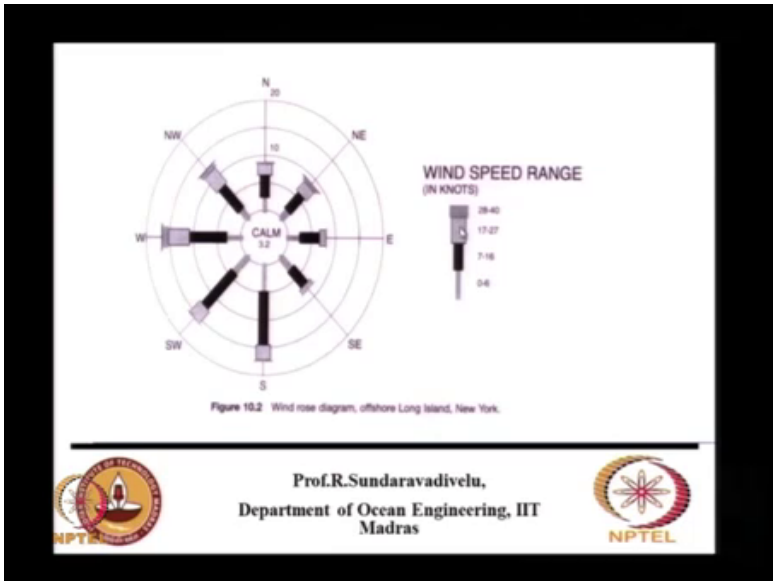

So this is called as a Winrose diagram for offshore long island New York. What is given here is the wind speed in knots. This symbol is 0 to 6, 7 to 16, 17 to 27 and 28 to 40 knots. So these are the different directions through which the winds are coming. So you have the direction which is coming is may be south to south west. You have maximum direction of wind that is coming in. That it is the percentage, how much percentage it is coming, circle represents some percentage. This 10 percent this is 20 percent.

So for example here it is about 0 to 5 percent is 0 to 6 seconds. 5 to 10 percent, 5 to 15 percent it is about 10 percent of the time it is 7 to 16 seconds and this is heavy about 3 percent 17 to 27 knots, is it clear? This shows the direction that is the wind is coming from south, from south it is coming. There are three types of wind space one is 0 to 6 another is 7 to 16 third one is 17 to 27.

5 percent of the time the (waves) are the winds are coming from the southern direction with a speed of 0 to 6 seconds. About 10 percent of the time it is coming from 7 to 16 seconds, 16 knots. And about 2 and half percent will say it is approximately of 50 percent. 2 and half percent of the time it is between 17 to 27 knots. So like that we can find and com is a very calm may be very close to 0 is about 3.2 percent. This is the wind speed windrose diagram.

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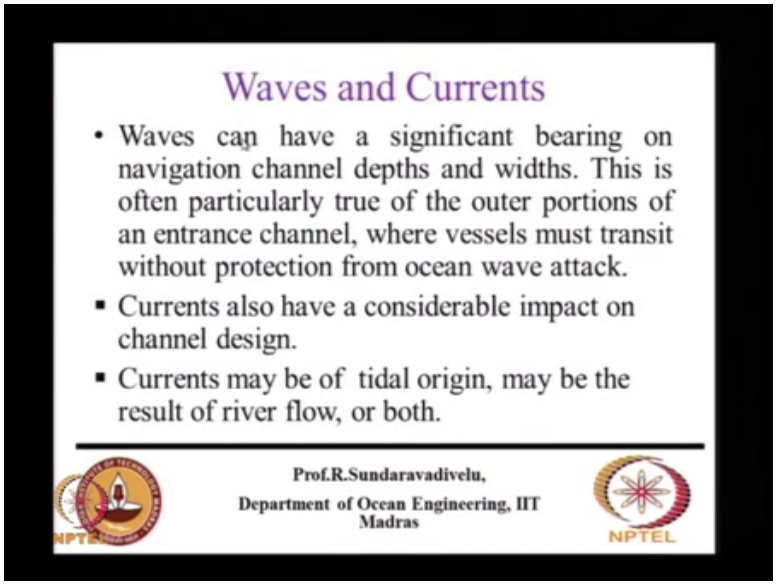

Wind also has significant impact but the waves can have a significant bearing or navigation channel depths and widths. So this is mainly for router portion of the entire channel where vessels must transit without protection from motion wave attack. Current also have a considerable impact. Currents can be of tidal origin may be the result of river flow or both. River flow means it is from the river to the sea, tidal means it can be into the river out of the river.

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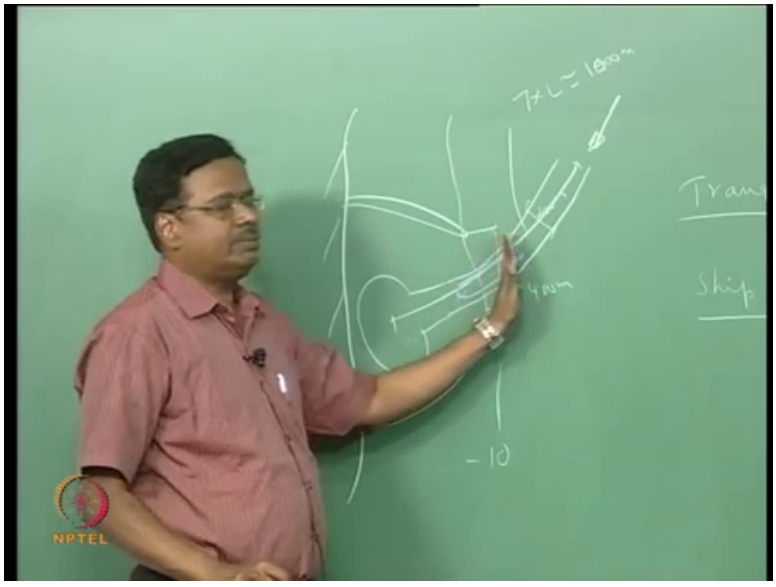

Suppose you have the shore line here and you have two break waters. Generally the break waters are stopped at minus 10 contours. And we have a navigation channel depending on the direction of wind and wave (())(26:54). Typically the width of the entrance channel is given is

about 400 metres. This is about 200 meters. The length of the channel from the centre line to this normally about 7 times the length of the vessel. Typically around 1500 or 1600 metres, this is a normal (())(27:24).

The problem for the ship comes and 50 percent of the ship major portion of the ship. So this is a centre line of the ship. Some portion of the ship is inside, some portion of the ship is outside. This is very critical because this portion of the ship is subject to less wave and current whereas this portion of the ship is subjected to more wave and current.

Suppose there is a ship here maneuvering is not that difficult even though the waves are higher for the full length of the ship. It is not very critical, another thing is if there is some slight tilt it will go and hit the break water. Some structure so this portion that is what is written there where vessels was transit without protection from motion wave attack. So this only create lot of problem.

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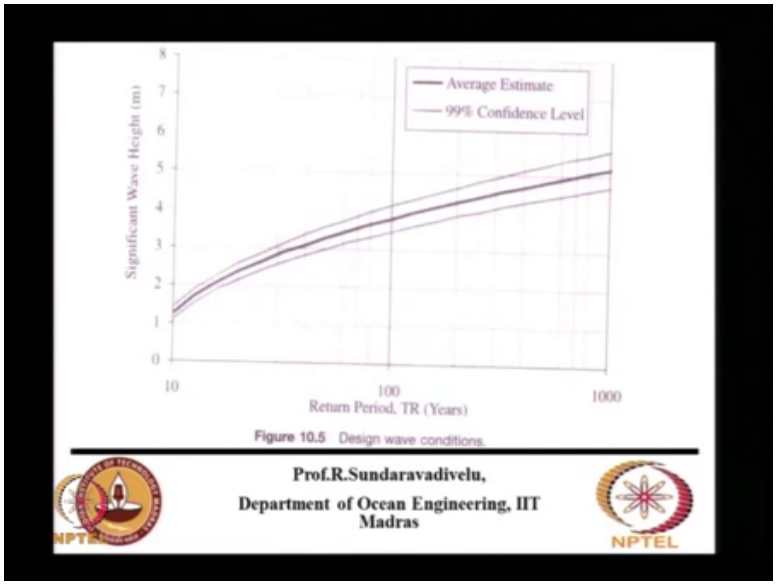

So we have discussed about this return period and significant wave guide, this shows the average estimate it is this is your average estimate or wave guide. Suppose it is a 10 year return period it is about 1.2 metres if it is 100 year return period it is about 3.8 metres. So this is 10 and this is 20, 30, 40, 50, 60, 70 I think something is maybe it is a log scale. So based on that you can find out. May be it is 10 square and 10 power 1.

So in between it will be distributed. So we have to estimate so if you go for 1000 years it goes to 5.2 meters. So depending on the this is for the one particular port what will be the value. And these are average estimate this can be higher and lower also, so this is this is the

99 percent confidence level within 99 percent confidence level you have to choose between these two points. So this is only average means it can exceed also. The 99 percent confidence level band is this.

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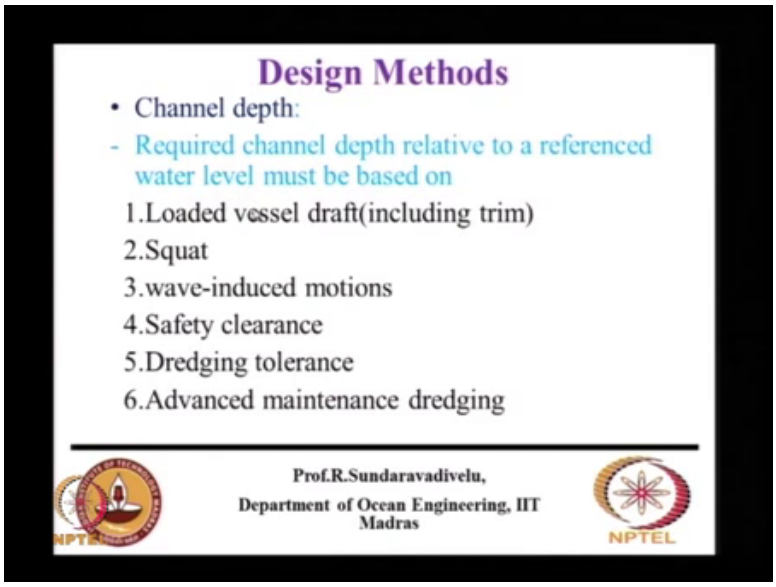

So this channel depth so what we have discussed is so far what is a wave what is a wind what is a current to be considered? Then you have to go for the design. One is the loaded vessel draft so if we see the ship there will be some trim will be there. It may be inclined like this because of how you are loading the ship.

Then squat there will be wave induced motions there will be six motions due to wave, heave, surge, sway, pitch role and ya. Then you have to give the safety clearance. The safety clearance depends on the soil type if it is rock you have to provide more safety clearance, if it is clay you have to give less safety clearance. Then you have to talk about the dredging tolerance.

Then you want to dredge exactly minus 14 you may not be able to do. So you have to give some tolerance for dredging it is normally given as about 0.3 metres. Then this is called as a advance maintenance dredging. Sometimes what they do is if you want minus 14 including dredging tolerance it comes minus 14.3. And every year you are same about 10 centimetre (()) (31:22) takes place. Then once in 5 years only you want to do the maintenance dredging. Then you go in for 14.8 metres.

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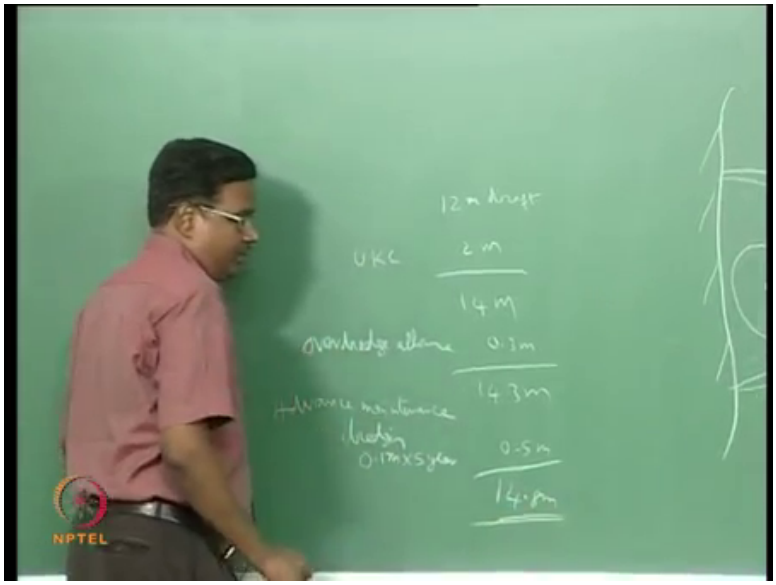

So 12 metre is the draft. So we have under keel clearance of 2 metre this you calculate 14 metre. Then you have the over dredge allowance 0.3 metres, 14.3 then you have advance maintenance dredging. So this acts like a seal to trap if you are same it will take 0.1 metre per year multiplied by 5 year and give 0.5 metre. Then you do capital dredging itself as 14.8 metre. Sometimes it can be 0.2 metre it can be 0.3 also. So you dredge more initially which will be less expensive and maintenance can be done once in 5 years.

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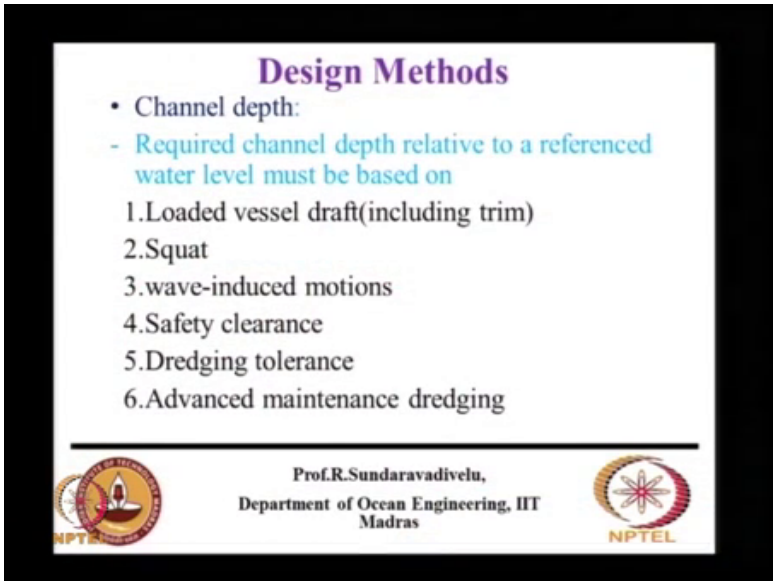

Some ports do not carry out this advance maintenance dredging, but we normally recommend this advance maintenance dredging. We are designing a floating doc in Port blare. The floating doc is kept by the side of the berth. The floating doc is maintained once in 5 years.

So below the floating doc for 5 years we do the advance maintenance dredging, because the floating doc will be in the same position for 5 years.

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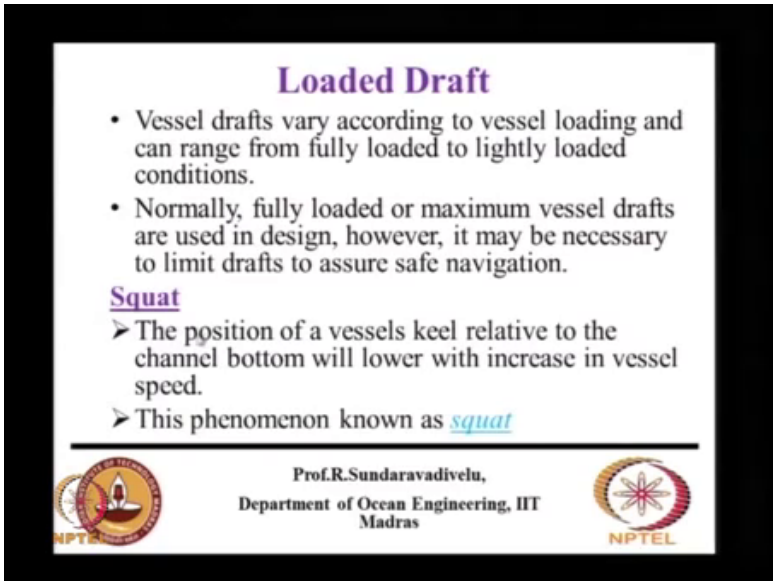

So the vessel draft can be fully loaded or lightly loaded conditions, so you normally take the fully loaded. Sometimes we have to limit drafts to a shore safe navigation. That means we may not load the vessel for the full load to aid navigation. For example (if the berth is) if the port is designed much earlier and it cannot take higher draft, but you cannot go and check the vessel because there is a particular type of vessel which is most commonly used for a particular type of cargo.

This point is clear you cannot change the size of the vessel. Otherwise it will not be available. Use the same available, but use it for lesser draft that means instead of 100 percent of loading the vessel they may load 70 percent only then bring the vessel inside. In Goa they do something else where they are loading iron ores they bring big size vessels which will go to mostly Japan and China where the vessels can have draft of 17 metres, draft can be 17 metres not the depth.

Whereas goa it can be only 12 metres. What they do is they load for 12 metre drafts in Goa port take the vessel outside then in the open sea they do a transhipment terminal that means you will have a transhipper.

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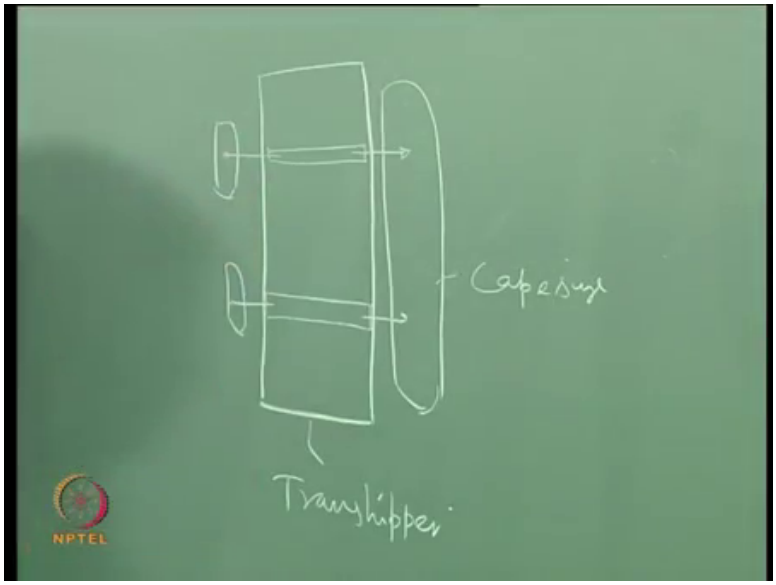

Transhipper is a just like a ship with some crane facilities then you bring the vessel on one side bring small badges which are coming from rivers in Goa. So there will be cranes here which will take the cargo from here and load it here. So this may be a cape size vessel which the Goa port not be handle will not be able to handle so they will put a transhipper here and go to 20 metre contour or 30 metre contour. This is being practiced now.

So they will have only 70 percent draft inside the harbour basin then bring it here and top it up and take it to Japan. Here you cannot go with empty 70 percent load ed draft all the way to Goa. The rivers also is possible in Tuticorin port they want to do like this they will bring a bigger vessel they will lighter the vessel then bring it inside the harbour basin.

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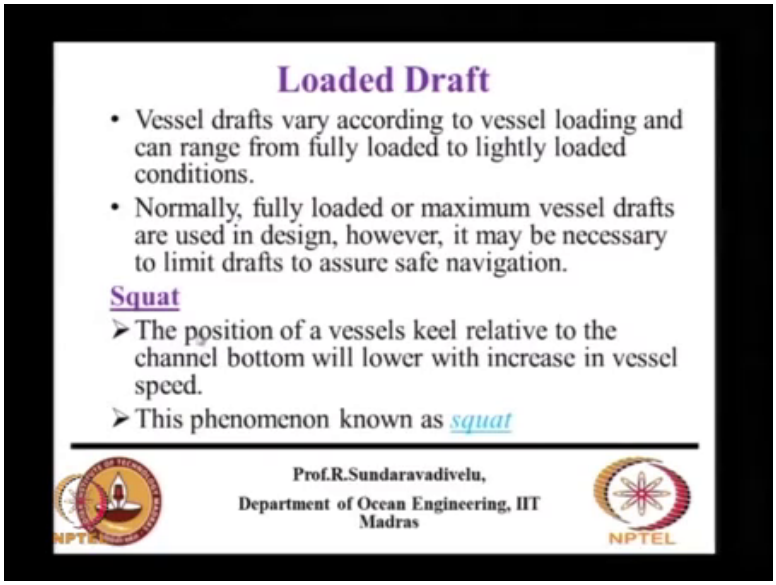

So today we will discuss about squat. Squat is the increase in the draft. So the the position of the vessel keel relate to the channel bottom will lower with increase in vessel speed.

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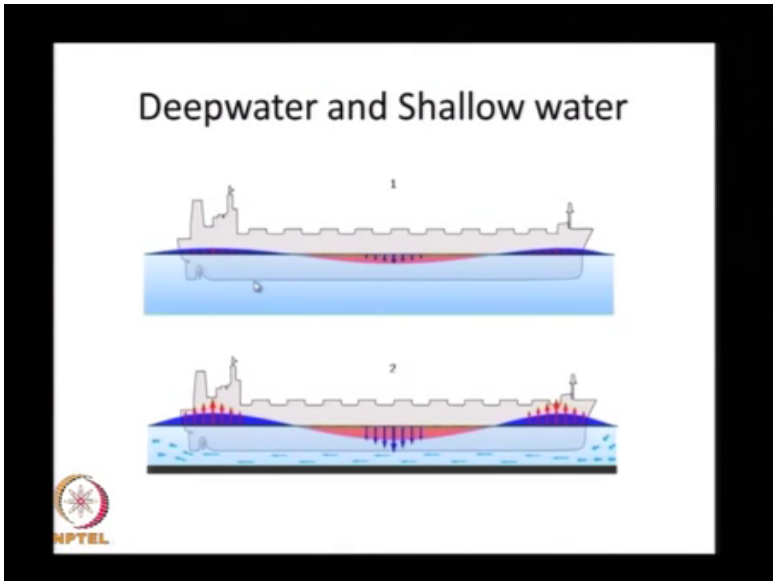

That is this is the bottom of the vessel. This bottom of the vessel will go down that means the clearance will become less in the restricted water way. Normally in deep water you will have this kind of buoyancy distribution is a support which is given by the vessel that is a pressure distribution sorry it is a pressure distribution whereas in a restricted water way there is some increase in flow velocity below the ship because of the pressure distribution will increase. When the velocity decreases pressure will increase.

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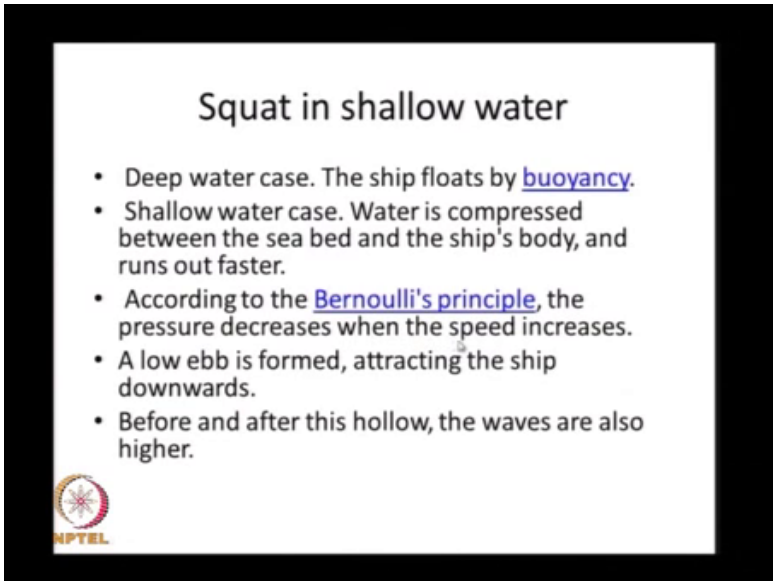

So in deep water case the ship floats by buoyancy shallow water, water is compressed in the sea bed and the ship's body and runs out faster. So there is a effect of bottom here, so in shallow water this water between the ship bottom and the sea bed is compressed and flows faster. According to the Bernoulli's principle the pressure decreases when the ship speed increases.

So when the pressure is decreasing when the ship will go down. A low ebb is found attracting the ship downwards before and after this hollow the waves are also higher. This is what is called as the Squat.

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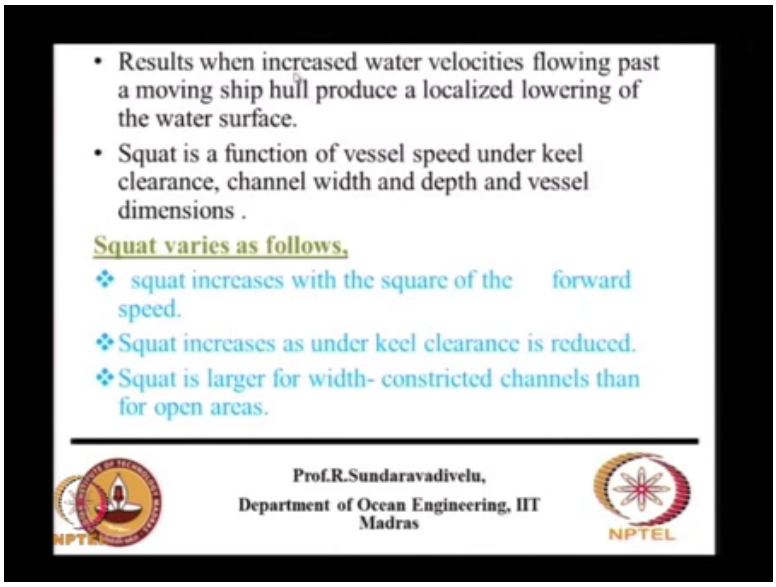

So when increase water velocity flowing past a moving ship hull produce a localized lowering of the water surface. Squat is a function of vessel speed under keel clearance, channel width and depth and vessel dimensions. And squat varies with the square of the forward speed. So the speed is more. squat means how much clearance got reduced.

Increase with the square of the forward speed. Squat increases as under keel clearance is reduced. Squat is larger for width restricted channels than in open areas. The width is restricted the squat will be larger. So you have to take care of this squat then finalize the design, ok thank you.