Design of Offshore Structure
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Module - 02
Lecture - 03
Concepts of Fixed Offshore Platform Deck and Jacket 3

So, basically we were halfway through yesterday the float over, we will try to finish the other items in that. Then, we will continue with the design to complete the introduction, so that we can move on to design in the next I think in coming weeks.

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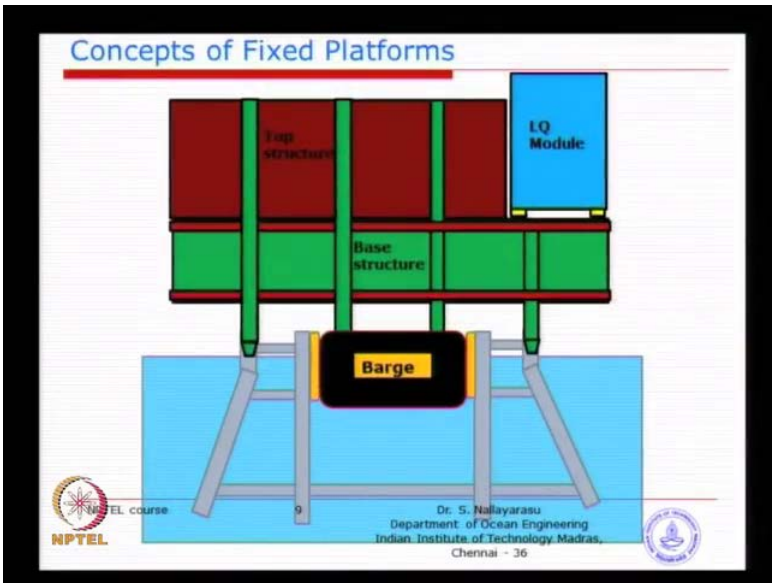

So, how it is done basically you see here this animation the bars is coming or the elevated by say 1 meter is a typical number and then come when it is into the slot yesterday you have seen the video. So, basically there will be a minimum gap maintained that gap is to make sure that accidental impact does not happen. You know during the matting process several locations will have different wave height several different sea states. So, if you if you have come very close with say half a meter or less than that due to the movement of the bars up and down you may actually impact.

So, typical numbers is about 1 to 2 meters depending on the sea state during which you are going to do this operation. So, if it is a very quite weather may be you can come with a smaller gap otherwise you have to do a larger if you see this so that that impact process

is very important what you see here is very easy, but actually it is going to go up and down.

During the process of going down and the process is not going to be so quick, it may take several hours may be three hours four hours during the process water level may change due to tide. I think most of you might have heard these tidal changes and then the sea state because of the wave height on the bars the bars may go up and down and that may create elevation change.

So, while you are ballasting water inside the bars as well you are actually moving up and down so this may create additional forces. Also, you will see that what is not shown in the animation is the lateral movement of the bars which you can see on this the sides of the bars. We have fitted with rubber fenders in order to take the impact forces arising from the movement of the bars which could damage the structure. So, once you have this and the gap between the bars and the structure is minimized the movement can be reduced substantially normally we have about less than 100 mm gap.

So, you know it does not roll if the gap is too much what will happen it will actually start rolling which may create even bigger problem. So, basically this design activity before the structure is designed you need to perform a analysis which is basically a motion response with such a big topside on top and then the sea state to be determined. So, what is the limiting sea state to which you can actually do this activity, so you will do a reverse calculation, instead of doing forward because everything else is fixed bars is fixed your topside is fixed location is fixed. So, what we want to find out during which days we can go there and then start installing this platform.

So, you will do just incremental say half a meter wave height everything is 1 meter wave height 2 meter wave height, then you find out which provides you reasonable sea state that you can install of codes no wave height will be the best situation. Then, you will go to the field and then weight for a very long time to find out there is no wave means, you may not be able to get it during say few three months. So, that is why you have to allow for the higher wave height, but then you have to work out accordingly. So, that is that idea is called float over matting analysis, this whole process is called matting between the topsides and the jack up.

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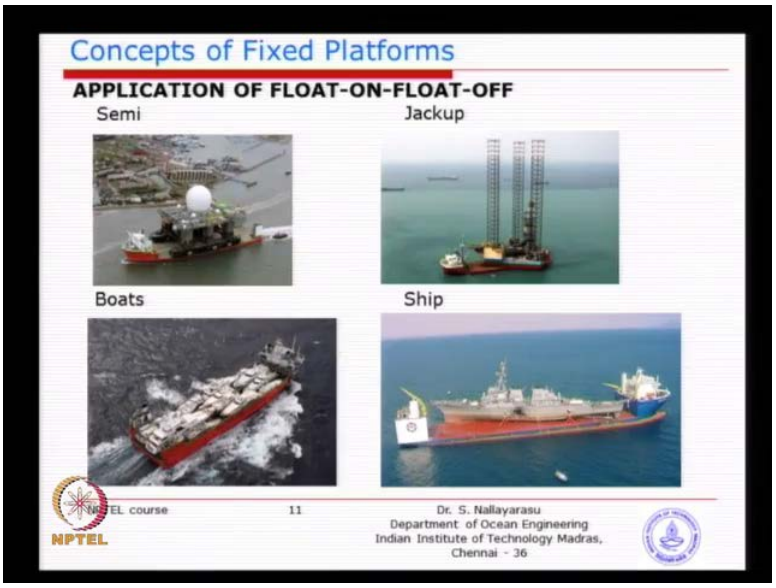

If float over also actually used in many applications, in fact last year we were doing one project in India. We were transporting a complete power plant from west coast to east cost you know this power plant is mounted on a flat bottom bars you say 220 mega Watt power plants the complete facility is on a bars. So, there it can be relocated anywhere were ever the power is required where ever the source is available like gas or fuel.

So, I was consultant for GM or they have had this in Mangalore, so from Mangalore to Kakinada, we actually loaded that whole power plant on a ship and then brought back to east coast and loaded off. So, this activity is called float on float off, basically you go, so you will see something. If you go to the next first slide, you see here the ship is carrying a floating structure which is basically a semi submersible semi submersible can float and form its functions at one particular location island gas exploration. They cannot travel for a longer distance like a sea going vessel you must differentiate between a floating structure performing island gas production and a floating structure going for transportation like commercial vessels.

They are two different classes you require different design in fact, so that is why most of the island gas applications we have floating structure like this semi submersible, I think I have shown you various pictures of different types of floating structures. They are not supposed to be travelling long distance not even short distance because they are not classed for such design. So, they are not called sea going vessels you have to have a

different classification and design that is why any design that you make for oil and gas purpose for production floating platforms.

They have to be transported by another ship you see on the first down there you are transporting a semi submersible which is perfectly alright in floating condition. When you try to from one place to other, they may not be able to survive the designed conditions or it may not be designed for such travel. So, that is why you have to load it on, so how do we load this such a big structure on to a ship is basically in a derider. You can do this operation or you can do it in an open sea condition, so both of them will be floating there you just submerge the mother vessel and bring this one on top.

Then, de ballast the mother vessel to take the load, so very simple idea both will be floating in one location and just submerge the semi submergible or the mother vessel. Then, bring it on and then de ballast to take the load go to the destination exactly do the opposite operation. Basically, you will again submerge as soon as the semi submergible comes in to sufficient buoyancy just pull it off. So, we call it float on float off and similarly, you see here a jack up jack up rig is been transported because jack up rig. If you actually tow by tuck boats they may take several weeks to reach another destination.

So, if you want to take it very quick I want to do the drilling in say next week I transport the jack up rig on a ship which is again exuberating the process you see here on this. So, many small boats are been transported by a bigger ship again float on float off thus the mother vessel will submerge. Otherwise, what will happen you will end up lifting these and putting in to which actually may not be possible because either it will be too big structure too heavy cannot lift.

When you do lifting these ships or the boats may not be able to take the stress because they are not designed for and that is basically the idea you see here another ship is being transported on a another bigger ship. So, this kind of ideas is using float on, float off in water most of the time.

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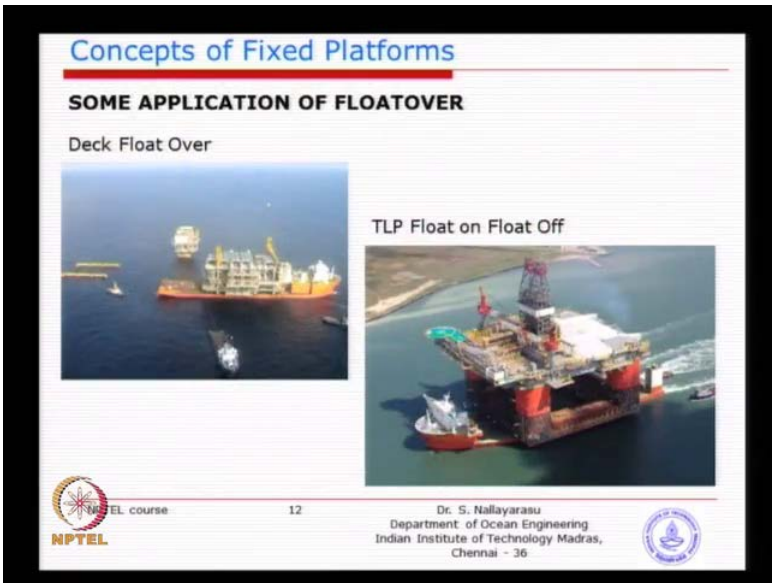

Conventionally, for island gas applications, we have two types of matting operation, you can actually do a float over or float around. For example, if you have a central column, I think I have told you a gravity platform you know what is gravity platform you have a central concrete column. You cannot float over operation because big column 20 meter diameter column is there, so you can have two barges coming on either side carry the top sides, so you can float around, so this is also sometimes used, but not very common.

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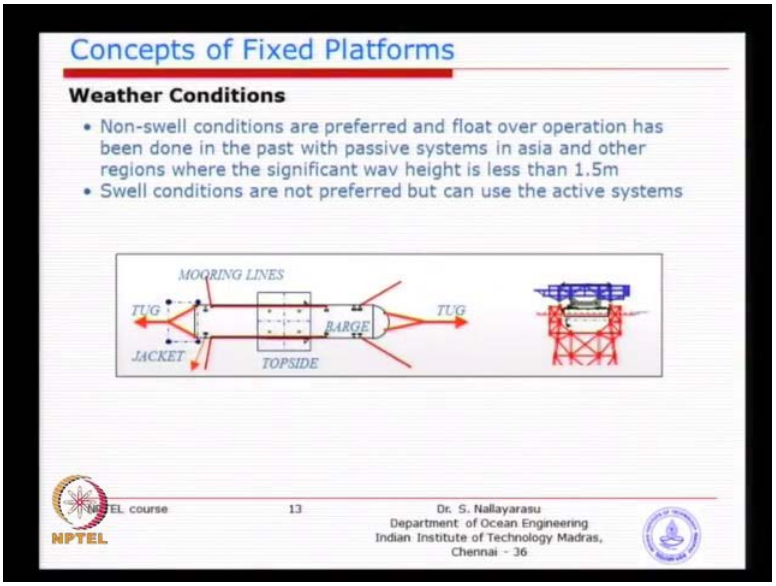

So, the video what we have seen yesterday gives you a clear idea how it is coming in and basically pulled into the legs. So, what you see here in the picture here these 1, 2, 3, 4 are the legs of the jacket which is already preinstalled and there are four additional legs hanging on the top sides. Additional four legs which is in a little light color supporting the deck on the bars, so you will have eight legs on the on the deck where as four legs on the jacket because four legs for supporting during transportation, which is in the inside. Four legs will be hanging in line with the outer lines, so when you go inside there just sit down one of the biggest problem is twelve conditions.

I think when you study your hydro dynamics codes; you will be introduced with long period waves which are potential threat to any installation. Basically, the response of floating system will be abnormally high especially for this kind of ships vessels if you have long period waves even the wave height is smaller. You will see that the response will be larger some time may go into resonance ships, if you see the natural period could be around ten may be 12 seconds. If you have wave periods also 10 to 12 or 14, you see that the hue response could be substantially higher.

In fact, we had a similar problem when we were trying to load out last year in west coast we had a very big problem because west coast is subjected to long period spells coming from you know Indian Ocean. Especially, the distance of travel is very large from Africa you could see that we could not really do it. Then, we have to do it in smelted water in one of the port because we are supposed to do it in open sea condition which could not be performed because of the shelf two times we failed. Then, we brought the whole thing in to Mangalore port where the swells does not enter and then could do the loading where as in the east coast.

We do not have such a problem, we could easily load out unload it in open sea condition very quickly, so this swells, so where ever this sea conditions are expected to be long period swells you should avoid it number one. If you cannot avoid, then you need to design it in a slightly different way with the sufficient margin and normally wave heights shall be less than one and a half meter. So, you can imagine if you go to a beach even today you will see easily this type of wave height 1 meter one and half meter. So, you can imagine the period of this installation, you will you will have a long weight load unlike the other installation.

May be you can have a slightly higher sea state where as this float over condition though it is very economical what we were talking about, but then the period available for you to get this operation could be very limited in a year. You will get may be 20 days, 30 days maximum in 2 months, 3 months and remaining period, you cannot do this. So, if you miss out this for example, then you will have to wait for the next year to come, so the whole business becomes little critical.

That is why you have to care full when you are performing this idea, so typical weather window weather window means what is the period during which we need to start this operation, the whole float over operation can take only 6 hours. The preparatory activities and the post activities after float over could take totally about 2 days, you know you should wait for right weather condition remove the sea passing and go inside get your alignment done. So, many activities will be performed during this installation.

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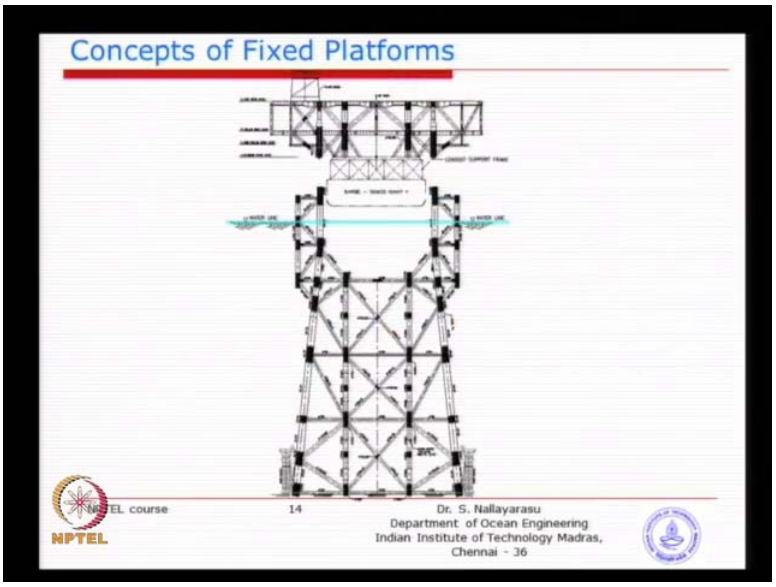

So, basic idea is that is the arriving condition.

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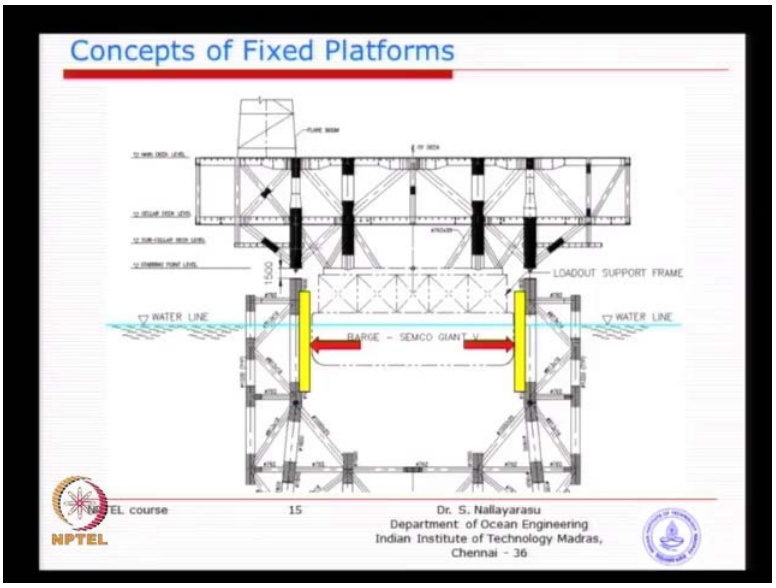

Then, you will be seeing around typical about one and half meter.

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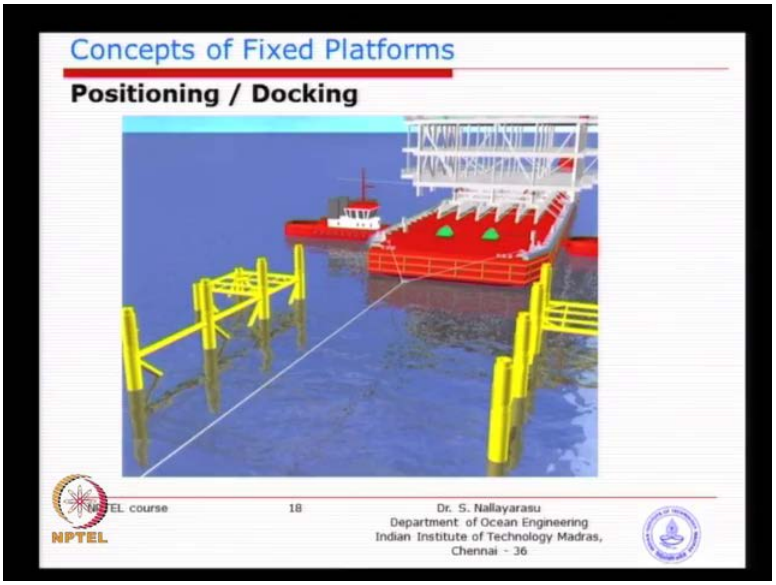

I think you have seen this video, you will be able to appreciate this, so how do we enter is a biggest problem when the vessel is such large size, you see here on the left side and right side, there are two boats aligning the vessel such that it can actually go in the slot. Otherwise, what will happen even a small deviation can damage the structure without any warning because the mass of the vessel is so high that even a smaller or the low velocity movement can damage the jackets very easily.

So, that is why you see the alignment and also you will have the wires connected to the forward ship or the boat going there some time what we have is instead of this wires going by boat, we will have a winch connected to the jacket legs. Then, the winch will actually move the ship slowly in a controlled manner or you can have a winch on the ship, but the wire is connected to jacket.

Either way, you know you can just bring it, I do not know whether we have you can see here the black color wire actually is attached to the jacket so that you will have actually criss cross wires. One wire is going from here to here and another wire is going from here to this leg, so when this is being pulled the control is there you know while this wires are connected to actually the winch. So, the winch will actually slowly rewind so that the movement of the mother vessel is slow and steady and also inside the slot directly.

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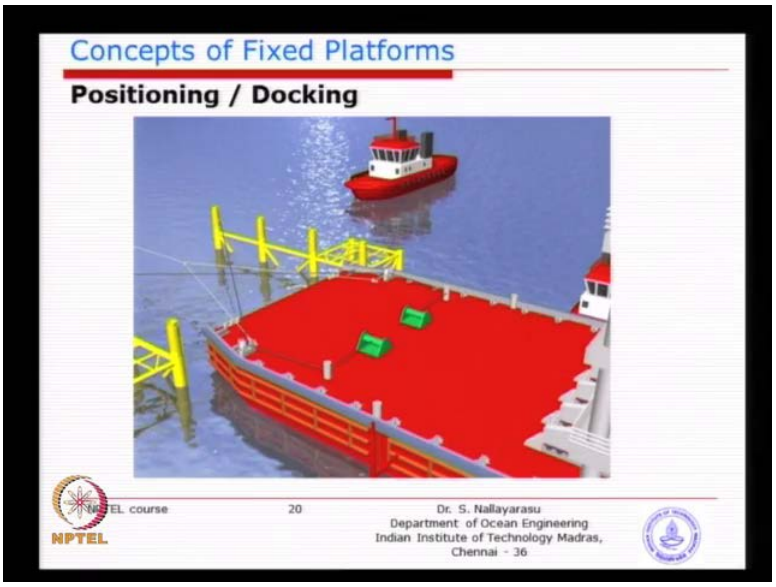

Something like this, if you see here is the winch taking the wire opposite direction, so when the whole thing is moving in it is fully controlled.

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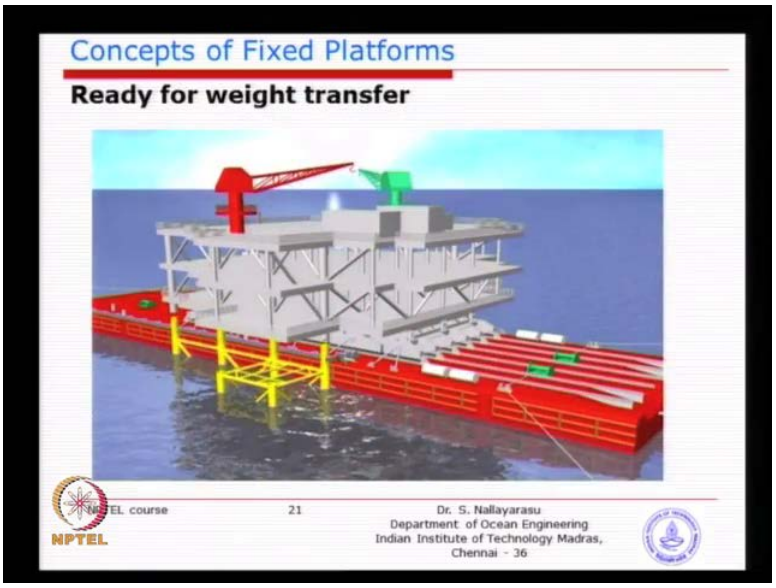

So, that is that is the critical position, so that is the time what happens is the legs are aligned. So, you do a laser control alignment first make sure the leg on the deck and leg on the jacket are aligned perfectly. Then, you start de ballasting the bars, now there is an alternative method basically whenever the situation is not right, for example you start ballasting the rate of ballast. The rate of increase of water level due to you know your tidal changes if the tidal changes are faster, then your ballast what will happen, you will not be able to touch, you will not be able to touch down at all.

So, is it a good idea to do this operation in a rising tide or the lowering tide, you have to plan it, but lowering tide is also big danger because if it goes faster than your expectations. So, what we need to do is actually at a particular site where you are going to do this installation look at the rate of change of tidal elevations and make sure that you fix up a right time not at the lowest time. You have to start just at the peak of the tide and then start doing this operation; it will help you because your ballast requirement will come down.

You can you can manipulate that, but the available time will be may be 2 hours, 3 hours by the time you might see that the tidal cycle is about 8 hours. So, you will have only a limited time during the that particular period, so you will have to fix up do this operation and get away because you do not get away, what will happen the rising tide will take the bars up and then hit back, you understand the idea.

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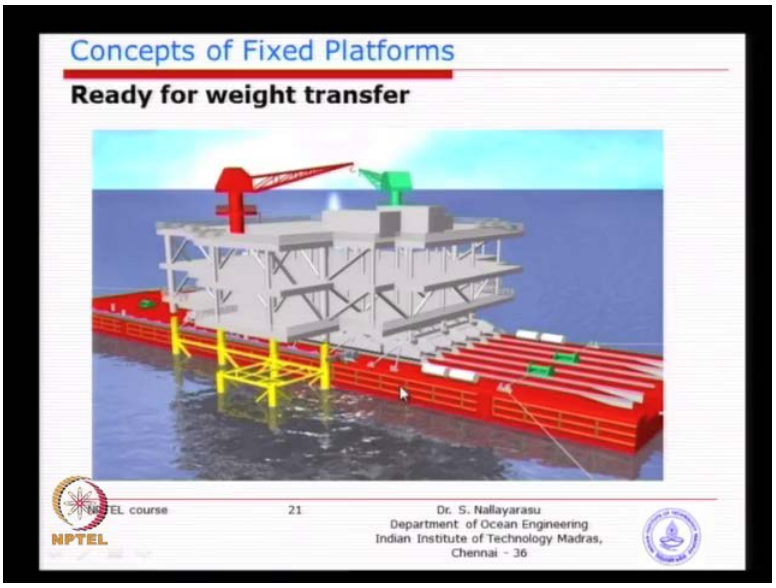

Even though you installed the bars remains, there only this bars will just go up and then hit against the structure. So, you will have to just remove this as quick as possible, so this whole thing is not going to be nice and clear because you are you are doing in open sea conditions. Things can change you have a predicted tidal a chart and measurements you have a weather conditions forecast, but you go there in case if you get into problem what remedies we can have. The important thing is you pull it back is not it just reverse it and go away from the location and wait for good weather conditions.

For some reason, if you are unable to go away what will happen you will lose the jacket you will lose the deck by damaging. So, in order to avoid what we normally have is I think that slide is not here, but what you can see here instead of supporting all of them only by simple welded supports. You can support the whole structure by hydraulic jacks so if you have say 10 or 18 numbers of hydraulic jacks below the structure. In case if it is moving down too fast the hydraulic jacks can lift the structure by half a meter whatever required to stabilize or if the movement of the deck is too slow compared to what you expected because ballasting is going very slow.

You are unable to do ballasting, then you can bring the jacks down, so this we call it active float over instead of you purely rely on only ballasting or de ballasting. You can use the jacks to move up and down the whole structure, but one of the problem is the hydraulic jack capacity would be very large. For example, 10,000 ton, so you need to

have say 4 or 8 jacks, each one of them 2000 ton capacity, each of the jack would be something like 1 meter diameter expensive, but very safe.

So, these two methods of float over one is passive float over where in we actually flood water and try to do the movement of the bar. You can actually keep the bars in the same elevation just movement of the cargo by means of hydraulic jacks which is called active float over or many times we do the combined. We have the hydraulic jacks, we have the provision for ballasting, and you got to the field you decide according to the situation. Either, I will ballast or I will do the hydraulic activation, so I am feeling 100 percent safe that successful installation will happen, so most of the projects you have both of them installed.

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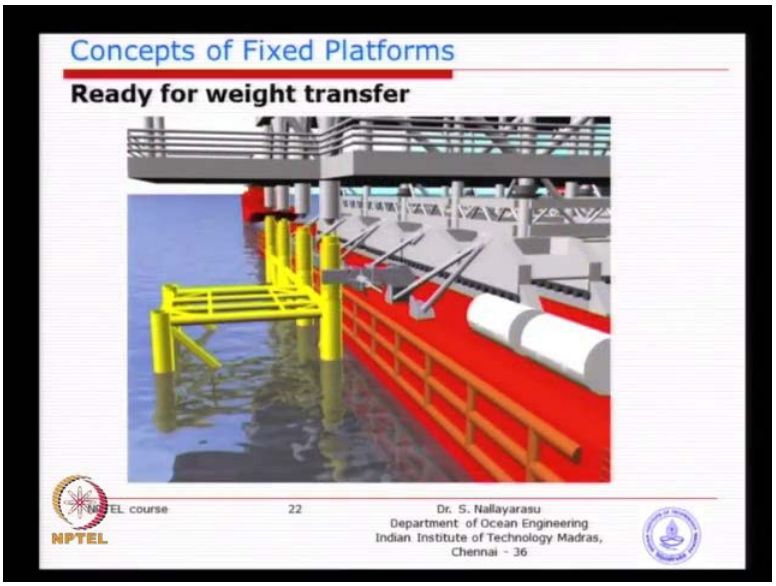

So, you see here the critical time is the alignment of the legs, so how do we do survey basically now a days most of the devices available in laser control. So, if you talk on the jacket legs as well as on the deck structure, so align it to millimeter accuracy in fact very accurate. Now a days, both in terms of horizontal plane and the vertical plane so that it does not create problem, but imagine whatever you do, this you still will see that the load. Transfer could be slightly dynamic; it will not be taking the weight and just nicely placing it.

So, you will see that there will be a impact force because sudden and you also see its not one support you got series of support on left side series of support on right side as I

mentioned you may have actually 4 or 8. You see here in this particular 1, 4 on left side, 4 on right side where as some cases you will see 2 on left side, 2 on right side. Depending on the design if you want to distribute more loads, but most of the time you will have four only 2 on the left, 2 on right. This particular project they had 4, so you see here when it is just impacting like this what will happen to the steel at the top.

It may actually get damaged or locally yielded there may be dent, so in order to prevent this we need to have some active devices built in either in the lower path or in the upper path. So, imagine if you put a hydraulic jack inside what will happen during the impact you can activate the hydraulic jack either to extend or to, but the timing of activation is so difficult to determine.

We do not know because eight supports one of them may touch because of slight tilting of the bars one of them may touch first the other one may not. So, this will be very difficult to manipulate, so what we normally do is we place some kind of elastomeric devices inside the jacket leg. So, that even if the impact happens the elastomeric devices will compress take the energy of impact by internal work done transfer the reduced forces to the structure.

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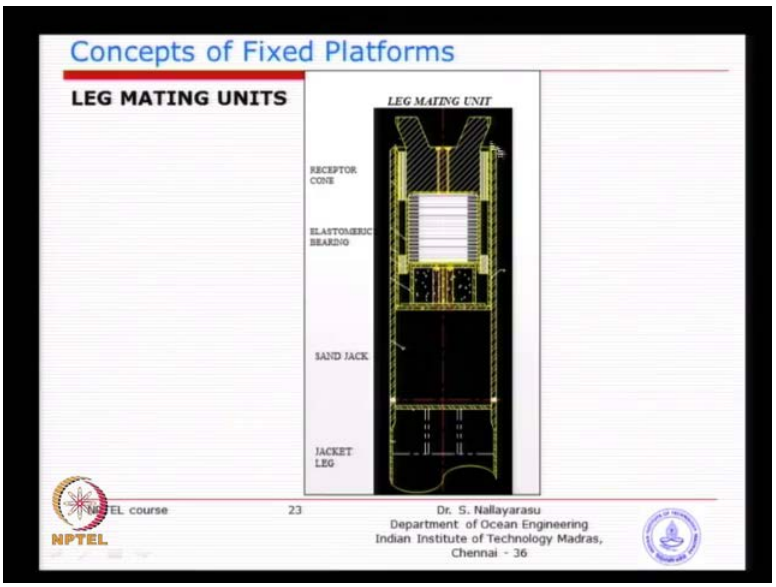

So, that is the idea behind, so you see this next picture we normally implant inside a jacket leg, this is a jacket leg what you see in here this is a jacket leg. So, inside here you place series of elastomeric pads, you know it is very similar to rubber, but very hard

rubber and you have a steel plate at the bottom to prevent this one from going down because its hallow, jacket leg is hollow. Then, you have filled with sand, so basically the bottom is welded plates you have sand this plate is not welded to the inside it is actually floating on top of the sand.

It is just resting on the sand, on top of this plate, you place several of the elastomeric pads on top of it you have a receptor cone just like a metal piece prepared in such a shape that it will receive without bigger problem. So, basically when it is impacting there the elastomeric pads will compress and shock absorption will be taken by the sand in here not seeing that dark color. Basically, inside here is a fully filled with sand you might see know sand is a very good absorber of shock gravel in fact many times you use gravel. If you see the railway tracks, why we fill with gravel is the good absorption if shock energy and basically one of the biggest problems is you need to decide what will be the compression required.

Now, we will have about eight pads placed here, so under that loading if it compresses too much what happens, the load will be transferred to this because you need this whole piece you have to go inside under the compression. Otherwise, you will not be able to get the contact of the deck leg and the jacket leg for welding purpose because you have to do the welding if it is compresses too much. Then, it is a problem impact load will come if it does not compress then you will not be able to do the welding you see the problem. So, the design of these elastomeric pads needs to be such that the compression is exactly what we wanted if it is a 1,000 ton reaction.

You need to design in such a way that under 1,000 ton it will be able to compress at least this much at least this much so that you will be able to do the welding. So, otherwise you would not be able to make a connection between the deck all of you able to see this no because this piece has to go inside. So, the deck can come and do the welding, so basically that design has to be proper, so this assembly is called a leg mating unit is nothing but, a shocking absorbing device placed inside. Sometimes, what we do is exactly we reverse it, we place this one inside the deck leg, sometimes we call it deck mating units.

Here, we call it leg mating units, does not matter you know basically a device to absorb the shock during the mating process. This is a elastomeric device to reduce the impact at

the same time we should have sufficient deformation such that the outer and outer comes in contact. So, circumferential welding can be done all around and the low transfer can happen, so in doing this process actually if you look at it, its first touchdown may be zero load, but already touchdown. Then, slowly gradually the load will increase; it will not be a sudden process because you are doing ballasting gradually.

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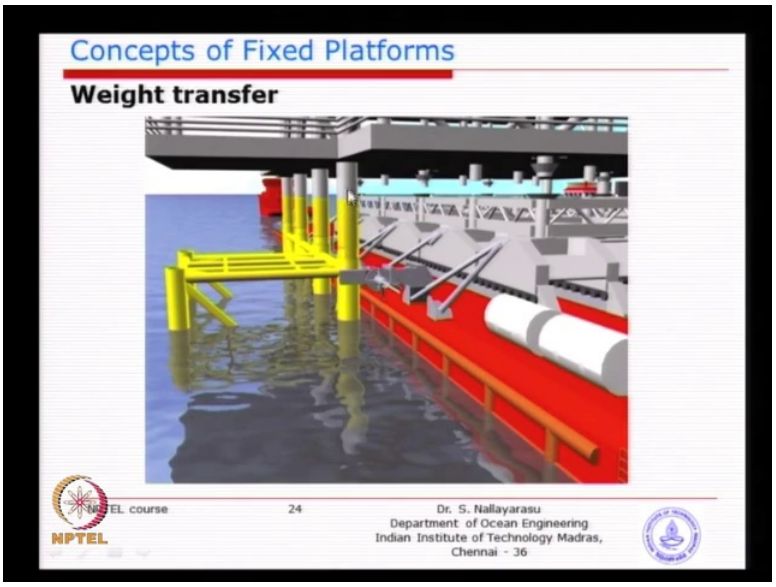

So, at this position that the receptor cones should have already compressed to whatever the design amount what we require. So, that is why you have seen a single contact line between the grey color and the yellow color, somebody will go around and do a welding. Once you start welding, you can see here several fellows have gone there and disconnected the supports and immediately unless you disconnect the supports. These bars cannot come out, so you go and disconnect the supports quickly pull the bars the way it came in you have to reversely pull out what will happen, otherwise.

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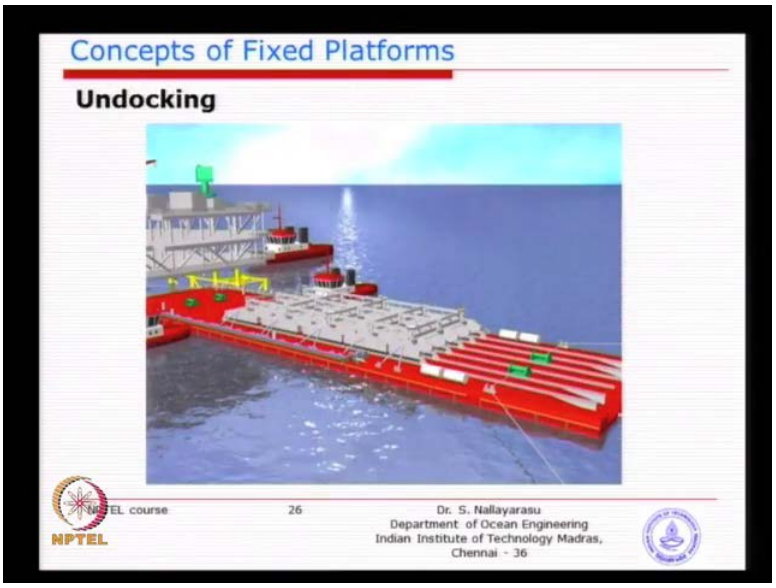

You see these bars, if you pull out in the same direction, the structure that you have installed will get damaged because there will be bridge there will be mass on the ship. So, basically you will have to go in the reverse direction the way that you come in and just go out wards.

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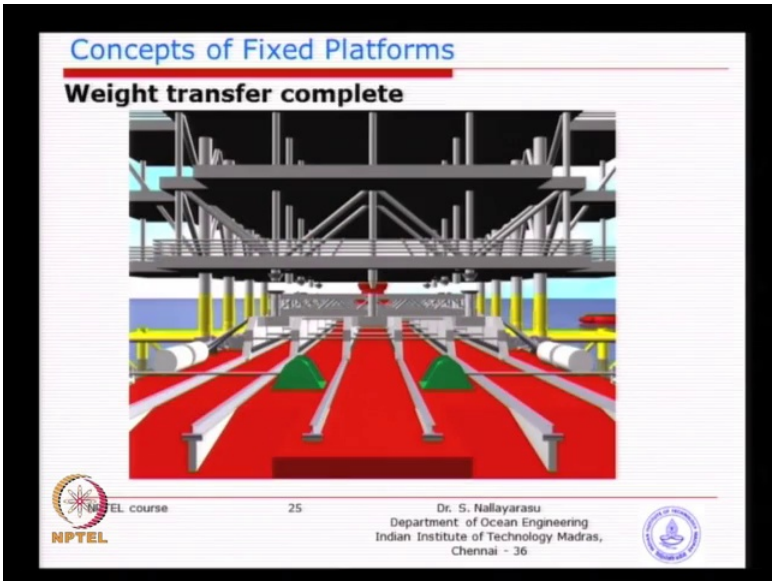

So, you will be seeing something like this underneath this are this were the supports that were actually supported during transportation to the site and just pull it backwards.

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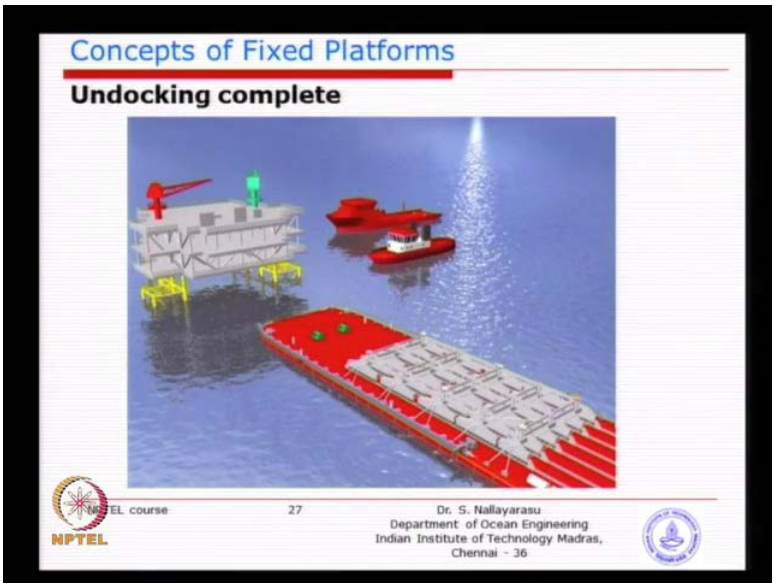

Once you come out, then it is very safe, so this undocking is also quite important because the timing if you just manage to pull out in time it will be good. Otherwise, I think that gives you an idea about various installations, I think we can summarize first before going on. So, what we have discussed is fabrication in the yard and then load out you have seen a video, I think most of you might have understood what is going on and then load out can be done in two ways either by skidding or by trailers or by the third way by lifting.

So, you should be able to make some simple sketches you have seen, so many nice pictures for examination point of view describe the load out by trailer you should be able to make a simple sketches and write description of what I explained. You will not be able to find in the text books, you understand the idea, so you just attend the classes, so you can write. Basically, transportation what exactly is going on transportation is the jacket and deck being relocated from the yard to the final site by barges or by ships.

We have discussed about various methods of transportation and then once you reach the final place the jacket can be installed by lifting or by launching and there again lot of sketches, you have seen drawings, pictures. You should be able to make a clear hand sketch but, not scribbling you should write clearly and the procedure how we described. So, if you are asked to describe a typical jacket installation from yard to site you should be able to make a simple step by step sketches describe the stages involved nicely

explained. So, launch by means of pushing the jacket in to the water or lift by cranes, but ultimately both have to freely float on water.

You have to up end it using crane, so have two methods of up ending one the up ending by crane or self up ending by jacket itself which will come to vertical position by the means of its own inherent buoyancy and centre of gravity correctly manipulated. Else, you do manual manipulation by flooding water and make the upright, so I think this whole process from yard to final installation it is to be understood because each stage we have different types of loading to the structure. That needs to be take into account when we are further going for the design activities, so what are the loads that is arising from this activity alone because after installation it is a final service condition which we know the loading.

During this process, during load out what is the load is only self weight nothing else, but the designed condition is different when the jacket is in service the jacket is in vertical condition where as in fabrication and load out jacket is in horizontal condition. So, you can imagine if you have studies mechanics the column become a beam behavior is different column carries actual load beam carries bending loads. So, you can see you will have to design the structure which was designed for some other boundary condition all of you familiar with boundary condition no support conditions.

So, you see here the jacket will be subjected to severe bending, so basically analysis what you are going to do is change the boundary conditions change the loading direction and carry out the design. In addition, you have seen the video during the load out process basically the structure moves up and down because the bars is I think if you watch the video you can see that at the time of transfer the barges heaving up and down. So, you can see that there could be a push up wards or push downwards depending on the location of COG and that can cause additional bending loads due to support settlement.

I think you might have studies in your applied mechanics bending moment due to support settlement so that could actually cause substantial loading. So, this load out is all about its own dead weight no external load is going to come except may be some small wind load, but predominantly dead loads, but manipulation by different boundary conditions. So, load due to installation first stage load out load is purely dead load second stage you put a jacket on to the cargo bars throw to the open sea conditions. So,

the bars are going to roll and pitch and move up and down because of external sea condition.

So, what happens to the structure the structure will be subjected to forces form motion if you have travelled by boat you could easily visualize you go on to the top of the deck what will happen? You will feel giddy because of the motion forces applied on to your body basically the inertia forces will come the heavier the structure more forces will be generated. So, this motion forces have to be accounted but, basically the loading is arising from its own self weight no other external forces the force is due to its own weight, but because of the roll and pitch motion you will see that inertia forces are produced. So, you have to design the structure for that type of forces, then when you go to the site during launching similar to load out you may have a different support condition when it goes into water.

You will see partly submerged partly on barge and then make it up right so each stage of installation its own weight is a problem by this time you should realize that that means reducing the weight of the structure is the most important aspect of the design. The lesser the weight, less problem for us after all, it also means money, more the weight that you want to put more money you are going to spend more trouble you want to invite because increased loading can cause increased stresses. So, that is that is idea behind off shore structures all ways minimize the weight also when you go to in final service condition when the jacket is up right more number of members means more amount of wave loading.

So, the minimum number of members and structures required you should design it so that you do not invite additional loading and then once you place the jacket on sea bed you will be able to do the pile driving on to the template. I think all of you are familiar with now what is called a template the whole jacket is called a template because the purpose of making this frame is to do the piling through the legs or through the skirts.

That is the idea, so that you can drive the pile and do the connection between the pile and the jacket once it becomes integral structure. Then, you can place the top sides and top sides we have only two method of installation one is by lifting and putting on top of the jacket which is already installed or by float over whichever by means. So, if it is a lifted object lifted design you may have a single lift sometimes even 5,000, 10,000 tons. If you

have a bigger crane, you can actually place the whole thing in single piece or split into several sub pieces assemble them on the jacket or you can do a single float over installation. So, I think this whole business first class three classes we were discussing the idea is why we need to know this.

If you do not know this, the design cannot be performed unlike the on shore structure you do not need to know actually all this will be normally by the construction team will manage that the size of the structure that you have deigned. It will be same even during installation, they will just make sure that they do not come and change because the installation related design is not going to govern or increase the stresses for onshore stresses. For example, when you make a multi stored steel structure, they are not going to make the whole structure built somewhere and move it you normally have a pre fabricated pieces small pieces bring it to the site and assemble it at the site.

In our case, the design is going to be governed by what methodology that we are going to adopt for the installation either it is a trailer or it is a skidded or by load out by other methods or float over every decision that you are going to make on installation. It is going to change the stresses, it is going to change the member sizes and that is why you need to know all this. So, you can do the activity accordingly, once it is installed at the final location, then it comes to the final service design that means during the next 20 years or next 30 years the platform is going to be at that location.

So, we need to see what are the loads applied on to the structure, I think we have seen on the first day so gravity loads environmental loads and then facility loads and then live loads. So, all of them is going to be present at that time we have to design as similar to any other structural design except the predominant loading is from wave and current which we are yet to see probably. Sometime next week, we can do that I do not know how much hydrodynamic wave theory; you have been taught in the classes. Otherwise, I will give a quick introduction and then we will go ahead because it is getting too late.

So, basically the in service design is all about designing the structure at the location where it is performing its hydro carbon exploration and 99 percent of the cases hydro dynamic loading will govern the design gravity. Loading will be very small compared to the hydro dynamic loading in terms of its severity not the magnitude could be smaller for example, 10,000 tons top sides may be 1,000 ton horizontal wave load, but that 1,000 ton

can cause a huge trouble. It is a bending load compared to the 10,000 ton gravity load which is going to go as an actual load to the structure.

I think all of you if you have studied your mechanics you take a cantilever column actual load could be potentially higher number where as the bending the horizontal load with a smaller amount. It can actually deform and fail by bending, so that is where even the magnitude could be smaller, but that governing case would be the environmental loading. So, the structure is have sufficient strength in doing, so we will just see that, so what is all about in service design. We will just look at one or two slides, and then we will carry on in the next class hopefully, I think at least week after next week you can go to hydro dynamic loading

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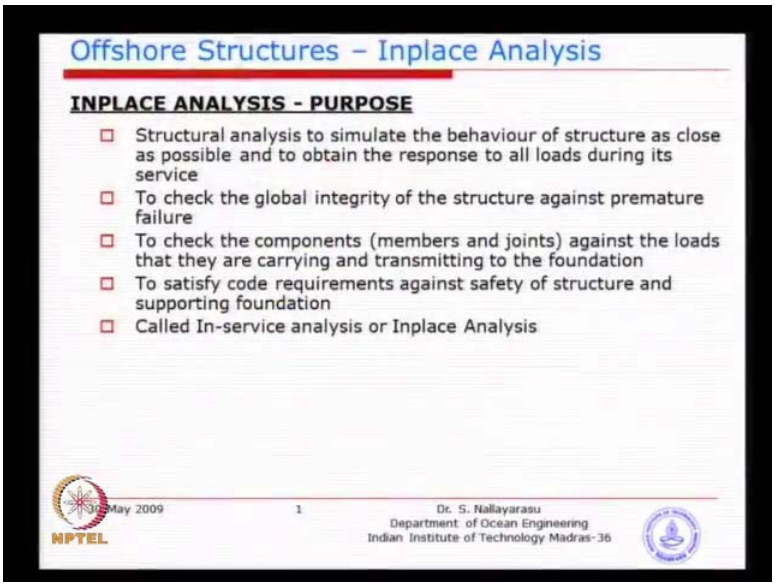

So, it basically simulating the structural system whatever necessary for producing oil and gas basically to make sure that the structure performs within the limits of code allowable in terms of stresses in terms of deformation. So, normally you need to do a three dimensional frame analysis if you have studies structural analysis in your previous codes or in fact we have a structural analysis codes in this M.Tech. I think I do not know whether we have all of you have abut at least 3 or 4 people will have a special codes, where in we teach about various forms of structural analysis for both floating structures and feature structures.

Then, that will give you an idea of the member loads or loads arising from various cases of loading and then each of this members list will be designed against a particular design code which we will see in this codes several codes are available. As you might see Indian codes or other national codes US, UK, European codes, ISO codes. So, we will have to select a suitable code for a design and basically perform the design of structural element one single piece in the complete system, but the system needs to be analyzed.

This means frame analysis has to be carried out there are several manual methods you might have studied in your applied mechanics course. You might remember moment distribution method you have heard of this name simple frame portal frame. You can perform bending moment calculations sheer force calculations what other methods are there moment area method you have heard of this slop deflection method. All of them will be leading to one particular solution for bending moment sheer forces on a frame. Now, if you have a simple portal frame may be you can half a half an hour, one hour, but if you see this structure, I think I will shoe you one bigger picture where is that there is no picture.

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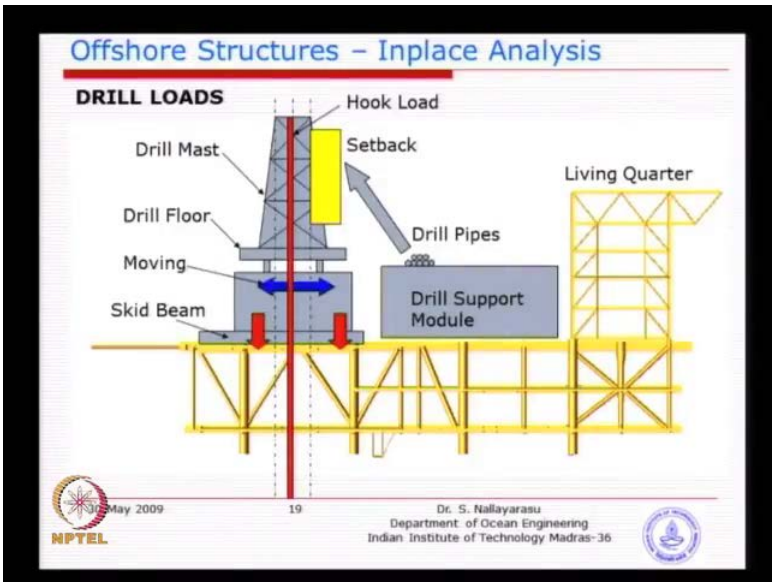

Here, we saw that one picture the other day you know may be you take a picture like this big structure thousand s of elements imagine, if you have to perform by manual moment distribution method it may take several days. Of course, it can be done, but it may take several months that is why now a days the same method what we talking about moment

distribution method or other methods as simplified matrix from. We call it matrix method, you know all principles are similar ultimately solve by computer by making a generalized solution for the larger structure. So, as early as 1960's people have come up with simple computer solutions based on matrix formulation of this bending moments and sheer forces.

Now a days several software are available many softwares, every software can do the simulation of a three dimensional structure like this. Then, apply the loads perform the boundary conditions, they can give you the load on each of the member sheer forces bending moments torsional loads all can be obtained from three dimensional analysis. As long as you simulate the structure in accordance with what is required apply the loads support boundary conditions provided correctly.

Then, you can get the loads which now a days now body is doing all calculations that is one of the part one of the saddest part because even for simple structure you start using computer because computer is available. You have to verify that what you have applied what you have simulated is going to reflect the real condition if not you may be simulating something but, in reality something else. So, basic idea is what we are going to see here is to simulate the behavior of the structure in the service condition and basic idea is supply loads and boundary conditions. This is called in service in place because what we have seen before reaching the site is called pre service and in service is nothing but the operational conditions.

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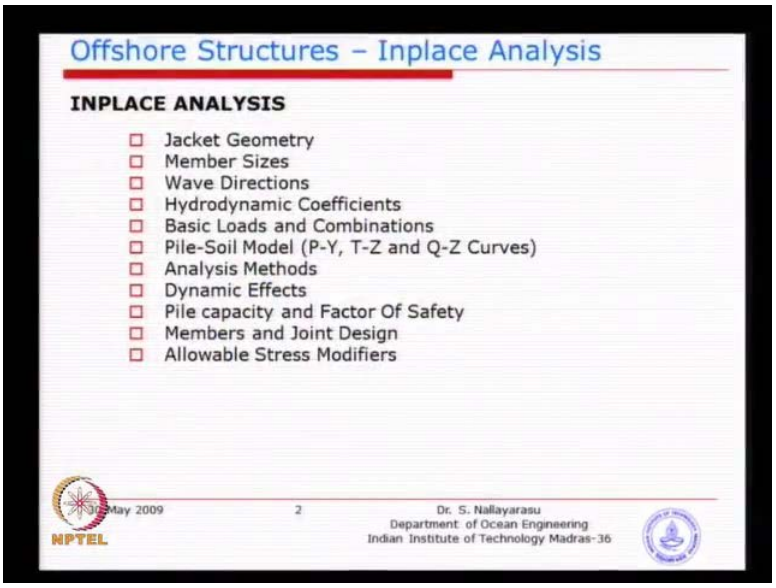

What we have to look at, so many conditions the geometry of the structure I think by this time, you could easily understand how the geometry was arrived. You could recollect how the geometry of the structure whether its 8 leg, 6 leg single leg or 4 leg is basically based on the top side area requirement. If it is larger the area you will place 4 legs, 8 legs or if it is a small top side, then you put only 1 leg, mono tower. This geometry has to be decided by the engineer who is arriving at the configuration and adapt whatever, whether it is a main leg pile or skirt pile also have to be decided depending on the site.

If it is a 100 meter water depth may be main leg pile is no good, I think I have already explained why because the pile is going to be inside unnecessarily increasing the weight so you can have a skirt pile on the side. So, you can reduce the weight member sixes wave directions hydrodynamics coefficients you will you will see later on loads and load combinations what are the loads can actually coexist at any time during the operation.

So, we will go through one by one, I think we may require may be two classes to complete this only what we will do is we will just skip the hydro dynamic coefficients because we will do that during the load calculations using wave and current. So, ultimately we do size structure interaction because this is a cantilever type of structure, we need to do a pile soil interaction. Then, dynamic effects because the loading is wave load is dynamic, and then we design the piles design the members.

So, in this course almost most of this will be covered except the pile soil interaction which we will be taking in the next semester, I think one of the courses. So, we will not go too much detail into that because there is a fully fledged course where in structures soil pile interaction will be designed dynamic effects. I will just touch up on because you have a separate course dynamics of structures in the second semester or third semester second semester. So, supposed to be in first semester anyway, so I think will just introduce little bit, so you will appreciate what is the importance of dynamics for the future structures, I think we will stop here.