Port and Harbour Structures
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Module 8, Lecture 44
Environmental studies of a project

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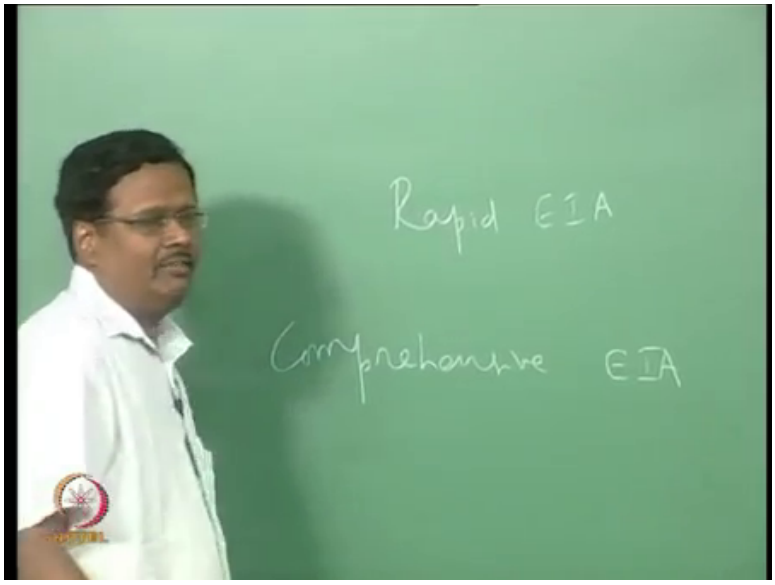

So this class we will see this environmental studies with reference to port projects, we will be doing two types of environmental study one is called as the Rapid EIA, another is called as comprehensive EIA, what is the difference between Rapid EIA and comprehensive EIA, faster; I told in one of the class what is rapid EIA and what is comprehensive EIA, comprehensive EIA means you have to do for one year, rapid EIA means you have to do for one season.

That is about 4 months right, it is not fast and all, only the duration is less, rapid is for 4 months, comprehensive is for 12 months, that is for some seasons either a non monsoon season or monsoon season, north east or south west like that,

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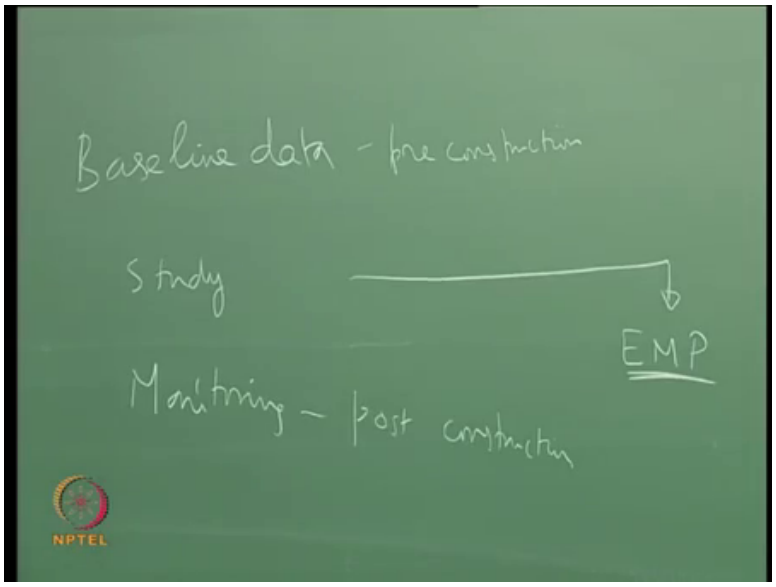

So another important thing what you have to do is for all this study we need to do have what is known as a baseline data, baseline data means you have to compare with the baseline data what happens later.

So even if the baseline data itself is very not acceptable, no point in blaming the developer baseline data means before construction of the breakwater or any activity what is the parameters that has to be first collected, then you cannot build the breakwater and then measure that is only monitoring, what you are do is when you do the construction of breakwater or a earth structure or a dredging what happens you have to predict and then compare with the baseline data.

And see whether it is acceptable or otherwise that is the second stage, there are three stages one is baseline data then you have to do some study it can be numerical or experimental then you have to do the monitoring, monitoring is post construction, baseline data is pre construction, study means what are all the structures you are to going to build

Based on which (how) what will happen to the baseline data that you are going to predict. Monitoring whatever predictor is within the limits that you are going to see, is what is known as EIA but after doing this study you have to do environment management plan, so you have to propose a environment management plan to see that the parameters are within the limits.

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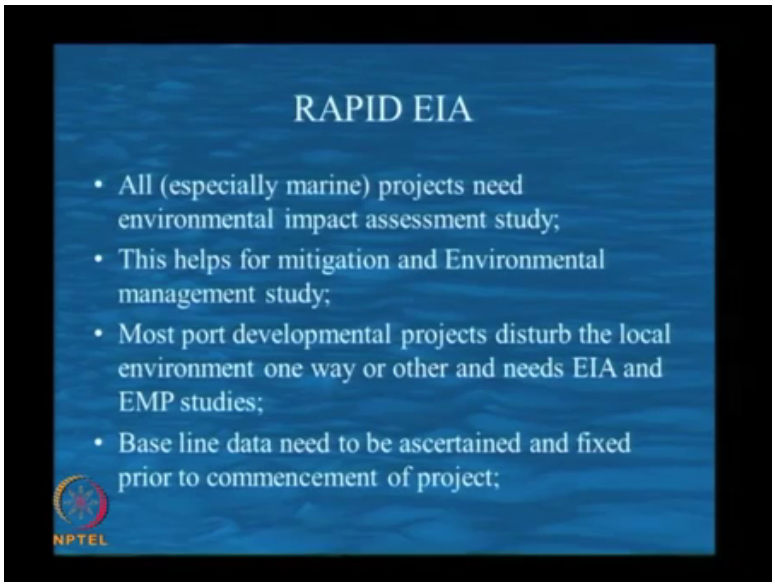

So this EIA study is for both mitigation and environmental management so most port development projects disturb the local environment one way or other and needs EIA and Emp studies. So important is baseline data this is to be ascertained and fixed prior to commencement of the project.

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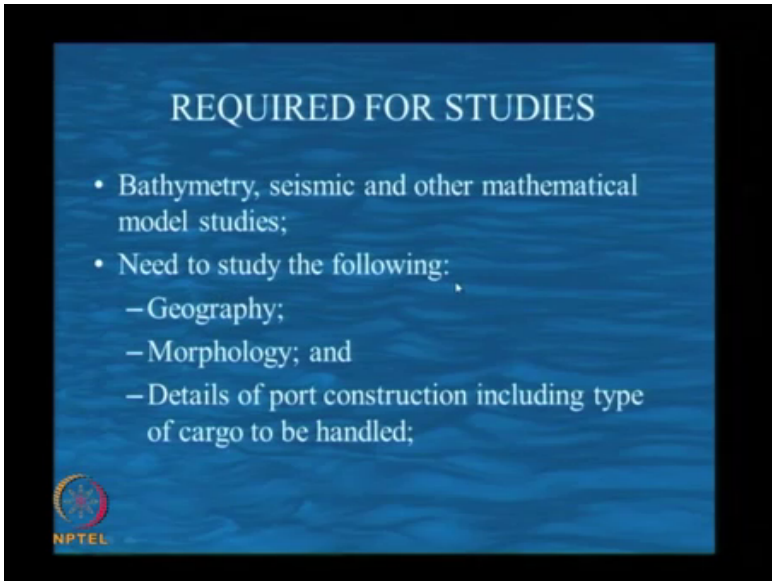

What are the studies that are required we already studied this bathymetry, seismic and other mathematical model studies. And we have to study the geography, the morphology and the details of port construction including type of cargo to be handle so what here we are doing is during the construction stage how the environment will be disturbed that is one part.

Another is when the cargo is handle how the environment will be (dispard) disturbed, these are the two different aspects which has to be studied carefully during construction phase the permissibility of this turbidity and other things can be permissible levels can be higher whereas when you are handling the cargo (04:37 prevalence) will be lower,

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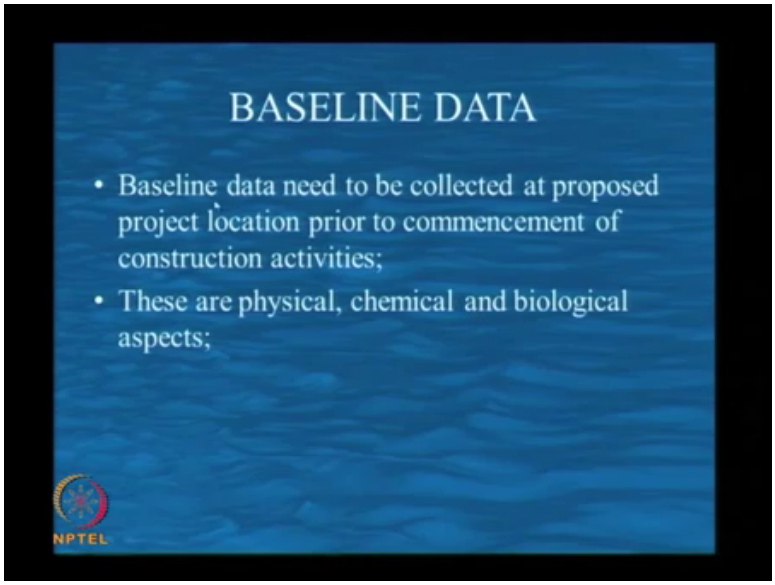

So you have to collect the baseline data at the project location prior to commencement of construction activities. There are three types of studies we have to do physical, chemical and biological aspects, physical, chemical and biological aspects these are the three data's that is to be dial, what are the physical parameters? Wind, storm, waves, current and tides this can be measured or this also can be predicted based on numerical models.

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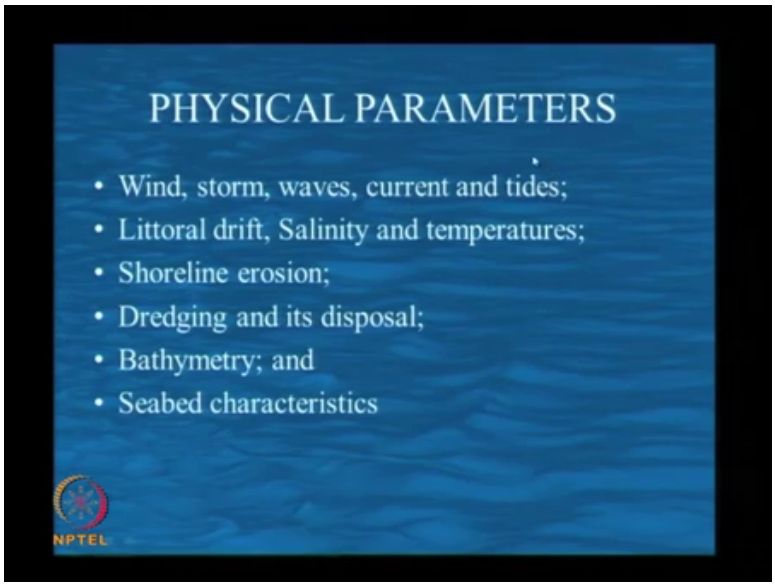

Typically we measure the tide at a particular location, very important projects we measure the waves and current.

Actually current and tides are together we can do the measurement, waves we can either measure or we can also predict, important project we measure the waves, storms and all there is a method by which we can predict the storms, another important thing for wind and storm is at least for wind hundred years and for storm about 60 to 70 years we have the data what is storm that has happened earlier what is the maximum wind during cyclone.

Which just happened so the historical data can be collected, last class we discuss about the littoral drift, the salinity and temperature can be measured when shoreline erosion if this is baseline data as well as after construction what happens that also can be carried out, we have the satellite imagery comparing the satellite imagery we can predict the shoreline erosion, I told about this comprehensive and rapid EIA, rapid EIA.

And comprehensive EIA depends mainly on the shoreline erosion, suppose the erosion is more than one meter per year in those cases we have to naturally do the comprehensive EIA, suppose the erosion is (nil) negligible may be one meter in over a period of ten years then we may not

have to do the comprehensive EIA, we can do with the rapid EIA, this point is clear when we do rapid EIA, when we do the comprehensive EIA.

Already there are locations where erosion takes place we are know also the rate of erosion, so if the rate of erosion I have given one meter per year I am not sure whether it is correct but there are certain values fixed, the erosion rate is higher than this baseline value then we have to do the comprehensive, then dredging and its disposal we have to study the bathymetry and seabed characteristics.

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Then we have to do the water quality parameter this is very important. Why water quality parameter is important? Marine growth if it grows so why we have to design the structures, it is for the fish, not biofolie, biofolie and all is for scientists and researchers, the local fishermen the problem is with the fish community,

What happens to the fishes see you know this Kudankulam atomic power plant and many thermal power plants, the fishermen's are telling if you are bringing in water from sea then use it for cooling.

And letting it off the temperature will increase, typically the temperature will increase by 7 degrees, so what we can let into the sea is not more than 7 degrees but there are certain state

government they are telling it cannot be more than 5 degrees, suppose you are taking the water at 28 degrees for cooling water purpose then you are cooling the boiler and other thing and you are lifting it out, if it is 33 degrees it is permissible.

Suppose it goes to 35 degrees in certain regulation, certain year it is permissible, it should not be more than 7 degrees so what happens if it is more than 7 degrees fish will die because it cannot resist the temperature ambient temperature, there is some location where we were asked to do some measurement we are not even able to do the measurement because it is very hot, we cannot go and stand there so if it is increasing (what is the) what can be done to reduce it?

You are bringing the water you are cooling the boiler you are letting out the water, the water temperature is high how to reduce the water temperature? Not expose to see environment, how to expose it, how to do that? No it is called as a pre cooling channel or a basin where whatever you are telling only what they do is there is a channel, pre cooling channel we make a very long channel by the time the water goes through the channel and then you will let into the sea.

Then the (water) will be temperature will be reduced or (ista) keep it for 24 hours then you remove it you have a storage area where you keep the water for 24 hours expose to open environment then it will reduce the temperature then you can (late) let it out ok, that is also possible, mainly it is about temperature, turbidity, ph salinity and dissolved oxygen, this (bio) bio chemical oxygen demand, ammonia, inorganic phosphate, cadmium, lead and mercury.

These are some (heavy men) heavy (ma) metals concentration, this is also very important they don't want this heavy materials to be distributed.

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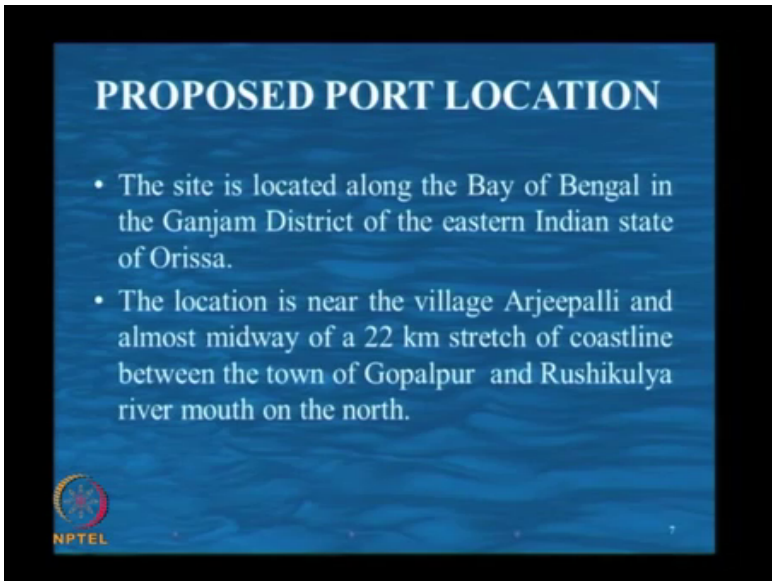

So now we will be discussing about a port which is being constructed now. This place is called as Gopalpur, this is Ganjam district in the state of Orissa adjoining the state of Andhra Pradesh, we have to study the coastline for about 22 kilometer between the port locations. And there is a river mouth called as Rushikulya River mouth so this is the port.

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This is the Orissa state, this is the Ap state, port is somewhere here this is the Chilka lake so this is very close to the Andhra border (we will) we want to (disc) study about 22 kilometer stretch

on the northern side of the port where there is a Rushikulya river so this is a port what is being built this is the eastern side.

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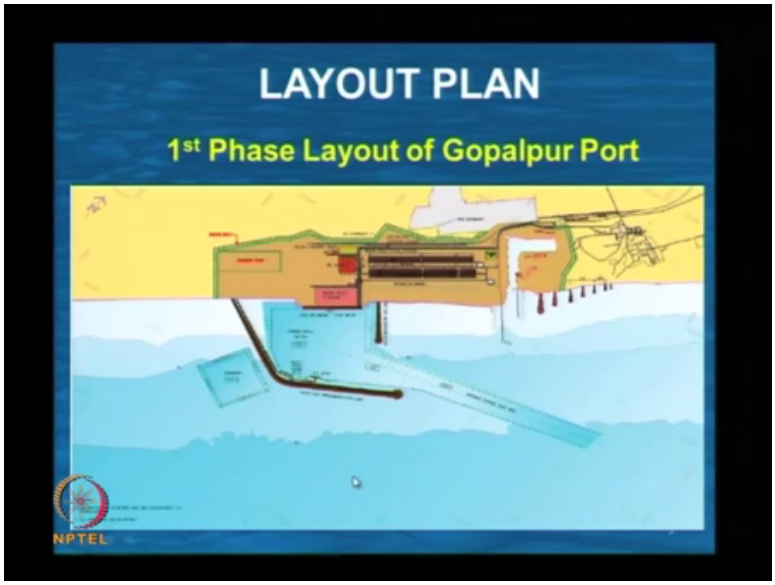

The color code as usually indicates. The darker the color the deeper is the water depth, there is one breakwater being built here southern breakwater this is the northern breakwater, there is series of groins which are built to reduce the erosion and this is a channel and this is a (tay)

Harbour basin area where we will be doing the dredging and this is the area where we use the sill trapped or sand trap which will be collecting the sediments and this is use for maintenance we remove the sand from here. And then dump it on the northern side that's what we do as a environment management plan,

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So many ports when you talk about they are consists of the following one is a breakwater. So I already told you how to design the breakwater already this discussion has been done how to design a breakwater then berthing structures we have done for a typical structure or how to carry out the analysis now one more lecture I will be discussing about the design of piles.

Beams and slabs mostly (it lis) in civil engineering but any how I will give some construction methodology along with the design so that you understand the components of this berthing structures then berthing area we have to do the dredging and the disposal the berthing structure is on the land side the berthing area is on the Harbour side then how to develop the backup area then development in hinterland that is a road.

Rail and pipeline or inland water transport connectivity, so we have to study various alternatives before selection of project and its location this is what is to be done, backup area means where you store the (day) stacker reclaimer and all you are using no, so I told about one and half hectares is required for one million tons of cargo approximately goes up to 8 hectares if it is weed fertilizer and all, so if you have a one million tons of cargo to be handle.

About 20 to 30 hectares area is to be developed the backup area then you need the road, rail, and other connectivity water supply, pipelines and all those things, development of hinterland is from

where you get the cargo, origin and destination so where the cargo is coming from if you take the Orissa if you are taking the coal from the mines it has to come to the port so there is a traffic density that has to be study.

Mainly this before selection of project and its location is if you take the Gopalpur it is very close to the Nh and railway line, the main thing what is to be (da) decided is whether it is very close to the national highway and the railway line so you have to put only feeder line from the railway line and the road network that if it is very close by whenever you put your roadway and railway line you have to cut lot of trees you have to acquire lot of lands.

So if that distance is minimal the environmental disturbance also will be less, another thing is how close it is to the origin suppose you take the coal and iron ore which are to be exported now what is being as plan to be exported from Gopalpur is either going from Vizag or Chennai or Calcutta so these three places are far away from Gopalpur so the lead distance will be less then there are some steel plants for Jsw, Tata and all for they will be importing.

Some coal different type of coals are there some coal they will import they will also export the finished steel products that is also very close to Gopalpur, then construction material is another area which is being plan to do the export then we have a Indian rarer metal,

The Indian rarer (the) limited, this is the atomic power plant nuclear related industry which is very close to Gopalpur they main this sand mines in Gopalpur and they take the rarerth. And then they will export so that is also adjacent to this boundary.

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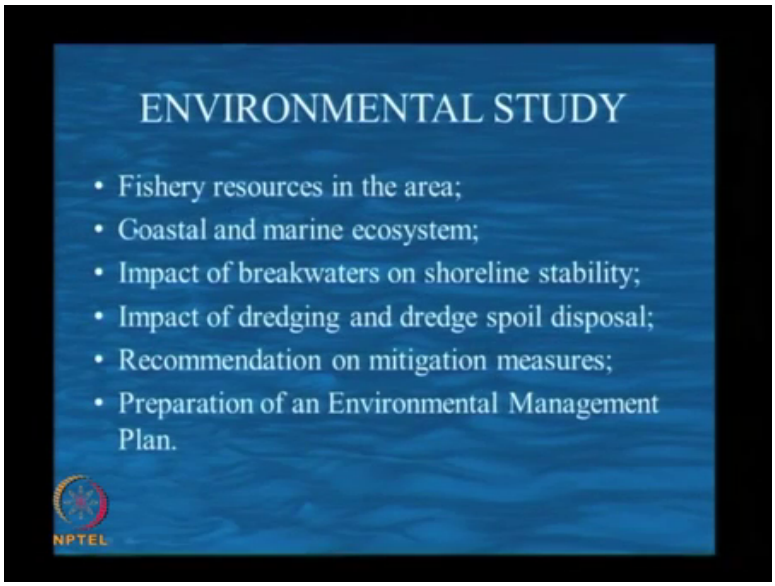

The environment study mainly we have to talk about the fishery resources in the area. So if you see (up) after agriculture most of the population in India they are living on fishery resources these are the two major components from which they get the income so we have to take care of this fishery (fisher) fishermen's livelihood then we have to talk about the coastal and marine eco system this can be backwater.

This can be mangroves, this can be the solule relay captel which is going through the Rushikulya river and things like that then the impact of breakwater on shoreline stability this we already discussed what happens when you build a breakwater then impact of dredging and dredge (saw) spoil disposal we have to give the recommendation on mitigation measures and we have to prepare an environment management plan.

And then carryout see apart from all these things I may forget this we have one more this is not related to EIAmp this is something what you know about this Csr, what is Csr? Corporate social responsibility this also very important so we see the Kudankulam power plant, Tamil Nadu government has given 500 crores as corporate social responsibility say to solve the problem of the local people, this government they have given 150 crores central government.

This all corporate social responsibility to take care of the peoples requirement over and above the normal development so this corporate social responsibility also should be considered whenever you develop your port project, typically they want about 5 percent of the total cost of the project to be use for corporate social responsibility.

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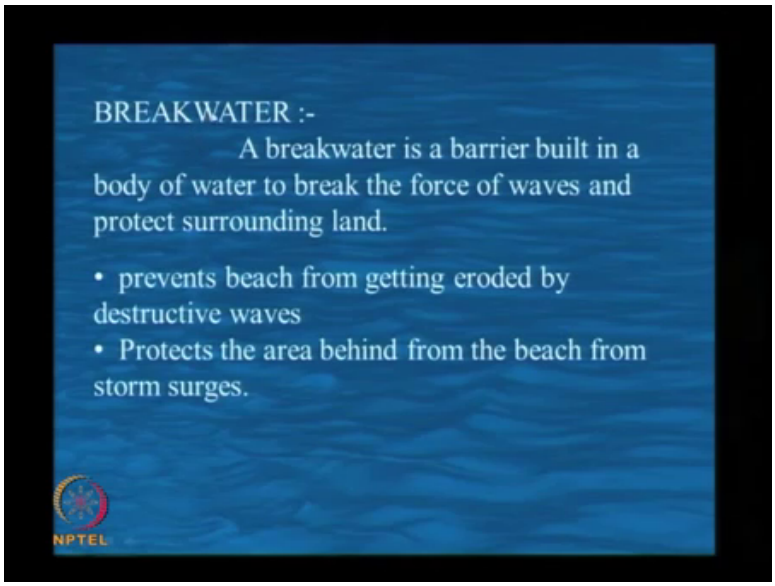

So this is breakwater is build to break the force of waves and protects surrounding land. And this provides beach from getting eroded by destructive waves, protects the area behind the from the beach from storm surges, this is the purpose of the breakwater.

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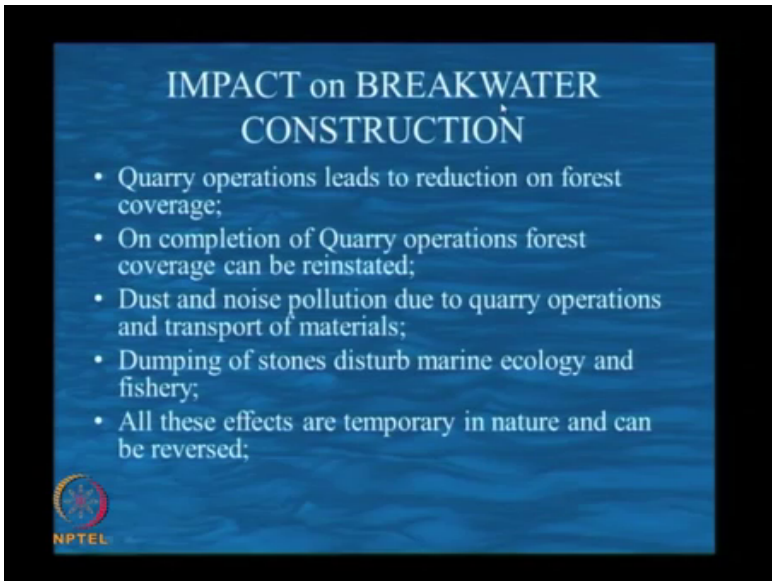

The impact on breakwater this can be on various counts one is the Quarry operations. This (rela) leads to reduction on forest coverage because we will be removing the forest cover then we will be removing the stone from the quarries and completion of quarry operation.

Forest (cover) coverage can be reinstated this is the management plan, so this is the impact this is the management, there will be dust or noise pollution due to quarry operations and transport of materials and the dumping of stones disturb marine ecology and fishery but these affects are temporary in nature and can be reversed whatever it (distrae) destruction it is doing it can be reversed it cannot be completely eliminated it can be minimize.

There will be some impacts but we can minimize the impact and we can reverse the impacts at a latest stage.

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Then we have to build the construction of the jetty, this is the initial stage this is the breakwater which is build in Gopalpur. (They star) they are going to start the piling work here this is the gantry which they have erected they have start piling here;

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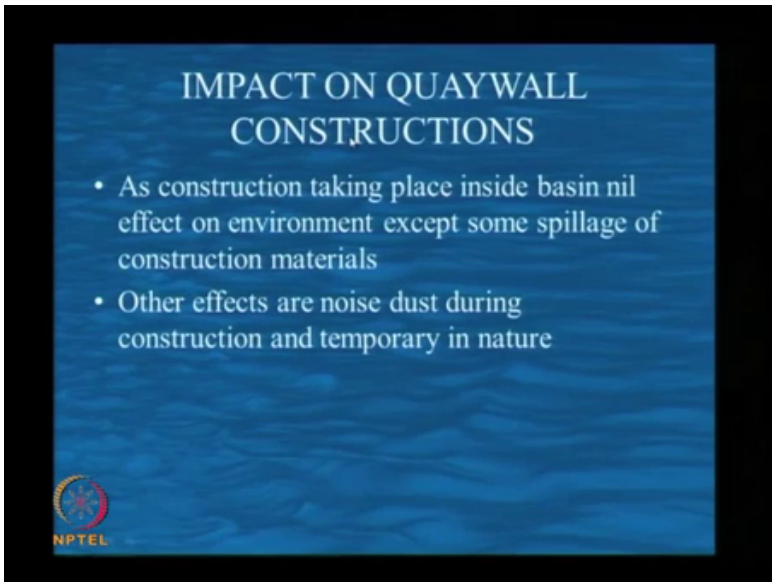

What will be the impact on quay wall some spillage of construction material only is the impact. The other effects are noise and dust these are all temporary in nature so in IIT Madras if we see most of the construction sites we are putting a barricade so that you have one purposes you don't see what is going inside another purpose is the dust doesn't come out and another thing what we have done is for construction we have a gate near Mandakini Hostel through which we get all the construction materials if you are getting it form the main road.

To getting in Gandhi mandapam road is very difficult for the lorries to come first, second is it will come through the campus area the road will be spoil and there can be some accidents also,

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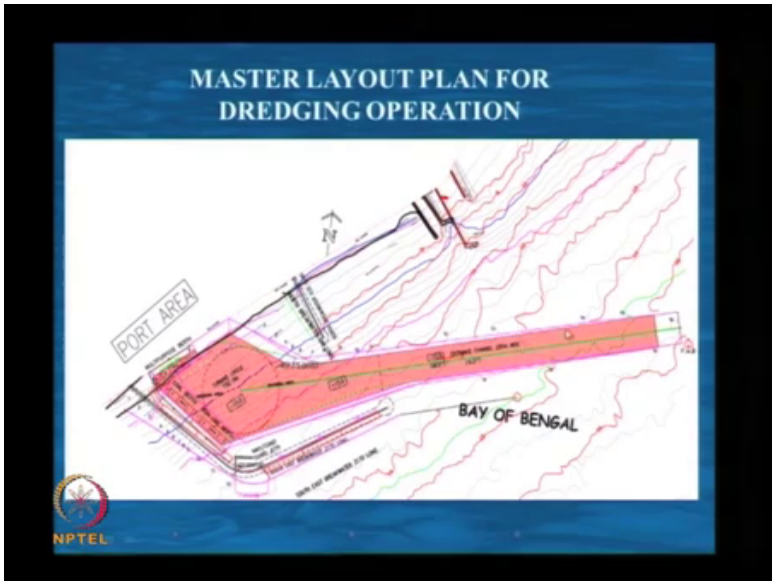

The next one is a dredging operation this is the entrance channel and this is the Harbour basin area how we are going to dredge this material. Here I have shown two cars one is in red color another is in blue color these two color indicates what happened to the shoreline. Over a period of time even without any construction some effects have taken place.

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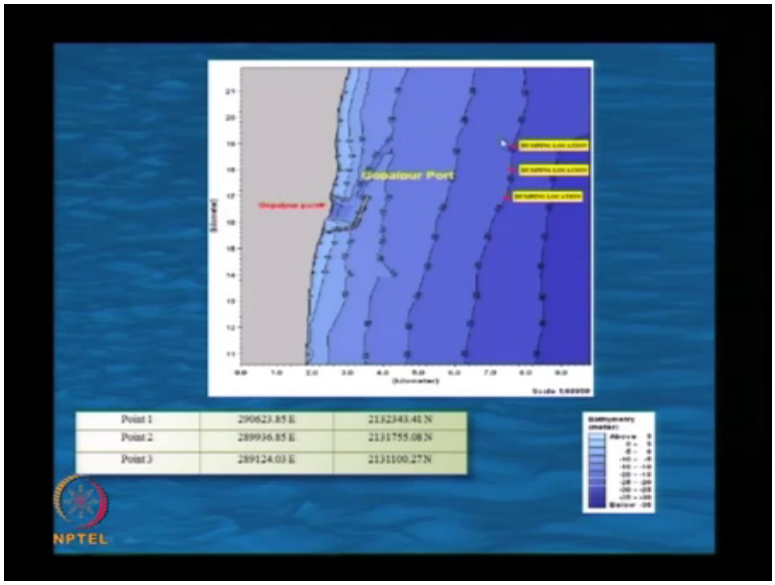

So these are the three dumping locations what is shown here you are showing the latitude or longitude, the bathymetries are shown here 0 to 5, it is 0 to 5, 5 to 10, 10 to 15, 15 to 10 and all, I think we are doing it 5, 10, 15, 15 meters, 20, 25 in a 20 meter contour at three locations we are dumping the material.

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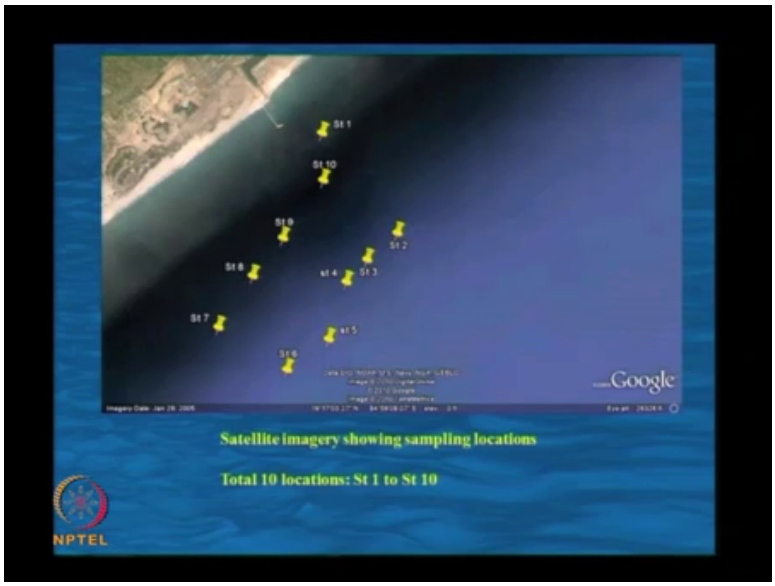

So when you want to do the measurement (this is the) this is called as a lagoon Harbour, this is the existing Harbour.

So for baseline data you have to collect the samples, water quality samples or temperature measurements we do it at these locations so that you can come back and do the measurement at a later date and compare what happen to this data with the baseline data,

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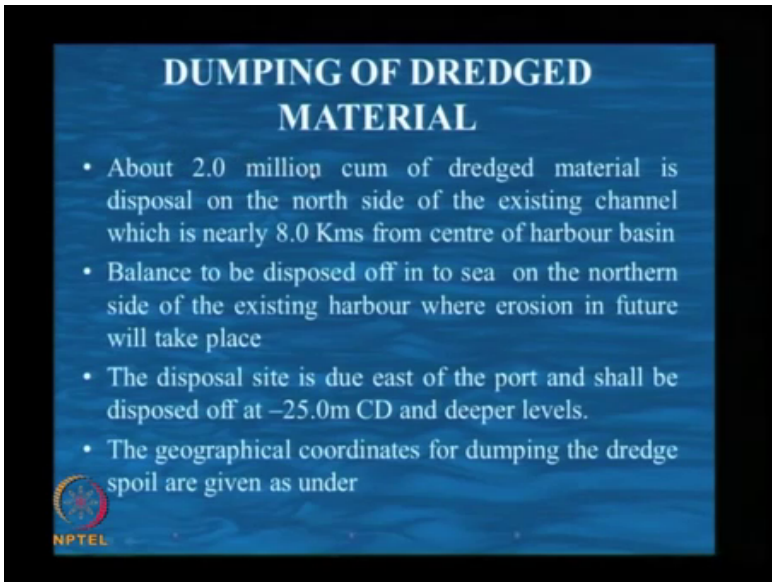

So out of 8 kilo 8 million cubic meter of dredge material 2 million cubic meter is disposed on the (north zone) northern side which is nearly about 8 kilometers.

From the center of the Harbour basin.

So this is one forth is dumped on the northern side as a stop pile so that the erosion what will take place will be minimized, balance we are disposing it on to the sea the disposal site is at 25 meter water depth, geographical coordinates are given so that the with the Gps the dumping barge can locate this points, so before dredging we have to take the samples and analyze for presence of toxic materials.

And uptime basic data this is very important suppose there are some toxic materials you cannot dump it on the shore, northern side we are putting 2 million cubic meter if there is some toxic materials there you dump it on the northern side we can either dispose it on to the sea or you have to have a separate (en) place where you can dump this toxic material, so you have to study the sample for that,

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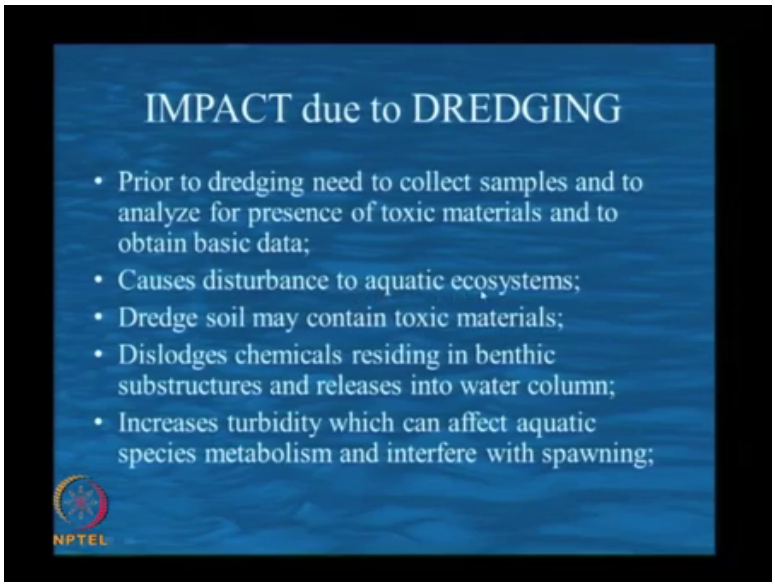

This aquatic eco system what is the disturbance it will carry. There is a place called as Gamra which is on the northern side of Orissa state where L and T has built major port L and T and Tata together most likely it is going to be taken over by Adhani imports,

Adhani imports is form Gujarat so the corporate are cheating started with L and T then they had a joint venture with Tata, now most probably it may be taken over by Adhani, at this place Gamra we have all this olive, ridley, turtle and all so when they want to do the dredging.

They put what is known as a turtle deflector, they have attached on the dry head, dry head means the head which removes the sample they put the turtle deflector so they have found out that this turtle deflector will not kill the turtle and it will make the turtle to move away from the place where they are dredging, this has a penalty that the dredging rate will be reduced but anyhow this has been given as a system which will be used to do the dredging at that particular area.

So that is what I have given this causes disturbance so (accard) aquatic ecosystem we have to make certain arrangements to minimize the disturbance if there is a toxic materials then you have to dislodge this in you have to make a separate area where we can dispose of the toxic material we put what is known as this fabric, geo fabric, the geo textile cloth, so it doesn't penetrate inside the soil medium you make a excavation put special materials.

So that you can dump this toxic material and then close it in a later date, this is support this benthic substructures and release them, fishing and the other biofolie activity then it will increase the turbidity which can affect the aquatic species metabolism and interfere with the spawning so to avoid this what we can do is we can (redu) we will see that the dredging is not done during the spawning period that is one activity which can be done to reduce the impact.

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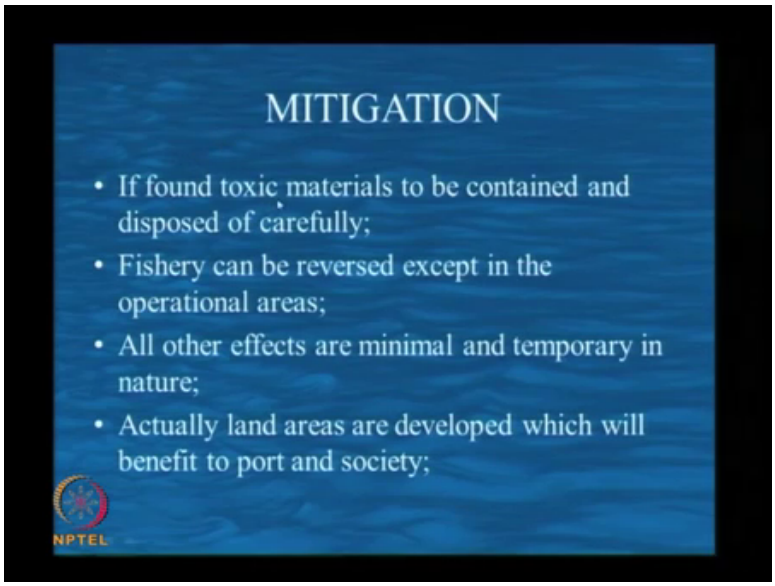

So we have to toxic materials means to be contained and dispose of carefully. Fishery can be reversed except in the operational areas, operational areas means where you are using the ships for berthing and rebirthing, all other affects what is described earlier are minimal and temporary in nature, so this land area is what you are developing will benefit to the port and the society that is a positive impact what you will be having due to this development. So with this this part is completed

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So if you want to be a good engineer you should know how the failure will take place, there are basically two types of structures in civil engineering structure one is called as a column another is called as a beam, what is a difference between a column and a beam? Column is what is it vertical load, axial load, what is beam horizontal load and so as you know, see column is generally it is called as a axial load, it can be axial compression or tension. Beam is bending and shear,

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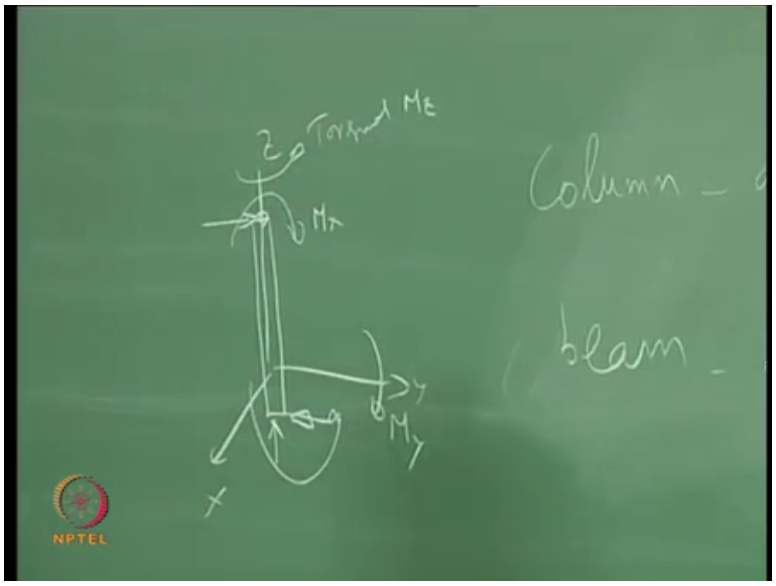

See typically you have a three axis system. Suppose you have a member here, this member maybe subjected to some force here this is called as axial force, some force in this direction is called as a shear force, some force perpendicular to this that is the another shear force, so you will have three forces and three movements.

So you will have a movement like this is called as a bending moment. What about the movement about different axis what is it called torsional movement, so this movement is about the x axis, it is about the z axis then you will have one more movement about the y axis, typically you will have three forces and three movements, one is an axial force, another two forces are shear forces, bending movement there are two bending movements about the major axis and another is a torsional movement.

Torsional movement is like a axial force any member will consists of all the 6 forces in some places some of the components will be zero, in some members some of the components will be very less, there is a provision when you can design it as a column or beam but generally for a major structure we have pile which will be designed as a beam column and there is a beam, and slab which will be design so we will have three more lectures.

Video lectures one is about the pile another is about a slab, the difference between the pile and the normal column what you see in the multistoried building is this piles generally have not the unsupported length what is there in the ocean structures,

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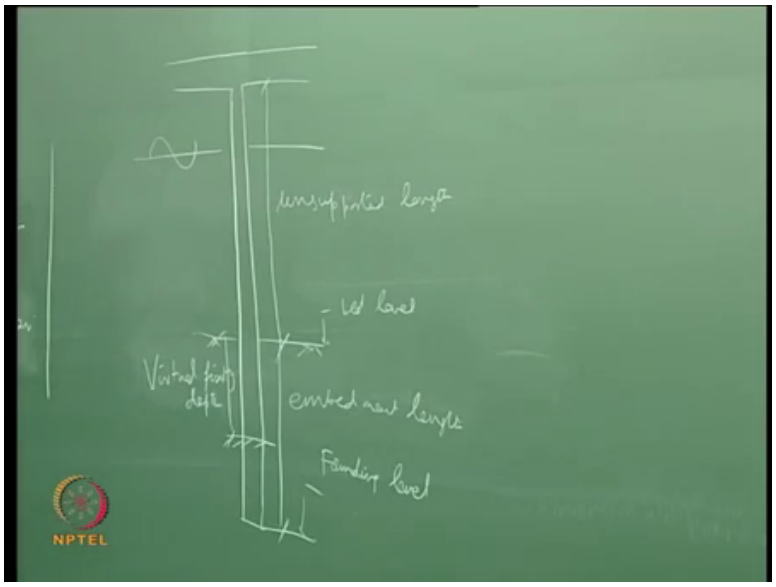

This will be your bed level this is called your founding level, this is your bed level, this is your water level which varies then we will have the deck here and this is your unsupported length.

This is your embedment length then you have a fixity point this is called as a virtual fixity depth because this doesn't exist, these are the various parameters.

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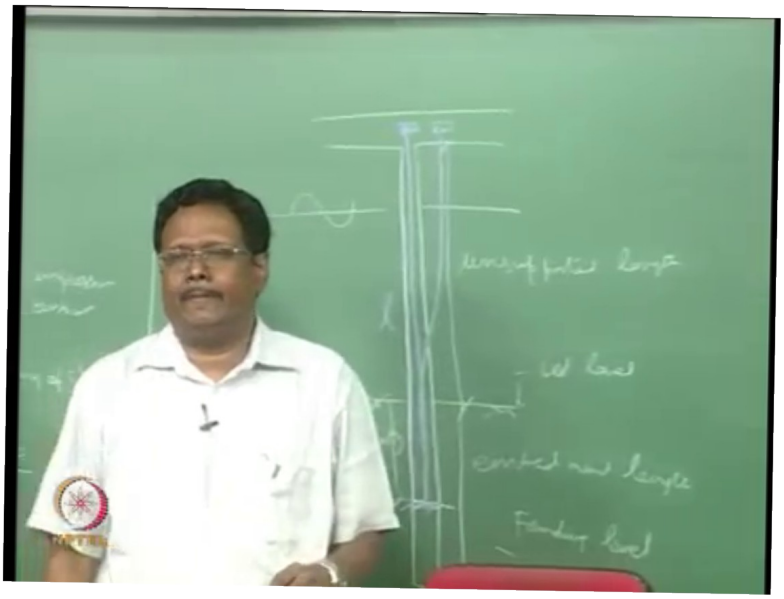

So when you talk about the column there are two types of column one is called as a short column another is called as a long column, what is the difference between short column and long column what is it, what is aspect ratio?

8 point what is it, No it is not so what is L here unsupported length is not correct. First length then effective length what is a length here, I have written so many length virtual fixity depth, embedment length, unsupported length all those things I have written what is a length here?

Whole length is not correct, whole length means from here to here that is not correct that is not length that is why it is not correct, that is a length this unsupported length also is not correct.

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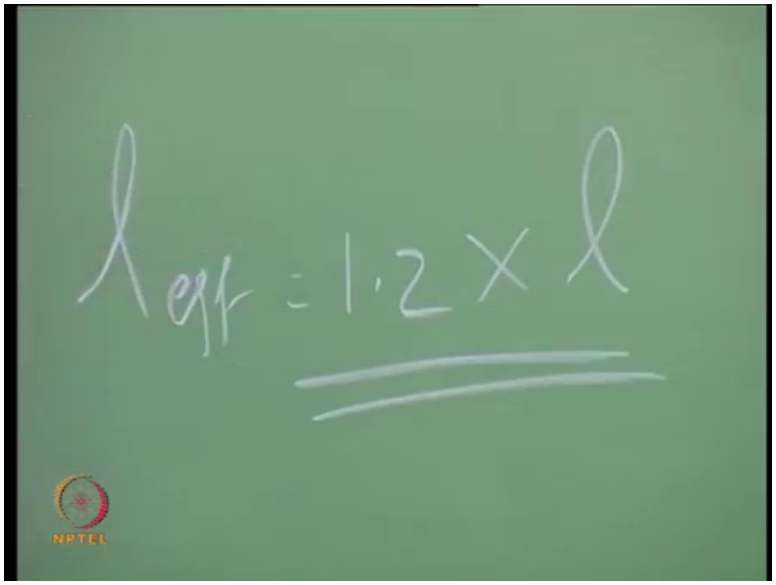

We have to take to the center of the pile and take it right up to the fixity point. And this is considered as restrained against rotation but allowed to displace right, so this is the actual length this is called as L we have to talk about L effective, L effective is some factor into the length what is this factor? Greater than one, even hundred is greater than one greater than one is correct, two is not correct.

Root two is also not correct, is 1.2L why this is coming here? Why this effective length comes into picture?

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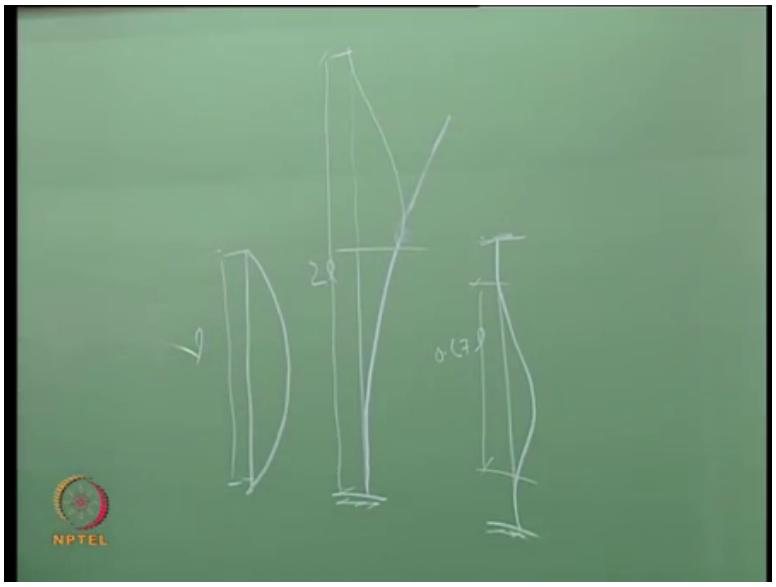

When effective length is equal to the actual length what condition effective length is equal to the actual length, both end fixed, what about mechanical engineering students you studied this effective length for what condition it is two, somebody told two, both length it is L equal to one li 15 is equal to one length, both end fixed is not two, both end fixed cannot be two, cantilever so you have three cases one is hinge, another is cantilever the third one is both end fixed.

Both end fixed the it takes buckling this is called as buckling so this goes likes this so you can bend and go like this that is how this becomes 2L, effective length equal to 2L here it is L, here it is 0.67L, so our case is.

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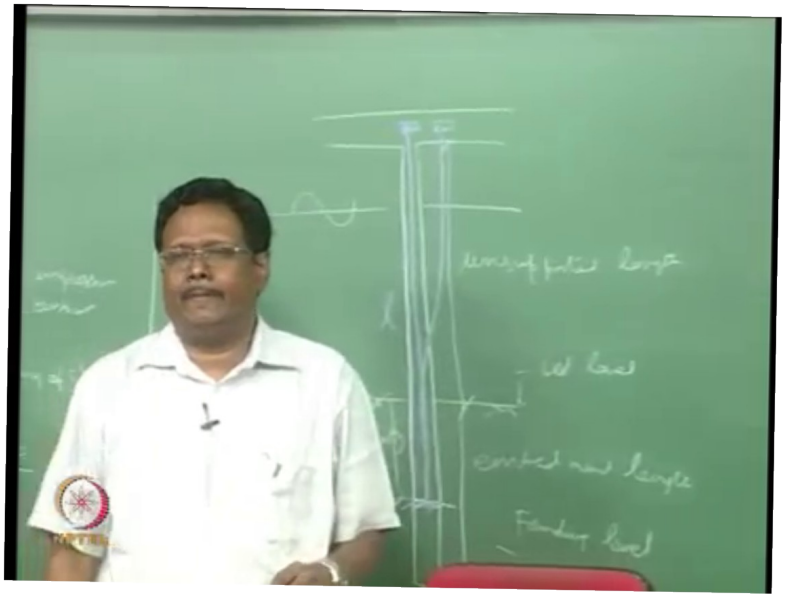

this is fixed against rotation and deflection whereas this is fixed against rotation, rotation is zero but it is allowed to displace so you will take the L effective (wa) what happens is when you (keep) kept a load like this.

The load will displace for a distance p actually the load will act at eccentricity of delta this is called as p delta effective ok.

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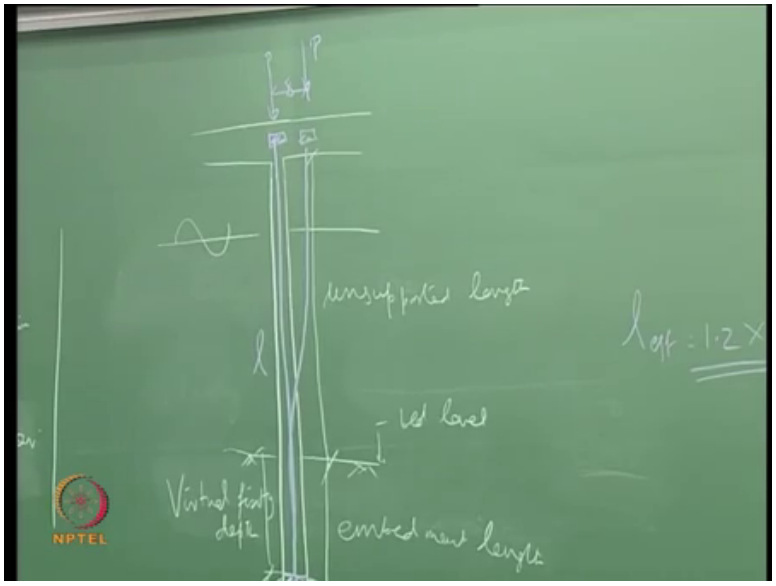

Nowadays we can do what analysis known as a p delta analysis if you do a p delta analysis you do not have to take the additional movement if you have to do the slender column, slender column you are telling L by d ratio apart from L by d ratio there is another ratio it is called what is that ratio what other parameter we can take instead of L by d.

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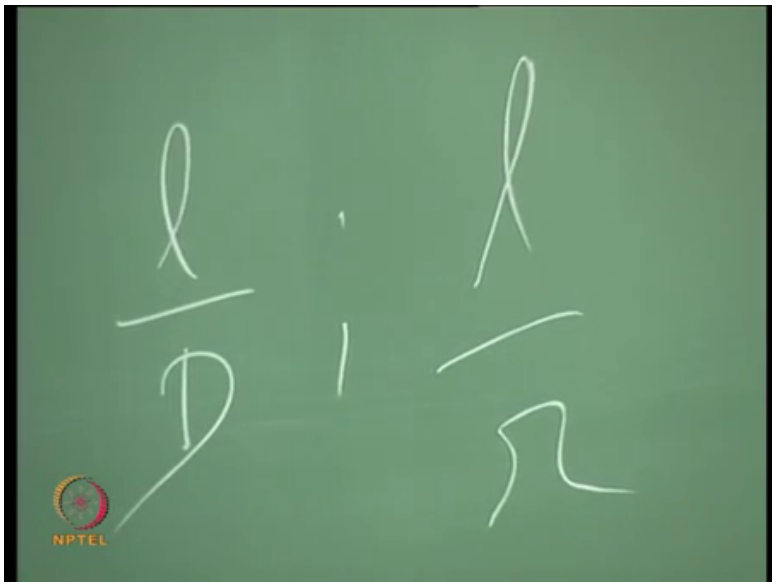

The slenderness factor is called as L by d there is one more parameter not L by d what is that, instead of L by d ratio there is another ratio, k l and all not required d itself d they use some other parameter what is that p or d whichever is smaller you got it also, two directions you will get two parameters they don't use d they use some other parameter length parameter what is that, I don't know why you don't know this is called as L by r, what is r, root of i by a.

You have to use better way is to use L by r only not L by d, so there is a limit L by d, I think 12 is the limit for short column if it is more than that you have to suppose there is a column which is subjected to a load and the movement, generally these piles are subjected to axial load bending moment and shear force right, we have to design the pile for all these things that is what we are going to do now

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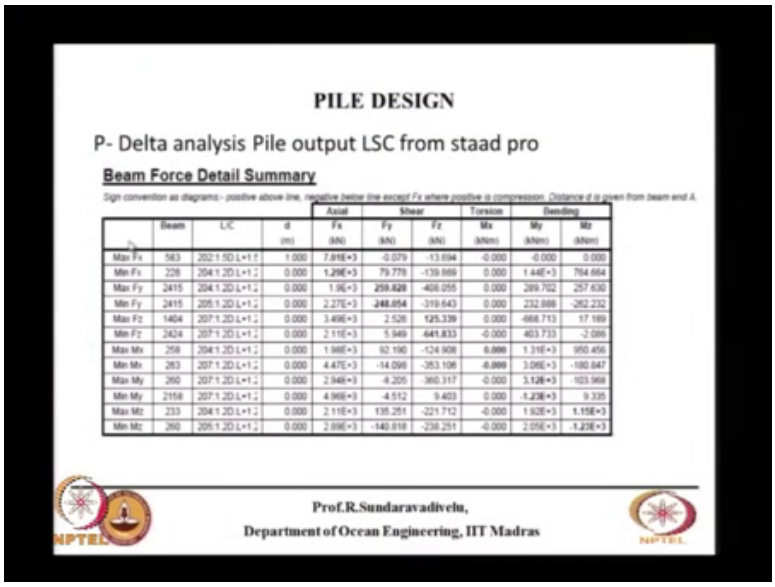

this is the table which will come after doing the (bid) beam data analysis. It gives fx, fy, fz, mx, my, mz, we get maximum and minimum in forces as well as for bending moments so we will have the axial force fx shear force fy fz at torsional movement mx and bending moment my mz if you do a finite element analysis there are two coordinate systems we used only the global coordinate system in which you place the structure another is a local coordinate system in which you take the member.

For that member the directions are given like this typically for this member we don't give this (haxi) suppose this is your member the local coordinate system this what is strong may be the global coordinate system the member joining this two loads this is generally called as x and this y and the z this is the local coordinate system that is why fx has become the axial force so you get this but I said you will have hundred load combinations.

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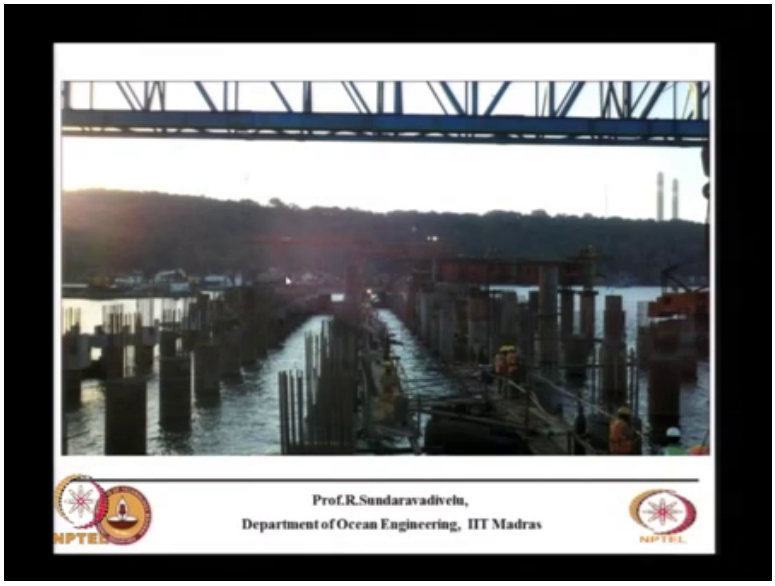

From that it will give this values so these are the piles which are being built during construction stage.

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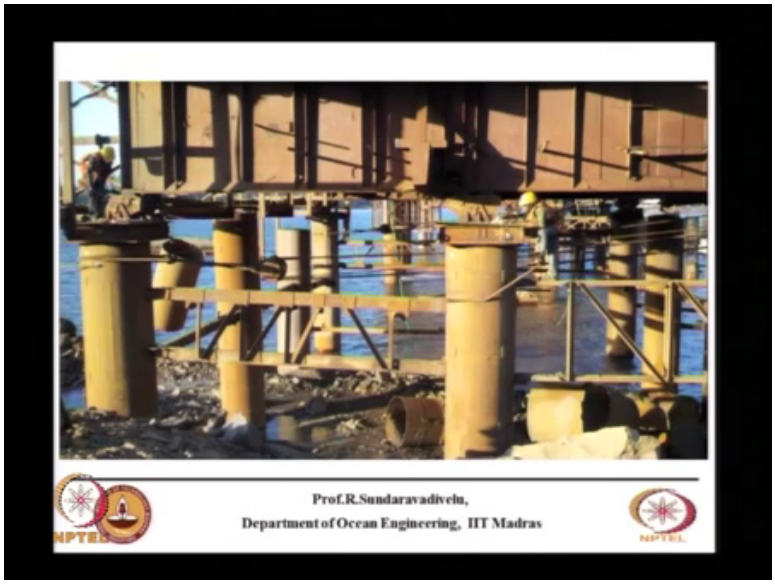

This is the roller over which the pile is moving.

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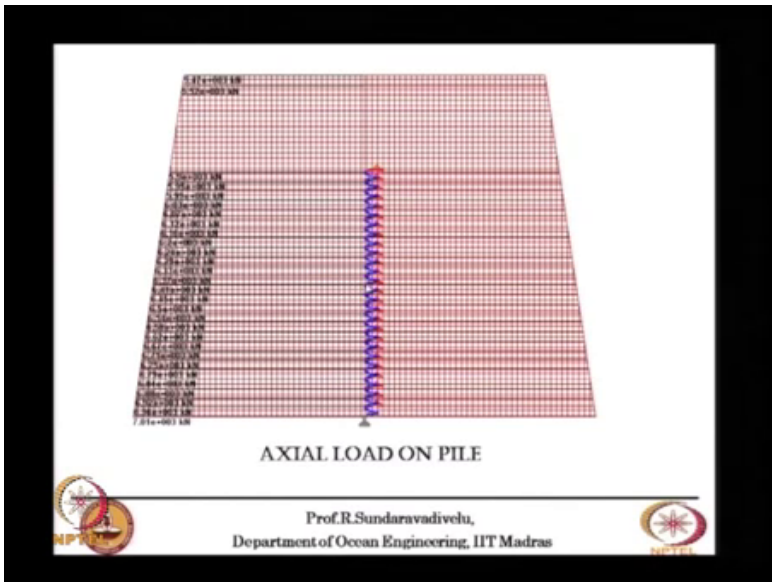

This is the axial load on pile.

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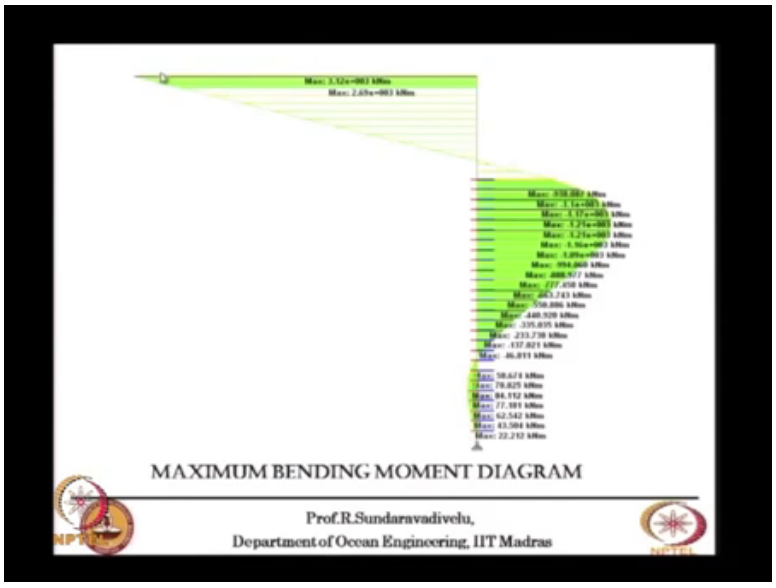

What is coming this is the bending moment for one load combination.So this is the founding level up to which we have done the analysis using the springs here, this is the maximum and that is coming at the central line of the beam column junction.

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Then this is called as a envelope the envelope means it gives for many load combinations what happens to the bending moment diagram in different directions so at this level you will have either moment this much or this much if you take this level this level you will have this much movement on one side and this much movement on the other side, so you have to design for all these types of bending moments,

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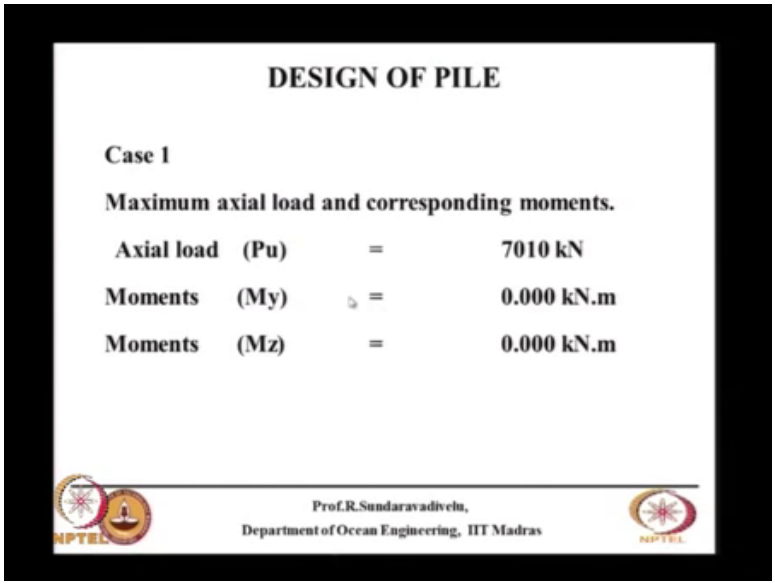

So when you talk about the axial load for this particular case.(we) the bending moments at nearly zero. We have the axial load of about 700 tons the very huge load so whenever we get this type of load we have to (tell) talk about two types of design one is the structural design and another is a foundation design, foundation design is always having certain risk factor associated with that we normally what we do is we do a pile load test actual pile load test we do and as certain that this load it is capable of.

We do it receiving, I will tell you how they do it, I have a power point presentation we will discuss separately on that there are (ma) many methods are there, there is a cantle edge method is there where they put actual sound under tons load that is done normally on land otherwise they do anchors they put the anchors right below that and then put a jack, jack will pull the anchor and distribute the load the third one is nowadays they do.

What is known as a high strain tarmac test that means there is no cantle edge suppose 700 tons is the load fond of times you are doing they drop a 12 ton hammer from distance they get the response from that they predict the capacity, the actually we have to do this before construction of the facility this we do a test pile separately then the (lo) load and then see (rees) I am recently designing one bridge for Indian Maritime University.

Near bucking hump canal there we wanted about 500 ton capacity the pile load test has given only 450 tons capacity so number of piles we are revising it before construction, initial load test we have to do it is very important,

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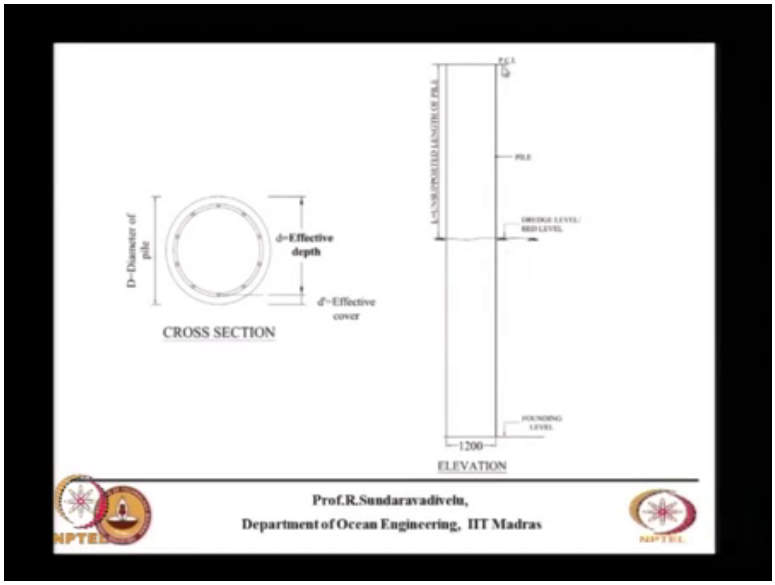

So these are the various levels which we have this is called as a pcl means pile cut off level, dredge level and founding level, when you want to design the pile we have the overall diameter we have what is called as a effective depth.

That is from the compressive and phases the central of steel then we have the cover this is called as the effective cover. Clear cover is from here to here then effective cover is shown here,

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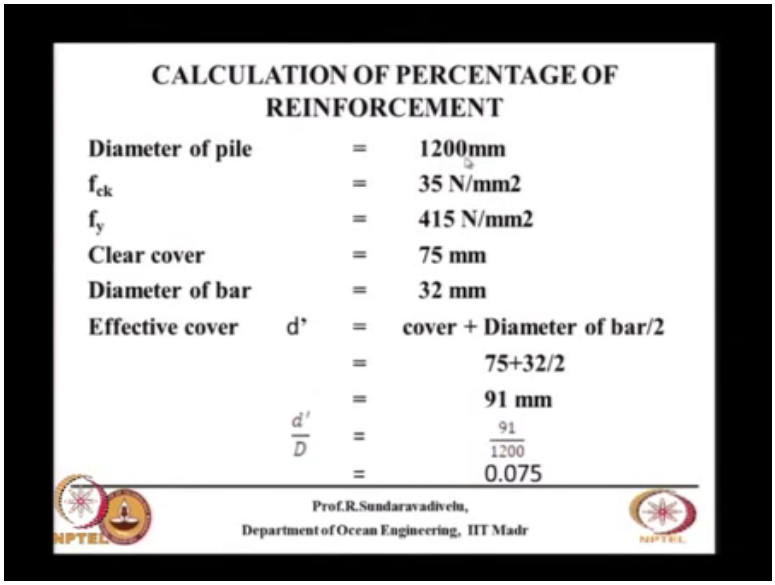

We have to assume the diameter of the pile even before starting the analysis I told the span by depth ratio can be around 12 to 15 for the piles.We have to assume the grade of concrete, nowadays we use 500 yield steel clear cover is 75.

Diameter is 32 then this is cover plus diameter by 2, this will be the effective cover, nowadays the clear cover is defined as a clear cover from the distribution sheet, earlier days it is designed as a main steel now it is form the distribution steel so that means you have to add cover clear cover plus distribution sheet is 12mm plus diameter of bar by 2 then you have to calculate a factor called as d dash by d.

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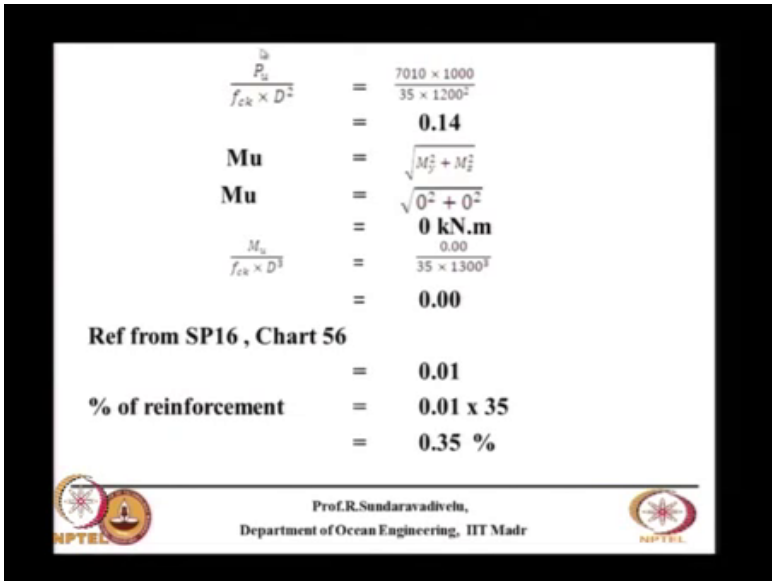

Then you have to find out these two factor pu by fckd square and mu by fckdq this we are using it to get it from the chart sp16 the chart number 56

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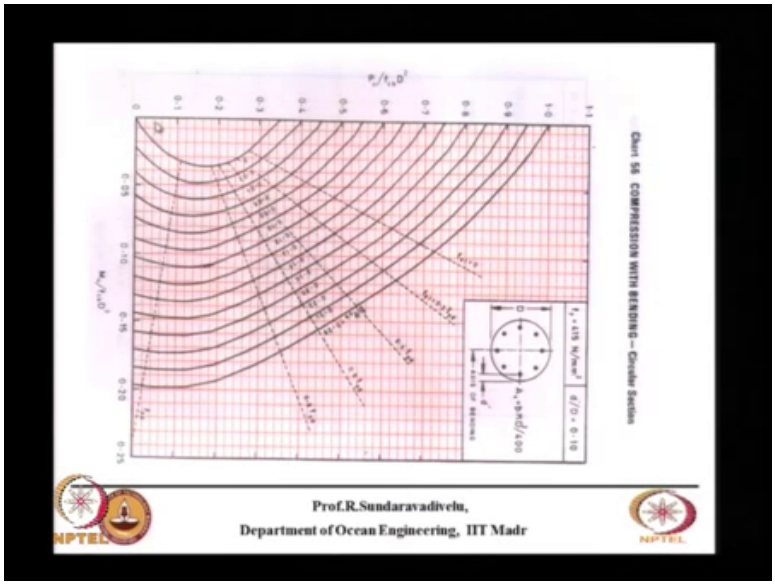

You go to the chart this is a chart which gives pu by fckd square in one axis another axis you get mu by fckdq here it has shown the grade of steel here it has shown the dd dash by d ratio 0.1

What it finally gives is the percentage of steel, percentage of steel is written here what it shows is these numbers what is mark here.

These are p by fck it is written here p by fck percentage of steel divided by strength of concrete

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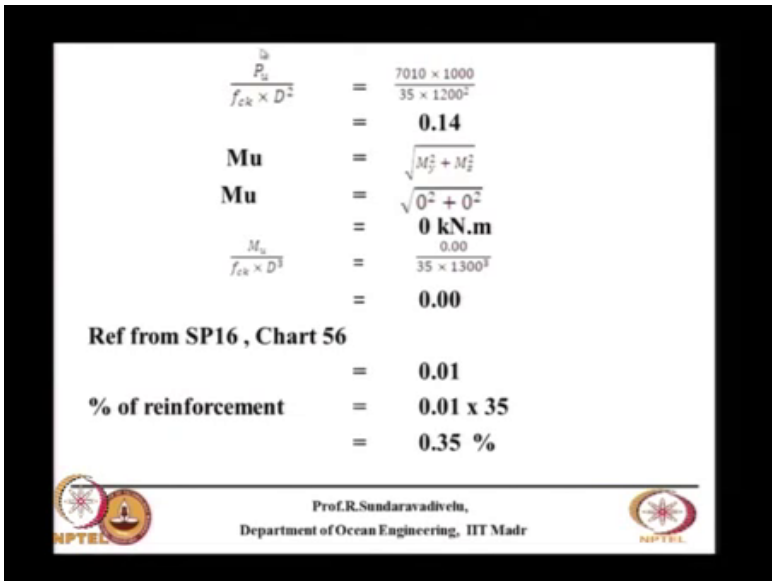

So the earlier case mu by fckd square is zero pu by fckd square is 0.14 so 0.14 is here somewhere here that means we don't need any steel that's all it shows but (the if you) if that point comes somewhere here let us say typically we don't want to put anything more than 0.1 the typical level what we use is 0.5, suppose this point is there this is about 0.02.

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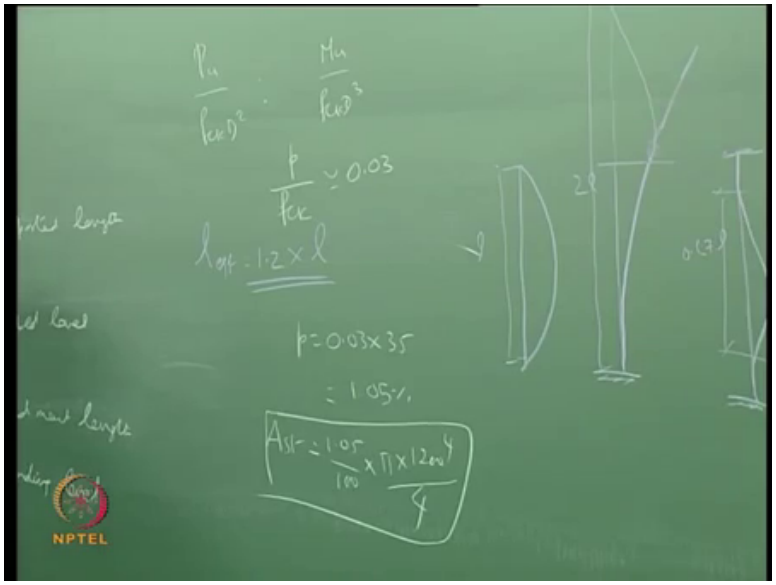

So for those who have not used the thing, I will just write down we will have what is known as pu what is known as mu, what you do is you calculate pu by fckd square you calculate mu by fckdq you go to chart and find out what is known as p by fck approximately this is equal to 0.03

it is coming p will be 0.3 into fck is 35 so it comes around 1.05 percent so ast will be 1.05 by 100 into pi into 1200 (42:44 add square by 4).

What we are finding out is what is a area of steel to be provided is it clear. The design what we are calculating is how much area of steel we have to provide how many number of berths we have to provide that's what we are calculating is it clear or not clear, from the analysis you get the axial force and bending moment if you are not done the b delta analysis the bending moment you have to add additional moment due to eccentricity.

(43:11 If you directly up build and analyze it) you can take the moment directly calculate pu by fckd square and mu by fckdq and go to the corresponding chart, this chart is having d dash by d is equal to 0.1 the cover is more d dash by d can go to 0.15 the diameter is less also d dash by d may increase so based on that you get all these values get p by fck there is one more value given here suppose your point lies here that means your stress and steel is this fyd.

That is the stress and steel if it 415 the point lies here the steel is yielding suppose the point lies somewhere here the stress and steel is 0.8 suppose if the point lies here the stress and steel is 0.6 so you can get the stress level in the steel also typically the stress level in the steel shall be kept less right,

So we have one more case that is your axial load and bending moment since it is a circular section you can get the resultant moment. Now you go to the chart we get 0.02 then you get a steel of 0.7 percent so it is 0.05 and 0.06 so we will see this here, this is 0.06 somewhere here and this is point but it is not coming although.

The 0.06 and 0.05 so this is 0.06 it is given here and this is 0.05 that is between 0.02 and 0.04 so they have not written correctly it is somewhere around 0.038, so this is not correct it is 0.038 and percentage of steel will become about 1 percent typically we have to get this between 1 percent and 2 percent.

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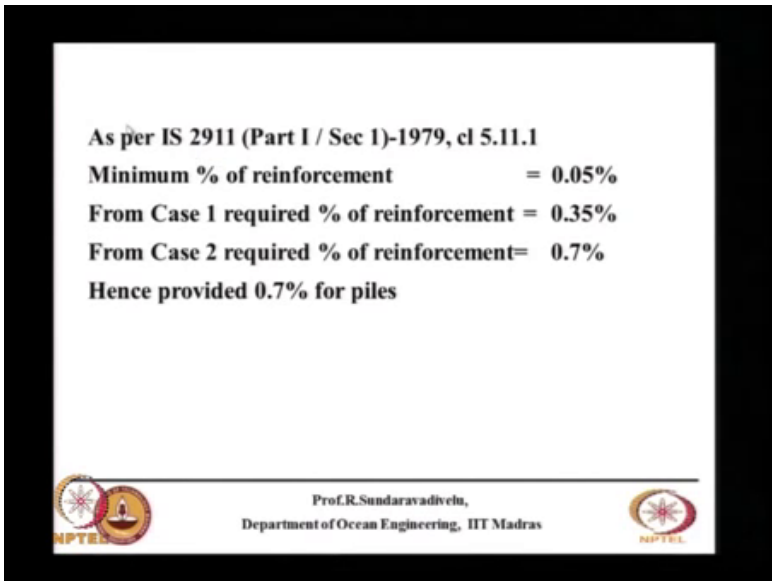

(This) there is a code call is2911 which says that the minimum reinforcement will be 0.05 but we are providing more than that we are providing 0.7 percent

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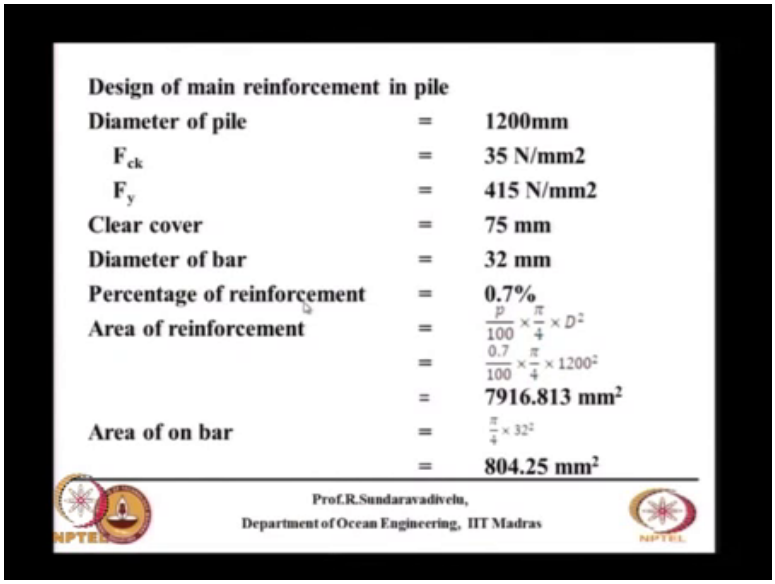

So once you put 0.7 percent it shows each diameter or theory to remember is 804 millimeter square so you put 10 bars that is what is required.

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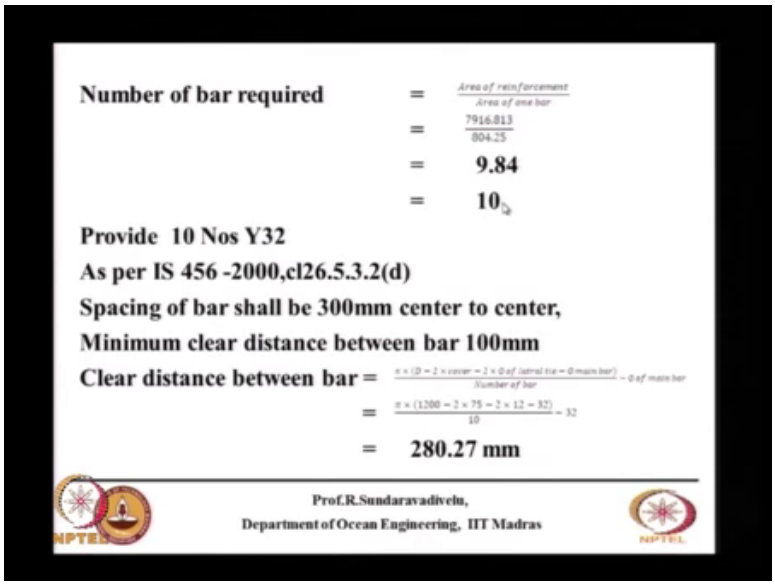

Then you have to calculate the clear distance between the bars it should be more than 100 millimeters that is another thing which you have to see.

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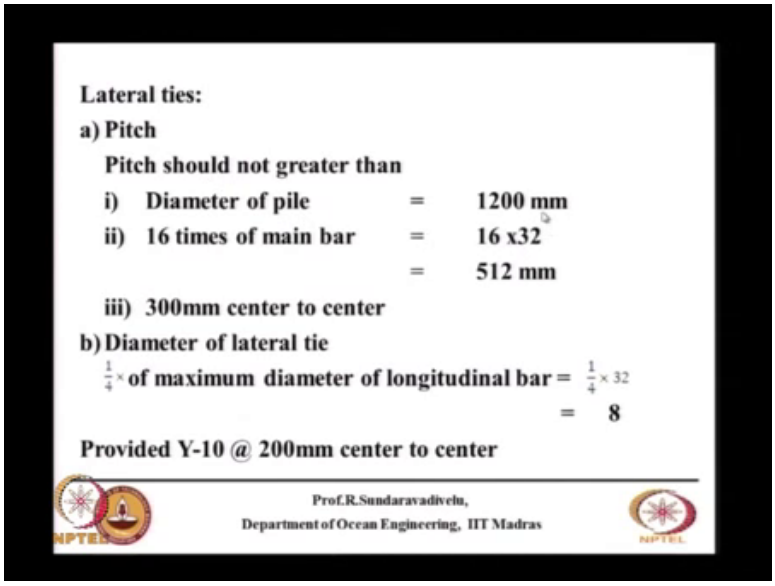

Then about the lateral ties you have to find out what is the diameter of the bar pile that is a distance between the lateral ties so (what) finally what we are doing is how many bars are to be provided.

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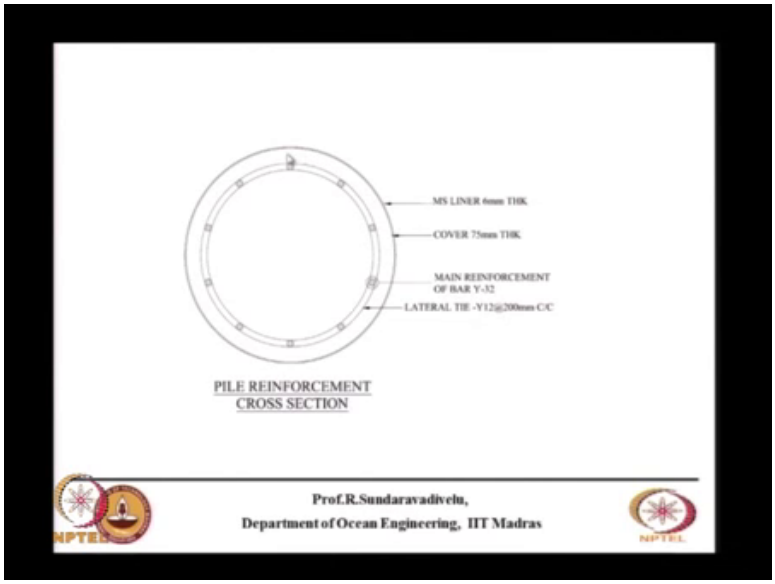

Number of bars the clear spacing between the bar should be more than 100 millimeters this is the inner bar is for holding the bar in position that is typically about 16 mm bars are provided at 1500 millimeter center to center.

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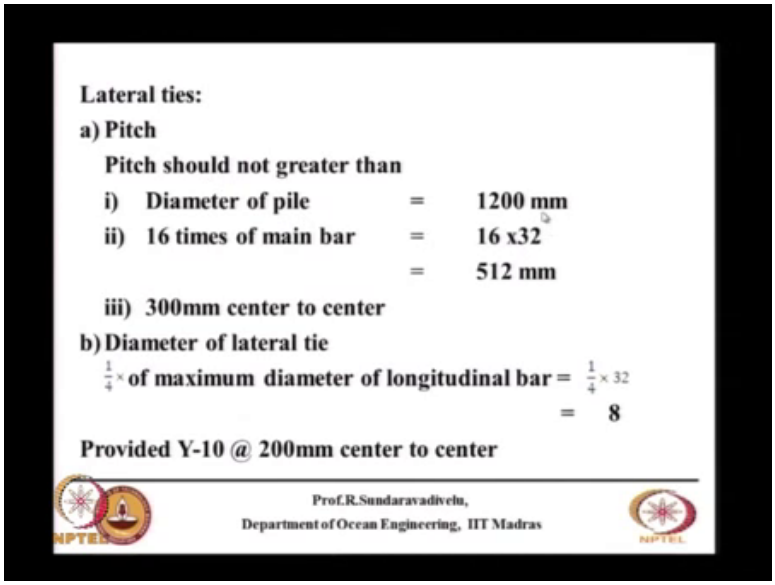

The outer bar is the lateral tie the spacing is limited by three consideration that is what is shown here diameter of the pile 16 times the main bar 300 mm center to center, and the diameter of the lateral tie should not be less than one four the maximum diameter longitudinal bar these are given in is456 based on which we design what is a lateral type o equivalent under center to center

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You see how they are tying the bars

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They are transporting by barges.

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They are lowering it into the pile this is the cover block this is the liner what is already driven under.

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This is concreted up to this the top concrete will generally be not good they have removed some top concrete here you have to provide this bars slab bars so that you can connect it to the beam section.

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So this is reinforcement detail for the pile cap ok, we will see in next class.