Port and Harbour Structures
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Module 4, Lecture 19
Types of Berthing Structures

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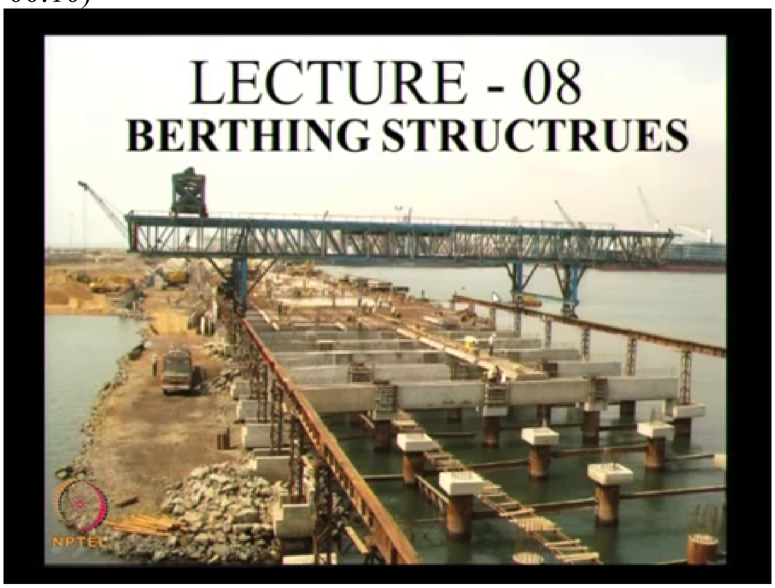

So berthing structures are built using piles, this structure what is shown in this slide being constructed as 5 rows of piles first row, second row, third row, fourth row and fifth rows of piles and the piles are used for building the deck also, you can see a pedestal on top of the pile which is already built there is another pedestal here what you are showing is a pile cap, top of this you have a pedestal and then we have the cranes, we have the rails being laid here.

And we have over head crane, the over head crane moves on this rail and this is use to lift this precurse beams and place on top of it so the design and construction should take care of this fact that we use the pile for temporarily supporting the chantry.

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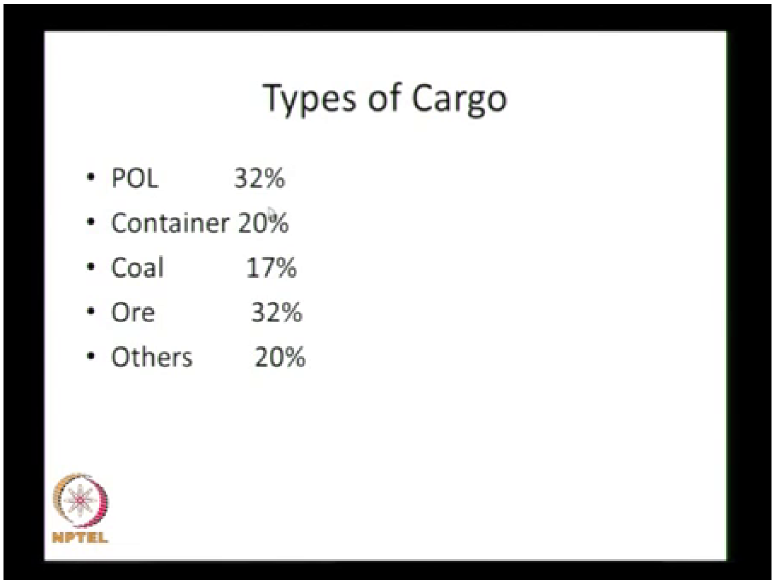

If you are going into the different types of berthing structures we should know what are the different types of cargo it handles, this is the Indian scenario Pol petrol oil and lubricant is about 32 percent, container 20 percent. Coal 17 percent, ore 32 percent the other cargos like wood, fertilizer, weed they constitute about 20 percent, so maximum cargo 32 percent is pol then container coal and ore constitute another component for which we have to design.

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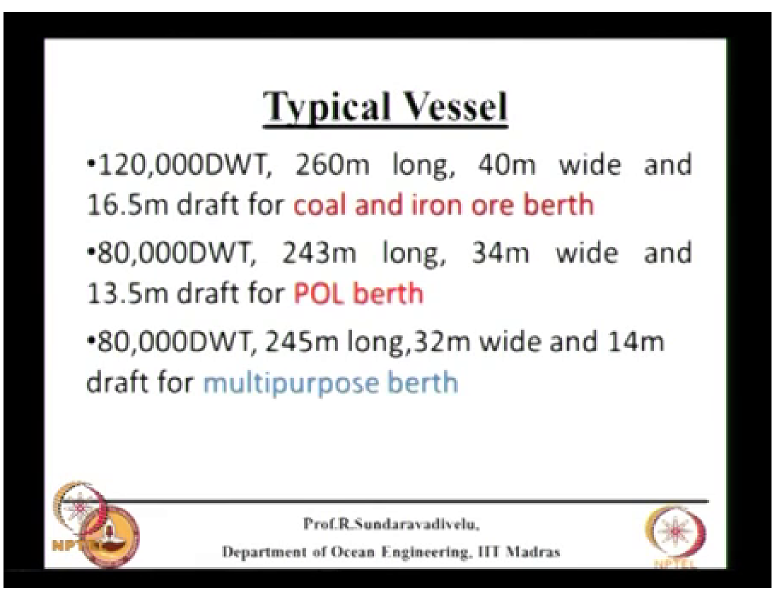

So we will be discussing about the vessel size that will be used for coal and iron ore for pol multipurpose berth this constitute the other berths as well as containers, this for a structure which we are designing for Gopalpur port limited.

Based on the number of vessels and the efficiency and optimization of cost the vessel size will be determine it is preferable to go for coal and iron ore 1,20,000 dwt vessel will be designing for this whereas we may use from 80,000 to 1,20,000 dwt vessel, so design is important that is why design vessels size if you are designing for 1,20,000 you can use smaller size vessels also, this dimensions are important about 260 m long 40 m wide and 16.5 m draft.

The draft controls the design whereas the length determines what should be the length of the berthing structure, pol berth there are two categories for pol berth one is for the product that is from a refinery if you are exporting the product then we going for 80,000 dwt vessel whereas the crude oil that is coming for refinery will be much bigger size maybe 2,50,000 dwt vessel, we may use a single by mooring system in a open sea so that I am not discussing.

We can have a vlcc very large crude carrier that can be on a berth also that also I am not discussing only for product export we have 80,000 dwt, length is 243 meters width is 34 meters and draft is 13.5 meter draft, I said about the length and the depth draft the width is mainly required, the width of the berth is a controlling factor for the (ca) cranes and other things (ca) cranes for handling the cargo the 80,000 dwt vessel length is 245 m and 32 m is the width.

And 14 m is the draft and if you see this dimensions it is not constant suppose you have 80,000 dwt you may have a longer length and longer width and lesser draft so it’s not that if 80,000 means it will have only this size depending on the size of vessel playing in the region they will decide what size of the length to be considered for the design purpose.

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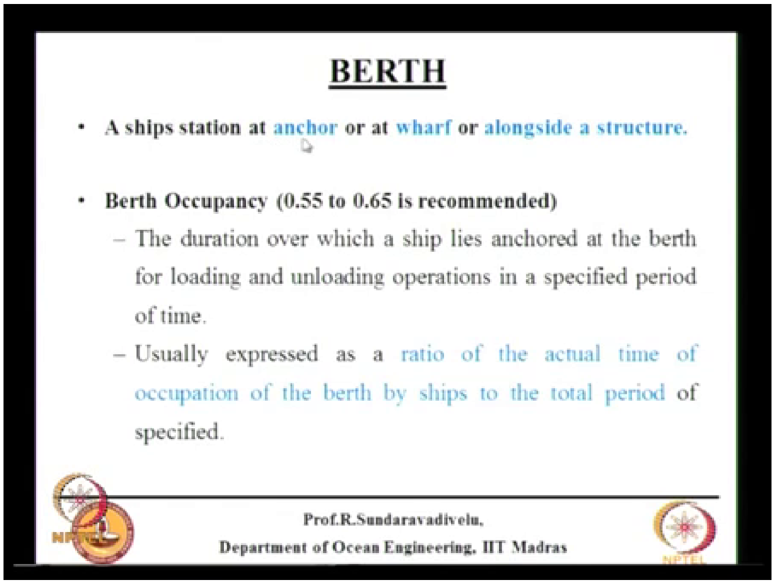

So what is the definition of the berth is given here. A ship (statio) a ship station at anchor or a wharf or alongside a structure, the berth occupancy I have discussed earlier that is about 0.55 to 0.65 is recommended, is expressed as a ratio of the actual time of occupation of the berth by ships to the total period of specify that is what is the total period if you say about 365 days you may not have 365 days maybe 300 days out of which how many days the ships are there that means 150 days.

The ships will be there in the berth that is called as a berth occupancy, so a formal definition is that duration over which a ship lies anchor at the berth for loading and unloading operations in a specified period of time, typically it is about one day or one and half day some places some smaller vessels can be unloaded or loaded even in 6 hours.

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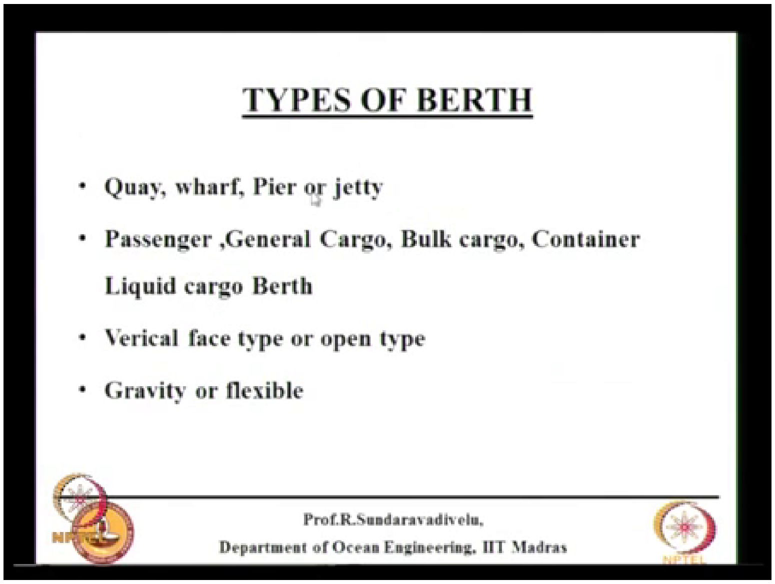

There are different types of berth we can call it as a quay, wharf, pier or jetty, I will explain this. There is the definitions differ from text book to text book but anyhow I will give the definition which I will be following in the class, we can also classify the berth as a passenger berth, general cargo berth.

Bulk cargo berth, container, liquid cargo berth, bulk cargo berth is this ore and coal, general cargo is wood, fertilizer, finished steel products, liquid cargo is that pol berth, we can also classify the berth as vertical face type or open type.

Is mostly hydrodynamic hydrodynamically open types are better because this absorbs the wave energy compare to vertical face type then we have a structural behavior where it is a gravity type structure or a flexible type structure, these are the classifications that is based on the configuration based on the type of cargo to be handle, based on the face of the structure hydrodynamically open types are better vertical face type reflects the waves.

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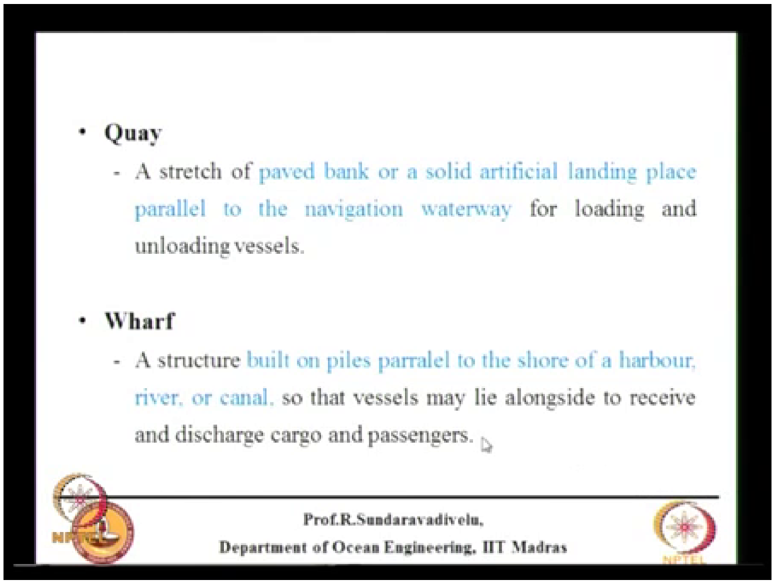

Based on the load transfer, this is gravity or a flexible type, this preferable to understand all these types if you are going into the design the quay is a stretch of paved bank or a solid artificial landing place parallel to the navigation waterway for loading and unloading of vessels, so we have a navigation water remains parallel to the inter channel.

Parallel to the breakwater, we have a solid structure that is caisson then you can call it as a quay.

Wharf is same definition alongside the (berth) breakwater but this built on piles and this is parallel to the shore of your Harbour, river, or a canal then we call it as a wharf, quay and wharf are parallel to the breakwater or coastline.

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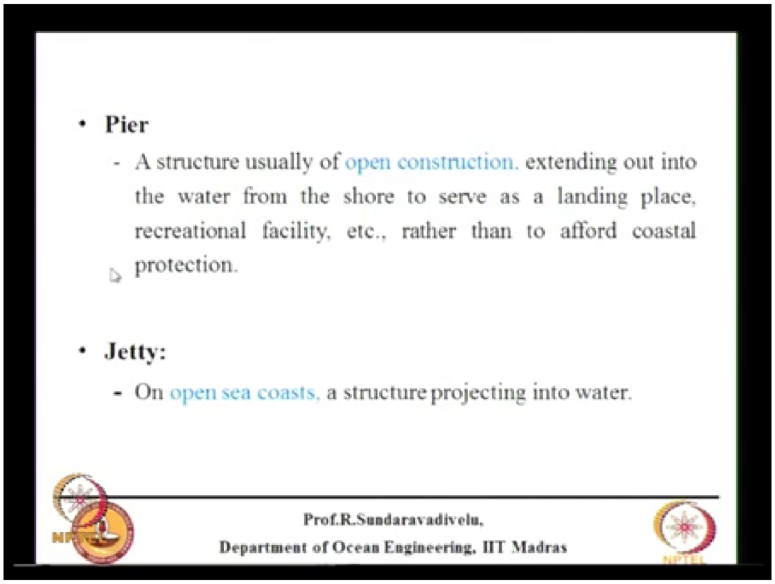

Whereas pier and jetty they are perpendicular to the coastline. Pier is a open type construction this extend into the water from the shore this serves as a landing place, recreational facility rather than to afford coastal protection.

People construct pier for coastal protection also, a structure similar to pier for coastal protection that is not called as a pier, jetty is in open sea coast a structure projecting into water but it need not have to be in open sea coast it can be inside the Harbour basin also, it’s not a continuous structure it consists of jetty here, berthing dolphins, mooring dolphins, I will show the sketch basically pier or jetty are perpendicular to the shoreline or breakwater.

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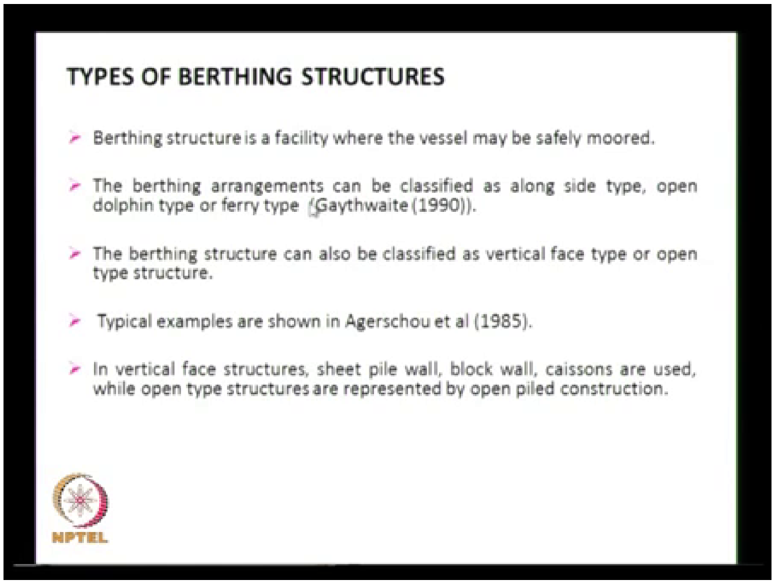

So the types of berthing structure are given in these text books Gaythwaite 1990. He has given the arrangements based on alongside, open dolphin type of ferry type, this is the other classification, the classification for vertical face and open type is given by Agerschou et al, so you can go through these two books, is gives most of the chapter what we will be covering in this course, the vertical face structure we have sheet pile wall, block wall, caissons. Open type structures are piled construction,

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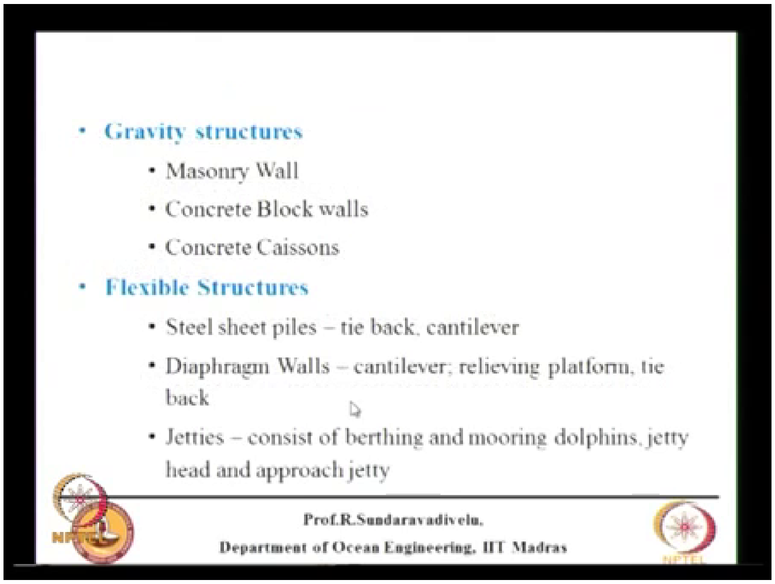

So I will explain all these things with figure, the gravity structure and flexible structure, gravity structure is masonry wall, concrete block walls or concrete caisson, flexible structures are steel sheet pile wall, diaphragm wall, Jetties.

So this type of classification the gravity structures and steel sheet pile and diaphragm wall together can be classified as a vertical face type, so you have to have a matrix to find out where it fits in.

So whatever classification we have given it will differ the steel sheet pile and diaphragm wall along with the structures will constitute a vertical face type.

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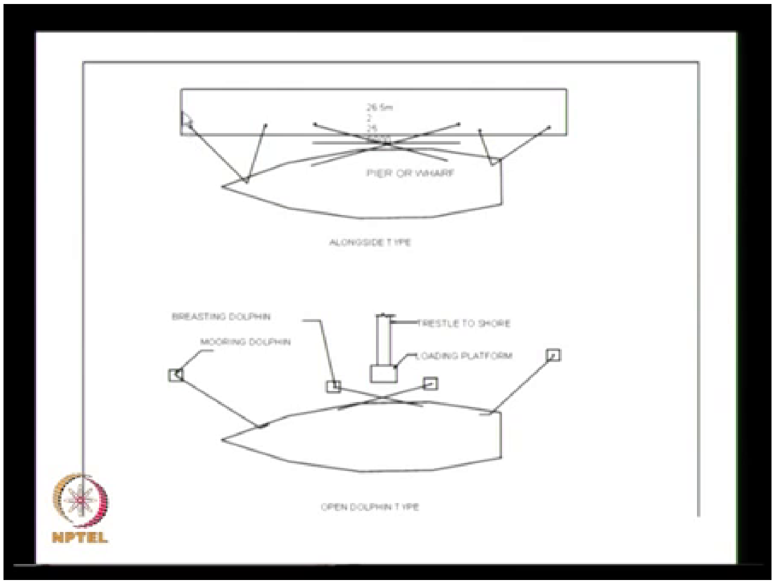

This is the definition given (by along) by Gaithwaite is the alongside type structure with a ship moved by this mooring lines, is a open dolphin type we have a trestle to the shore.

We have a loading platform; we have two breasting dolphins, two mooring dolphins, so have alongside type and open dolphin type.

The difference is this is a continuous structure, this is isolated structures here the crane will move on top of the structure to load and unload cargo from different places whereas here the pol cargo will float to the center, we will have a marine loading arm here from where the cargo will be transferred we have structure connecting this, these are called as catwalks just for a person to move from one place to another place.

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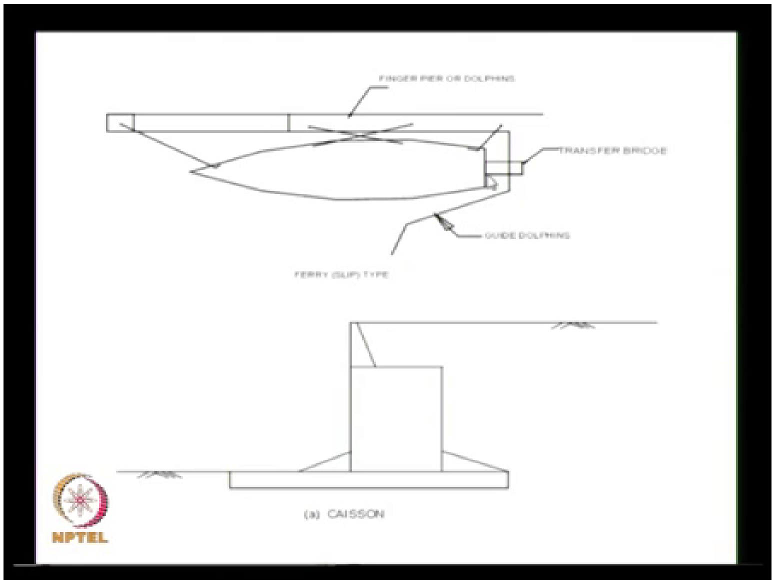

Then we have the ferry type structure. Where the ship is like this the berth configuration is like this we have a transfer bridge and we have some guide structures, dolphins the core and other things can be exported through this, this is the ferry type, you please draw the figure of all these three types, so you should be able to explain what are the three different types of berthing structures, each structure depending on the type will (ka) will constitute different type of loading.

This is the gravity type structure where below the sea bed we create a filter medium so that the caisson will get supported here and we provide some covering mechanism also on this side and water level will be like this the gravity type is also a vertical face type, this can also be called as a quay.

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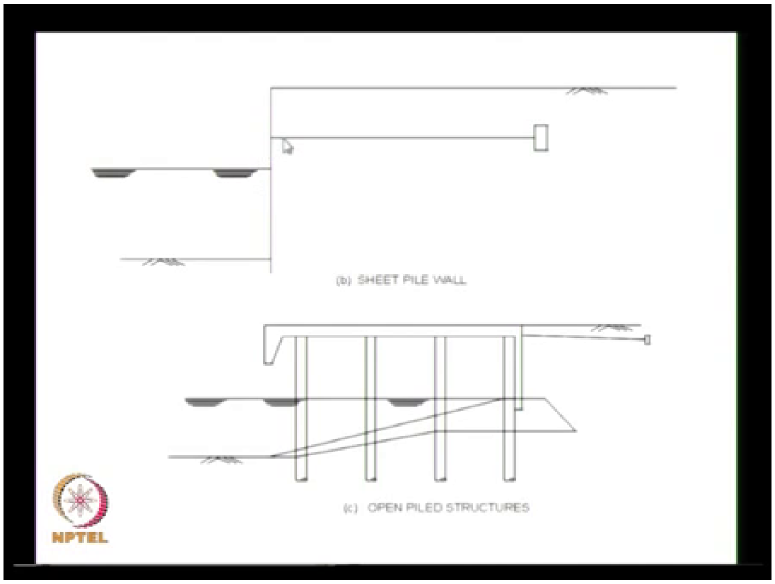

This is a sheet pile wall anchored back, this is called as a dead man wall. Is also a vertical face type, but this is a flexible type. Flexible means whenever there is a earth pressure acting on this the structure will deflect and depending on the level of deflection the active earth pressure will be formed, there will be bending moment and shear force, is also a vertical face type, this distance will be slightly more than what is shown in the figure then we have the open type structure, open type means water will move below the deck there may be a protection like this, this will dissipate the energy.

As the wave is moving here and the water depth is limited the waves will break and it will dissipate here so that way it is better, this can be called as a wharf, this can also be called as a open type structure, this can be used for alongside type also, this is the most commonly used structure in India.

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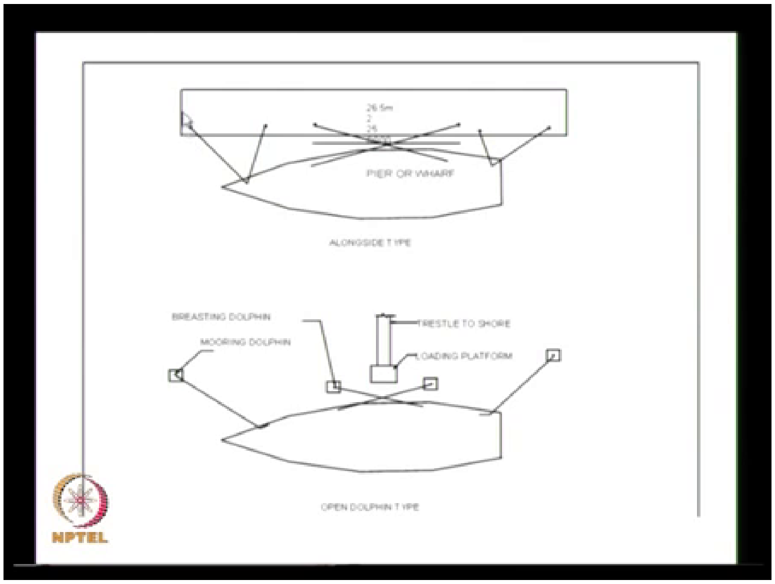

So you have to draw depending on configuration three types depending on the load transfer three types

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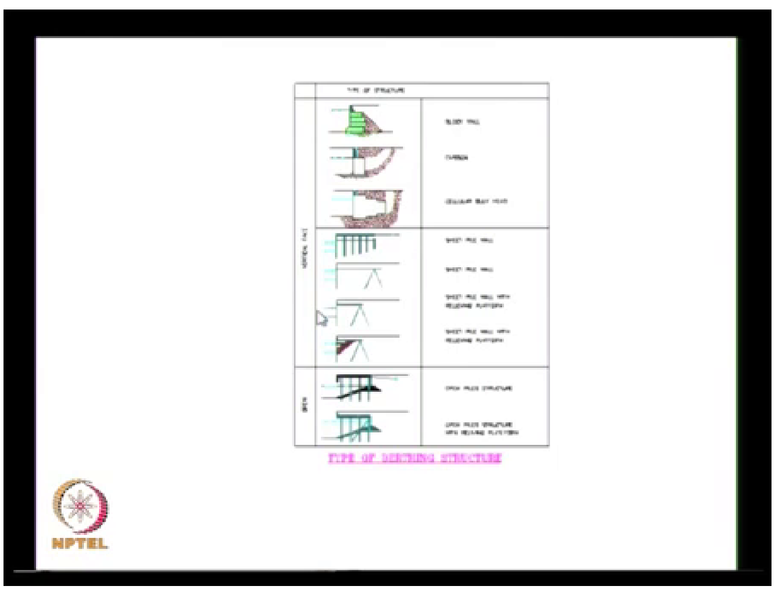

This shows the text from Agerschou book. Here we have classified all the structure as a vertical face, the structures is open type, so this particular structure is made up of block wall or lesser water depth then we have the caisson this is for larger water depth, then we have cellular bunkered is also can be used from shallow to deep waters and this is a steel sheet pile wall supported by piles and an anchor wall, here which is steel sheet pile wall connected by anchor rod to racker piles.

And here we have a deck structure here much below the ground level and we fill this with soil so that the vertical load is more, this called as a relieving platform the difference here is the deck is at the top level here the deck is at slightly lower level, this also a similar structure then we have the open pile structure here we have an anchor rod for this retaining beam, here we don't have a anchor rod for the retaining beam and here we have racker piles also.

Vertical and racker piles, racker pile means it is inclined, typically the racker piles are one horizontal to three vertical to one horizontal to six vertical that is slope normally they drive the racker piles otherwise the construction will be difficult,

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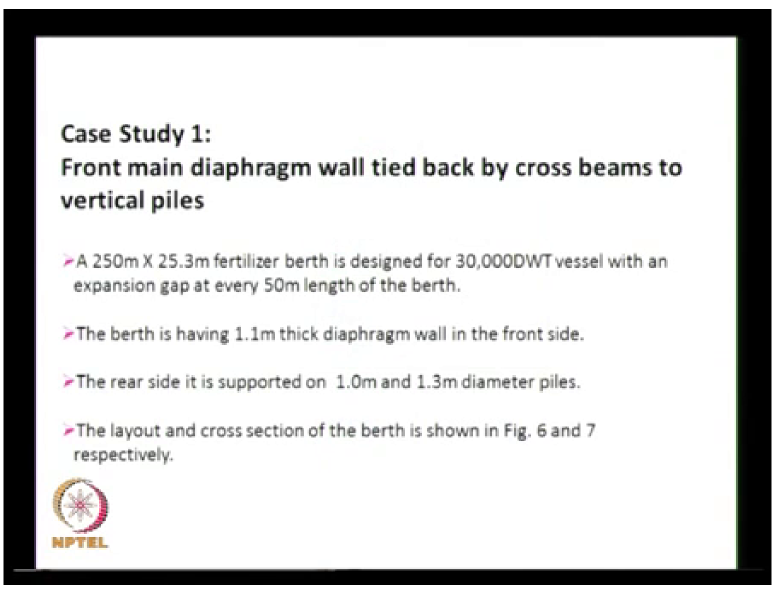

So we will be discussing different case studies. The first one will be for a structure here.

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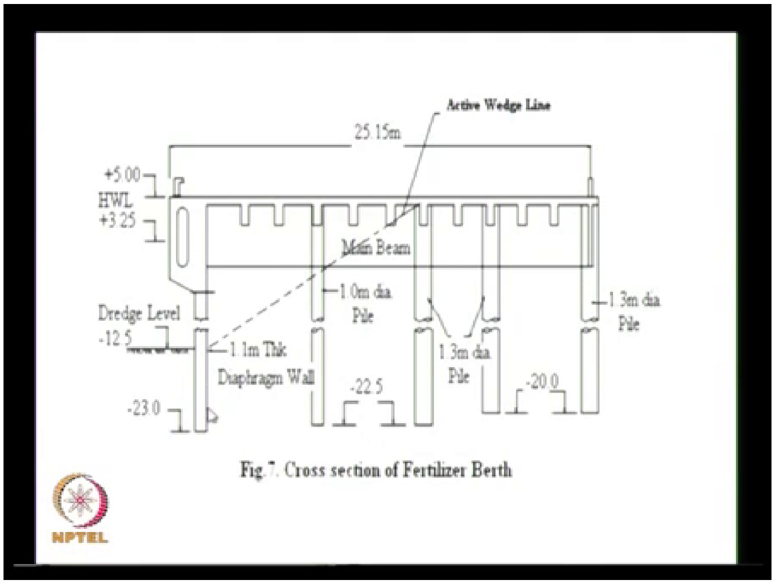

Fig.7. Cross section of Fertilizer Berth

The structure consists of different diaphragm wall with number of vertical piles with a top (crey) cross beam.

And this is coping beam connecting the diaphragm wall, diaphragm wall is a continuous structure, these piles are different diameters 1 m, 1.3m, 1.3m these piles are spaced at 4m center to center, when you want to do the analysis and design you have to draw a edge line in this portion the soil will be moving towards the diaphragm wall when the diaphragm wall is deflecting, so for this reason the soil will not offer support to these piles.

So if you are putting springs for the analysis you have to place the springs below this active edge line, so you don't get soil support above this for the pile, the structure width is about 25 meters and we have the bollard here the fender will be fixed here, there is a opening provided this is for services and utilities and here we have the dredge level here the deck is very thick about 3.65m that is about the height of this room, this is a very old design built in 1980's.

We have lot of cross beams also but nowadays we go for a much slender tech system, here different levels are mark the structure is built in Bharat import, top level is about plus 5 meters, high water level is plus 3.25 then dredge level is minus 12.5, the founding level is minus 23 meters, so minus 23 to (pl) plus 5 that is 28 meters that is equal to about ten store building approximately,

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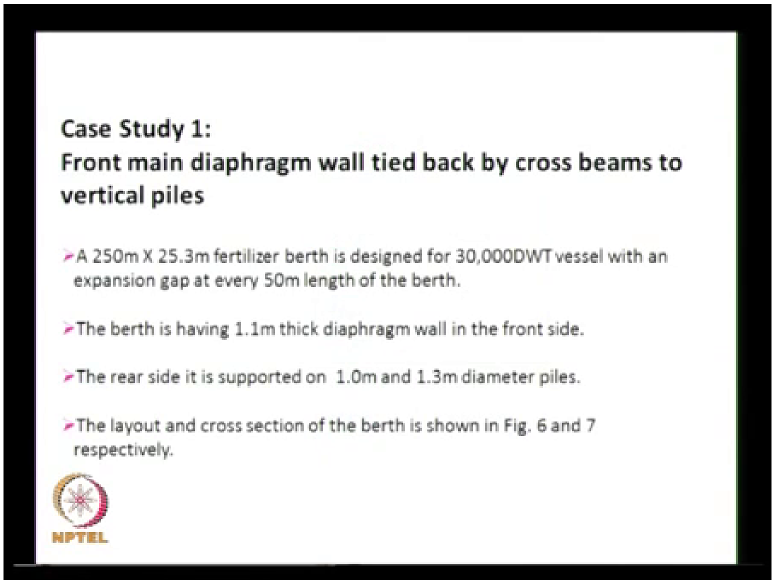

So the length of the berth is 250 meters width is 25.3. And the vessel size is 30,000 dwt and we provide expansion gap at every 50 meters, suppose we have the berth is 250 meters we don't build for 250 meters, every 50 meters we provide a gap,

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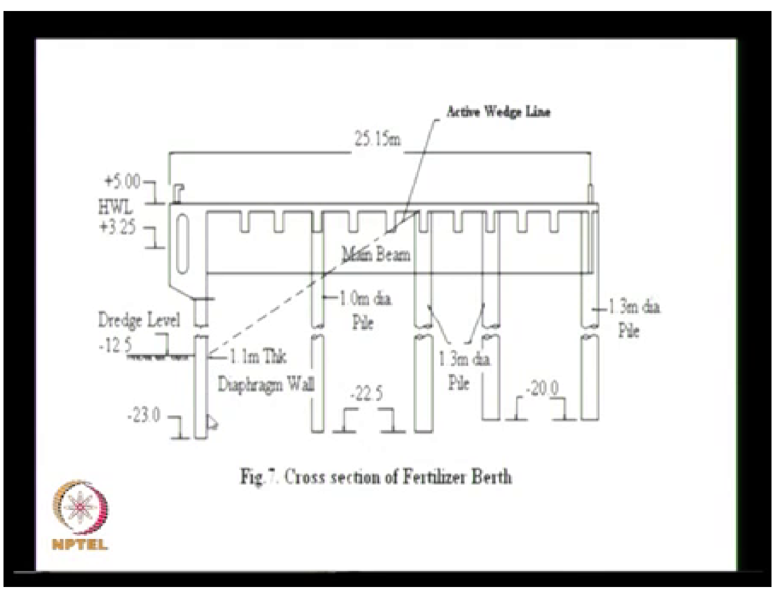

Fig.7. Cross section of Fertilizer Berth

In next lecture what we are see we know the problem for this type of structures here, once you have the diaphragm wall in the front it has to take the full earth pressure so what we have now decided is instead of keeping the diaphragm wall in the front.

We will keep the diaphragm wall on the back, then it will become some kind of o open type structure, so you see the drawing here.

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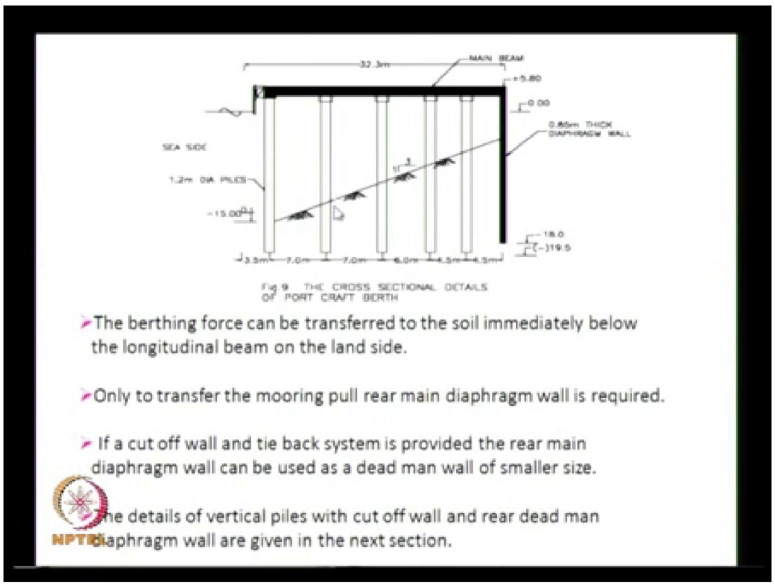

So we have the piles in the front and you have the diaphragm wall on the back, (you) in your case diaphragm wall is in the front this is design for a deeper draft, so we have dredge level of minus 15, then we can assume a slope the soil will slide like this, the slope of the soil is one vertical to three horizontal.

So in this type of slope when we provide, when we have a width of about 30 meters the level here will become minus 5, that means the earth pressure acting on the structure will be reserve the top level to the dredge level it will be the top level to the slope cut level, so here it is for a top level is plus 5.8, 5.8 to 15 that is 20.8 meter it has to take the earth pressure whereas here it will be 5 plus 5.8, 10.8 meter, the force acting is plus when the force acting is less.

The number of piles can be reduced; here we have more number of piles in the cross section whereas the longitudinal direction we have only at every 7.5 meter, earlier it was every 4 meters now it will be every 7.5 meter, so when you have this type of structure when the ship comes and hits the berthing force will be transmitted immediately behind the soil behind the diaphragm wall, immediately to the soil behind the diaphragm wall.

(We) only for transferring the mooring pull we need this forces transmitted to the diaphragm wall and the piles, if you provide one more alternative suppose you provide a tie rod and a cut of wall, this thickness of the diaphragm wall can be reduced or you can provide a beam and eliminate this also, so such a system we will give in next slide.

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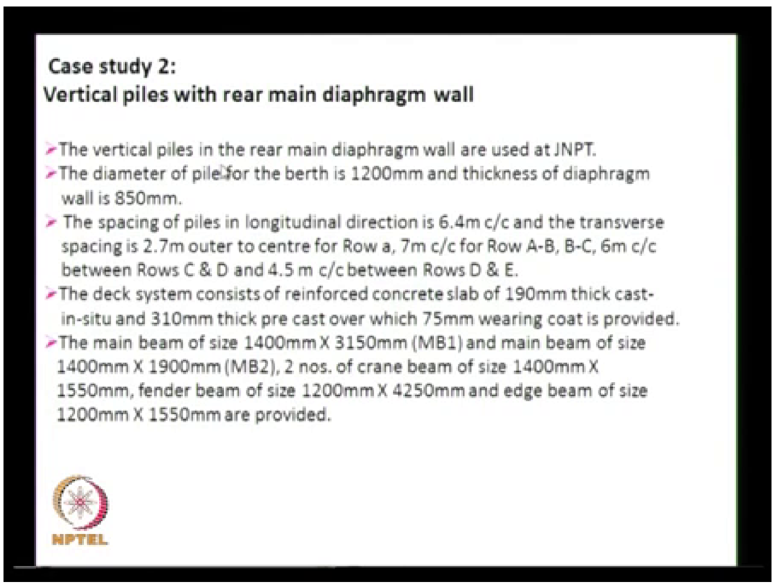

So this berth consists of vertical piles with the rear main diaphragm wall is used in Jawaharlal Nehru porters diameter of the pile is 1200mm and thickness is 850mm if we provide a front diaphragm wall the thickness will be about 1300mm that's why it is reducing I said the spacing in the longitudinal is 7.5, I think it is 6.4 meters center to center and for different rows of piles the distances are given here 2.7 meter is a distance from the pile row a to the outer phase then we have 7 meter between a and b, b and c 6 meter, c and d.

I am sorry a and b and b and c is 7 meter between c and d is 6 meter between d and d is 4.5 meter, so from this points central line to the (central lin) this the outer phase is about 3.5 meter here the spacing is 7 meter here it is 6 meter here it is 4.5 and 4.5 that is what is written in the text there this shows the plan of the berth, the each berth is having a length of 60 meter and here we are providing a expansion gap, why do you provide expansion gap?

Why do we have to provide expansion gap? What is it; ya (one) once you have a temperature variation between summer and winter, summer may be about 40-42 degrees, winter may be around 20 or 15 degrees that much temperature differents may be 15 to 20 degrees, there is coefficient of thermal expansion is there right, if the structures are too close without a expansion gap, when it is expanding it will transfer some force.

And sometimes it may crack the structure also that is why we provide a expansion gap, similarly when there is a earthquake that is taking place what happens to the structure, structure also oscillates when it is oscillating when there is no sufficient gap, one structure will hit the other structure, the third is when the soil profile varies over a length of 250 meters soil profile may vary the first block of 60 meter may have rock cut minus 15 meter level.

The second block may have rock at 25 meter level, third block may have at 20 meter level, so the foundation depth may vary, the foundation depth varies your deflection varies due to horizontal load that also you should take care is it clear, three reasons only your friend has told that is due to temperature, temperature there can be expansion or there can be shrinkage also, the second is due to seismic force any lateral force it can be due to wind force on the crane.

Wind force on the structure, it can be due to berthing force, it can be due to mooring force, berthing force and mooring force may have a component along the direction of the berth need not have to be perpendicular to the berth, once you have a force they are perpendicular parallel to the berth then there will be deflection that also you have to see.

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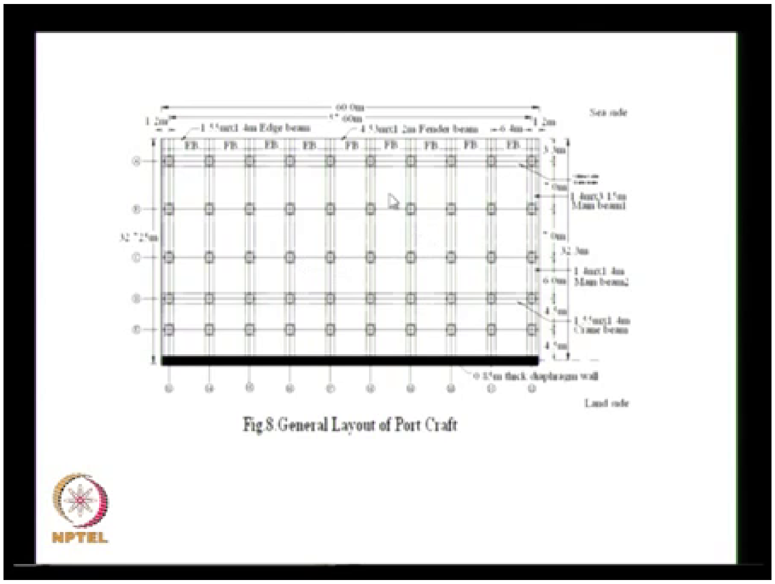

Fig.8.General Layout of Port Craft

Another thing is deflection due to earthquake can be increase that means if we have two structures side by side. This can move together in tandem or sometimes when this is moving this side, other structure may move opposite side that also you should take care.

Third is a foundation the foundation need not have to be same at all the places for that also you have to take care, so here this is the plan of the structure, this is the sea side and we have provided two beams, one is the beam on the sea side another is the beam on the land side this is the center to center of the crane beams.

These are the piles, this is the near diaphragm wall and from this point to here is about 3.3 meters, here we provide bollards as well as fenders so we need a fender beam here and these are the cross beams which are connecting and the slab is positioned on top of the structure,

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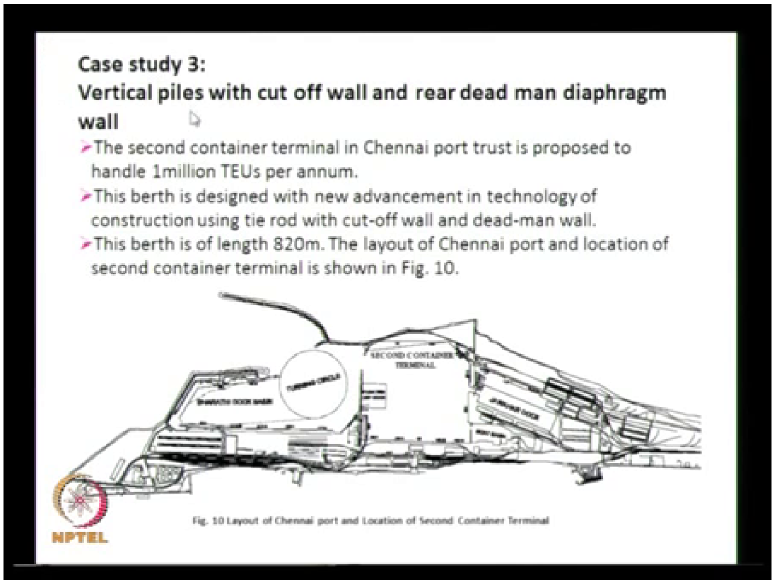

So the third case study is the vertical piles with cut off wall and rear dead man diaphragm wall. So what we are trying to do here is instead of providing like this the diaphragm wall.

And having a natural slope of soil one in three we provide a rock to embankment so that the bed level instead of minus 5 it becomes 1, so we provide a embankment here like this and provide a cut off wall with a tie rod and a dead man system,

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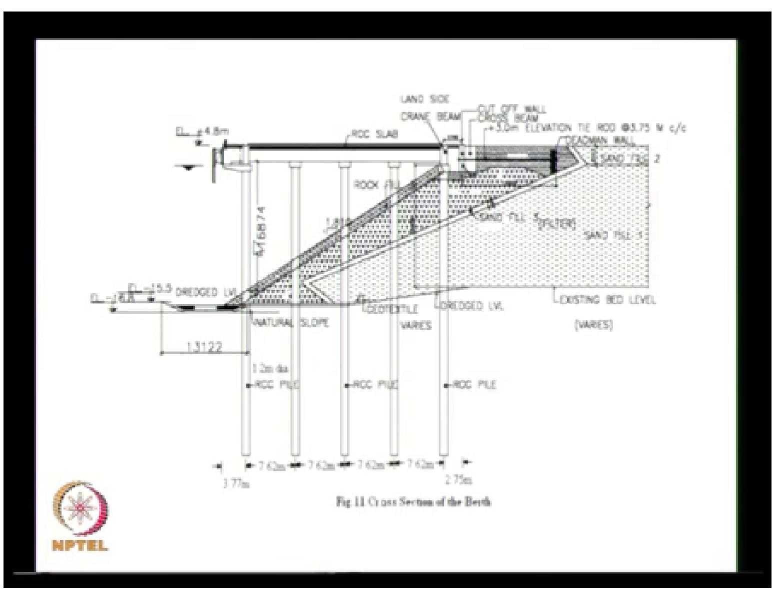

So we will see the figure this very recently built. This is built in 2000, 2000 may 2006 or 2007 the earlier structure Jawaharlal Nehru porters is built in 1995 or so the other one was built in 1980's.

So three decades how we are improving we are telling here the dredge level is minus 15.5 built in Chennai port, here we have top level is 4.8 we have a natural soil here one in three slope what we are doing is this is the natural, actually the structure we are filling on this side also we see the structure here this is a second container terminal, we are (billing) filling it on the this is the breakwater we are filling soil here also that is why in the structure if you see.

We have a sand fill here then we have a filter layer then we are also filling it with various types of stones and make the slope one vertical to 1.8 horizontal this is one vertical to 1.8 horizontal so that the slope line cuts very close to the deck where we provide a cut off wall then we provide a (tie b) tie bag in a dead man wall system so we are avoiding the diaphragm wall, when you avoid the diaphragm wall, is a continuous structure so we save lot of money.

This for all vertical piles and the deck system and we provide beams here in the front as well as here so we have only this much as width of the container crane that is about 30 meter, we have provided the cross beams here when the slab is supported between the cross beam so this structure is much more economical compare to any other structure, this tie rods what you are placing the location is important, location is at place 3 meter this can be placed above or below.

Also depending on the location the force will change and this tie rods are placed at every 3.75 meter center to center, here the spacing of the piles in the longitudinal direction is about 7.5 meters so (we) in between cross beams we have one more tray back system any doubt in this, I am discussing about three systems, the first system we have the front diaphragm wall, the second system we have the rear diaphragm wall, the third system we don't have any diaphragm wall.

First system in the front diaphragm wall takes all the earth pressure, the second system the natural slope for the soil one in three is used to reduce the force on the rear diaphragm wall, the third system the rear diaphragm wall is completely eliminated by providing a top fill embankment with a slope of one vertical to 1.8, so if it is a soil one in three only will be stable we put rock one in 1.8 will be stable, if it is a very soft clay one in five will be the (29:54 sloble) slope.

This angle of repost it is related to if you dump the soil there will be a slope which will be formed naturally that is a soil what we are taking as a natural slope, if it is a very big (fold) boulders even you may have one is to 1.5 slope, size of the slope before designing any berthing structure we have to explore various alternatives, I have given three alternatives may be I may sound that this is the best alternative but depending on some of the site situation.

This may not be the best alternative, sometime I may use front diaphragm wall itself as a good alternative ok go by what , this is for a particular situation if you have marine soft clay and all may be we may go in for a front diaphragm wall in Vizag port Vishakhapatnam port depends on the situation, so this second container terminal this is in Chennai port this proposed to handle one million teu, what is teu, the biggest port in the world handles 45 million teu.

Biggest port in India is Jnpt which handle 4 million teu, Chennai port handles 2 million teu, the biggest port is container port is in China Shanghai, the next biggest is in Singapore, so we are so much behind, this berth is about 820 meter long over here, so I may arrange a side to side to Chennai port sometime, (class talk skipped)

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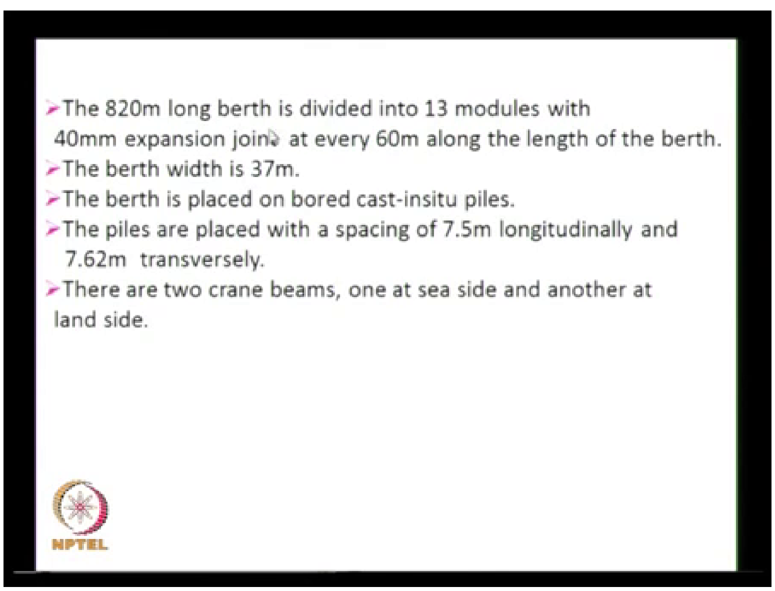

The 820 meter long berth is divided into 13 models each model is about 60 meter with a expansion gap of 40mm. The width of the berth is about 37 meter, the berth is placed on bored to cast-insitu piles so when you talk about piles we have different types of piles, we have bored to cast-insitu pile,

we have driven cast-insitu pile, we have pre cast piles, I will not get into the details of all these variations but you please be aware that there are different types of piles, the spacing of the pile is about 7.5 meter in the longitudinal direction, so about 7.62 meter in the transverse direction.

There are two crane beams, one is at the sea side and another is at the land side,

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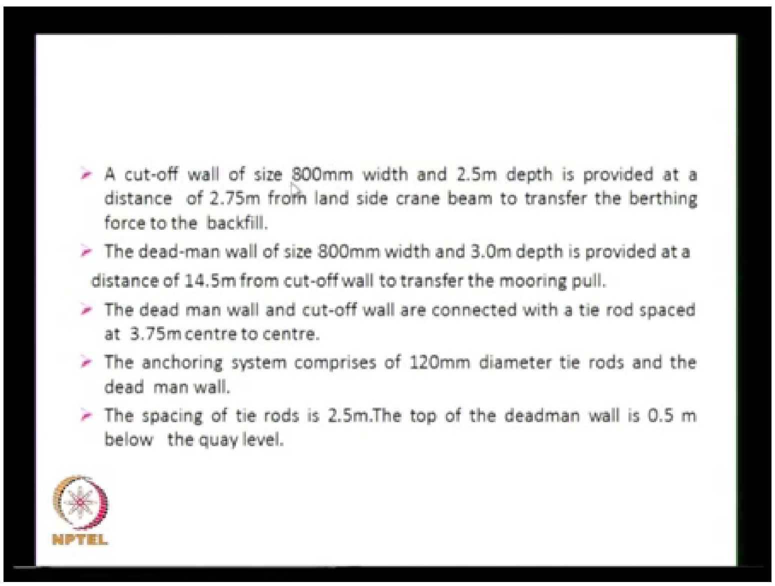

There is a cut off wall which is of width 800mm, depth is 2.5 meters this provided at a distance of 2.75 meter from the landside crane beam, this is required to transfer the berthing force to the backfill.

There are two types of lateral force one is a berthing force, another is a mooring force, berthing force will be transferred directly to the (ll) backfill by the cut off wall.

That means all your piles will not be subjected to any force from the berthing is it clear to you, if you want to economize the structure you can do it by various means you can go in for a sophisticated software and do your rigorous analysis then you can design a structure also with very good software, spread sheets but apart from these two alternatives the best way is to reduce the forces coming onto your structure or system.

When there is a berthing force if we can transfer it immediately to the backfill behind the cut off wall, none of the force will go into the pile and when you have a mooring pull, we are provided the dead man wall of size the same thing only is about 3 meter depth is at a (34:52 temporary distance) of 14.5 meter from the cut off wall to transfer the mooring pull, I will show this here this is your dead man wall, this is your cut off wall.

When you apply the berthing force immediately (blay) behind the cut off wall, the force will be transferred to the backfill, if we pull it through the (molab) bollard from the cut off wall you go the dead man wall through the tie bag system dead man wall also transverse the load by passive pressure, so what you are doing is you are you are transferring the both berthing force as well as the mooring force to the backfill, that means you are reducing the forces on the piles.

Only due to dead load, crane load, live load you have to design the pile it's only vertical force through the cut off wall size is 800mm by 2.5 meter the dead man wall size is also 800mm by 3 meter it's a very small depth and width also very small which will economize the structure this tie rod spacing is 3.75 meter center to center this anchor consist of a 120mm diameter tie rods and spacing of the tie rod is at about (the) this wrong this spacing is 3.75.

The top of the dead man wall is 0.5 meter below the quay level this we don't take the (diaphe) dead man wall right up to the top, we are keeping it about 0.5 meter below the ground surface, so when you have the passive pressure distribution you can have some effect wedge effect like this, you don't have to keep it at the top, typically the dead man wall central line should coincide with the tie rod location, this is another thing that we have to see.

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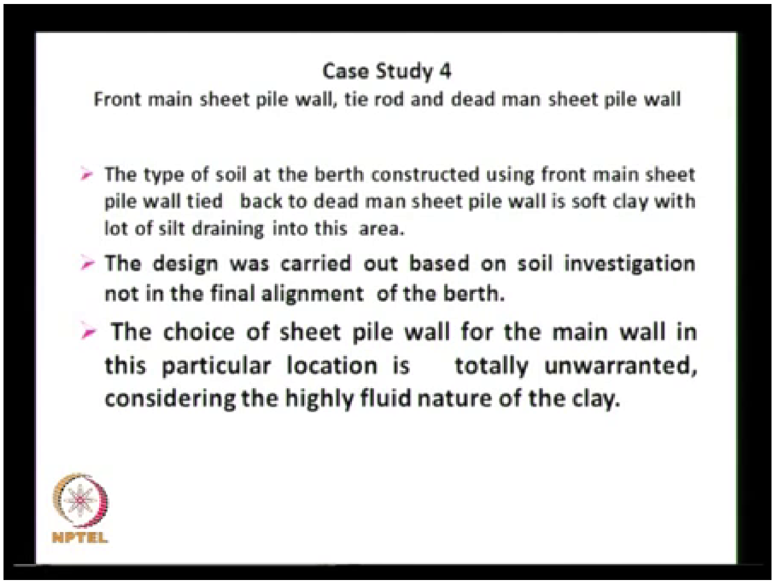

Now I am going to do show one structure which is failed very recently. Failed means about 45 crores have gone nothing can be done, this is happened in Vizag port.

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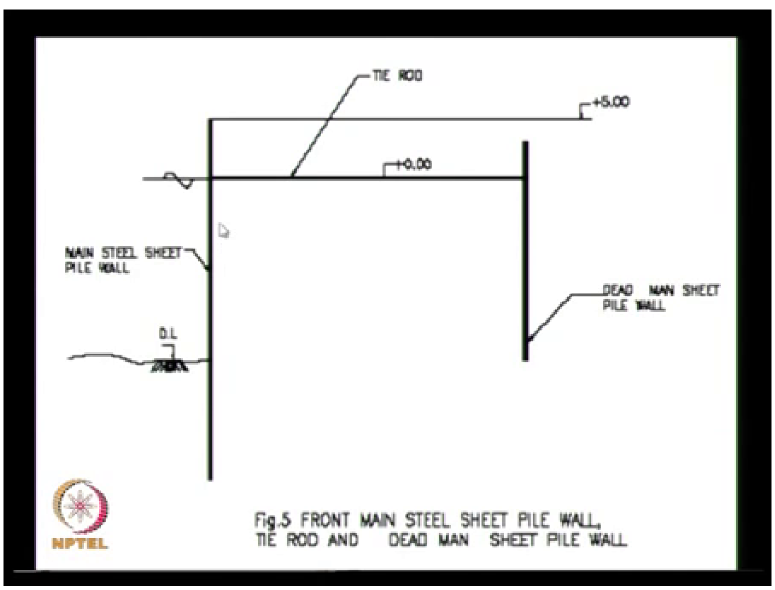

They have a front sheet pile wall, we have a tie back system, we have a dead man wall, see in this design they made mistakes. Normally when you design a structure if you make one mistake most likely to not fail, if you make multiple mistakes it's likely to fail.

This is in Vizag port where (a) where we have a marine soft clay they used a steel sheet pile wall, they have not taken it into the rock, we are steel sheet pile wall cannot be taken into the rock, that is the first mistake they have done then we have an active wedge here there is a passive wedge from the dead man wall, these two should not meet the anchor rod should be placed for a very long length so the location of the dead man wall is not correct the second reason.

I think they have kept at a distance of about 20 meters they should have placed the distances 40 meter, they have not taken the soil parameters correctly one of the class we discussed about active earth pressure and passive earth pressure you want to calculate the active earth pressure it is ka Gama h minus 2c, c value they have taken very high that means the active earth pressure is less there is a surcharge behind the dead man wall.

They have not taken the surcharge in the dead man wall in the design purpose, they have not taken the differential water pressure properly, so there are about five reasons it has failed, one is the steel sheet pile wall when we provide since the (soi) this embedment depth is called as a embedment depth, this has to be design properly, below the dredge level we have very good soil for about 4 meters below 4 meters we have rock, suppose they had soil for about 10 meters.

And (thips) depth is about 20 meters they have driven the sheet pile wall to another 10 meters, they would have done it, they have only 4 meters sand below that they have rock so they didn't want to do it in the rock that's why they stop this 4 meter below this inadequate embedment depth this has to be calculated then location of the dead man wall you have an active wedge, the soil is sliding along with the sheet pile wall.

There is no soil in front of this to take the passive earth pressure, if you want to do you have to shift it further then when the active force is to be calculated you have to use Gama h minus 2c, the c value they have assumed high that means the earth pressure is less, then there is some earth pressure behind the backfill that they have not assumed properly then there is a differential water pressure that also they have not assumed properly.

What they have done is they have driven the sheet pile wall, they have put the anchor with the dead man wall the soil level was at plus 5 at both the soil, they start excavating this side as they start excavating the sheet pile wall was deflecting and as it was deflecting more and more there is a connection between the anchor wall and this, this is given way the soil has settled they have the sheet pile wall separately bending here like this, the anchor is not connected.

The whole soil has not settled down this what is happening, nearby we are designing another structure where we are using a sheet pile wall with some rows of vertical piles connected to a by a beam and all the piles are taken into the rock and sheet pile wall instead of using, you are using a diaphragm wall concrete diaphragm wall, we remove the rock particles here for about 2 meters so 4 meter of sand and 2 meter of rock.

Diaphragm wall is going and we have more number of piles, piles even if you have a active wedge you can put springs below that and then rock it is there it will take the load, here this dead man wall sufficient depth also it was not driven, the soil is a marine soil of clay up to the dredge level so there is no sufficient resistance offered if they have taken this dead man wall sufficiently into the sand then also it will not have failed.

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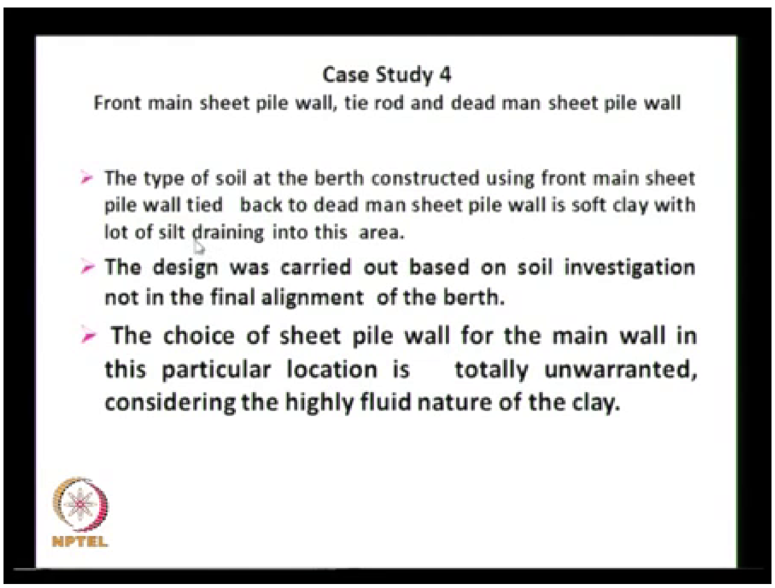

This is soft clay with lot of silt draining into the sea, when they are driving the sheet pile wall because of its own weight it gets into the it goes down, you don't have to hammer it just because of the weight it has gone the such type of soil you should not use the steel sheet pile wall, there should be some resistance, another mistake is they designed based on a soil investigation not in the final alignment of the berth, soil investigation used is at a different location.

Not at this location they change the alignment they first did the soil investigation then the changed the alignment when you change the alignment you should go in for new soil investigation the new alignment is about 50 meter away from the old alignment this choice of sheet pile wall for the main wall in this location is totally unwarranted consigning the highly field nature of the clay,

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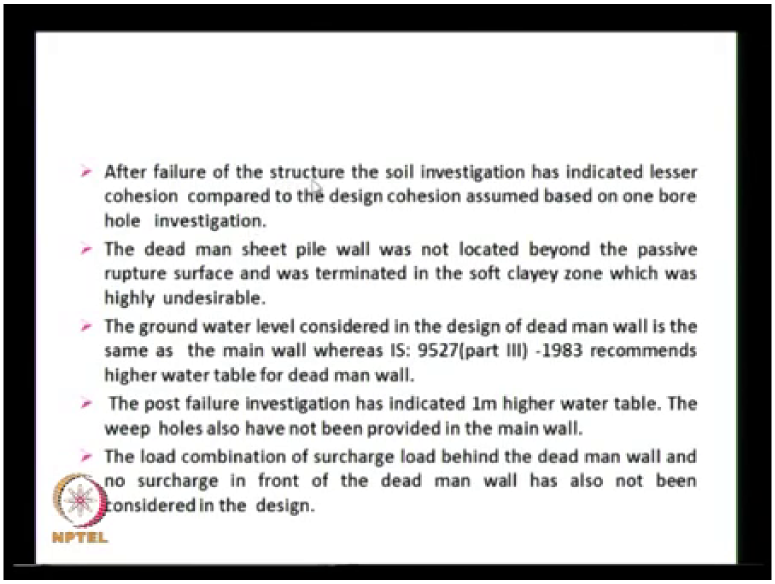

So after we have done this failure we did the soil investigation. We have got lesser cohesion compare to the design cohesion assumed based on one bore hole investigation.

Normally if the berth is 250 meters we have to take 5 bore holes the more alignment they have taken only one bore hole, we have to take 5 bore holes, the dead man sheet pile wall was not located beyond the passive rapture surface and was terminated in the soft clay zone which was highly undesirable location is wrong termination is also wrong.

The groundwater level consign the design of dead man wall is the same as the main wall whereas this is9527 recommends higher water table for dead man wall, the rear side we have a dead man wall for that is code stipulates higher water level that they have not done, the post file investigation has indicated 1 meter higher water table the weep holes also have not been provided in the main wall suppose you want to reduce the differential water pressure.

You have to provide holes in the main wall so that the water will sweep through that they have not done, the load combination of surcharge load behind the dead man wall and no surcharge in front of the dead man wall has also not been considered in the design,

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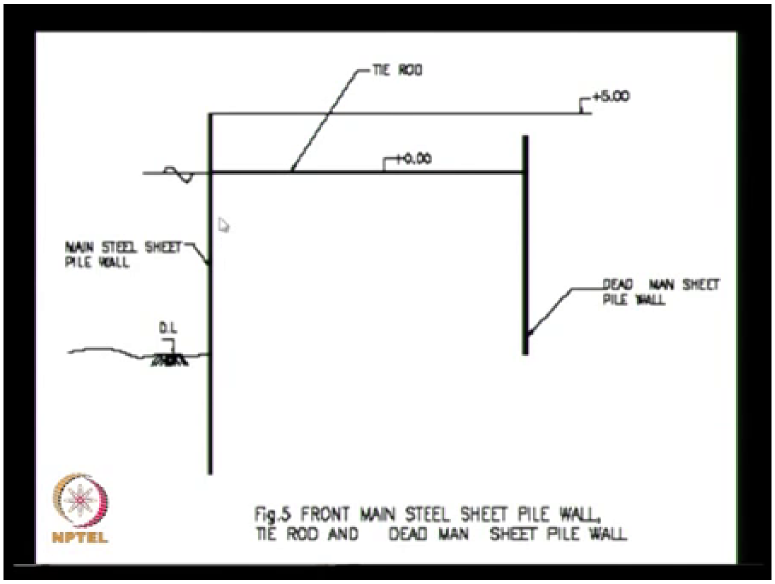

So that's why I told you but I will explain here they will stack the cargo here, but there will be one combination where they will stack only behind here, there may not be any cargo here.

There may be some crane going that condition has to be considered it is given in the code is9527 that they have not considered, the end result is they have not followed the code which has given all the specifications to be considered in the design, if you are not following that then the failure will take place ok.