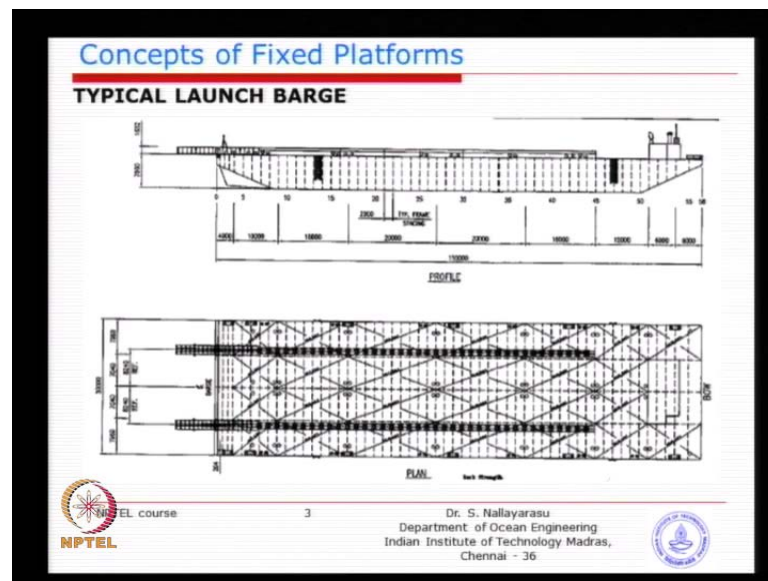


Design of Offshore Structures
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Module - 2
Lecture - 2
Concept of Fixed Offshore Platform Deck and Jacket 2

So today, we are going to look at transportation launch and upending. I think yesterday we were looking at load out and lifting; I think the difference is very clear. Load out is by skidding or by trailers and lifting by means of crane, basically a handling technique. Today what we are going to just quickly look at transportation and then installation in offshore. Transportation is a means of taking this structure from fabrication yard through the final installation site. So, mostly I think I have shown you some pictures yesterday normally we transport using flat bottom barges is just a rectangular pontoons.

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Now, when you try to do launch of the jacket means again you are going to slide it away from the floating system either barge or shift. In order to slide it away you need to have a prearranged skids like what you see in the picture, you got two parallel skids will be very similar to our railway track, you know only thing is stronger enough to carry the jacket or top sites which ever you are transporting. In launch, normally you do not launch the deck, what will happen it will going to water. The super structure needs to be only

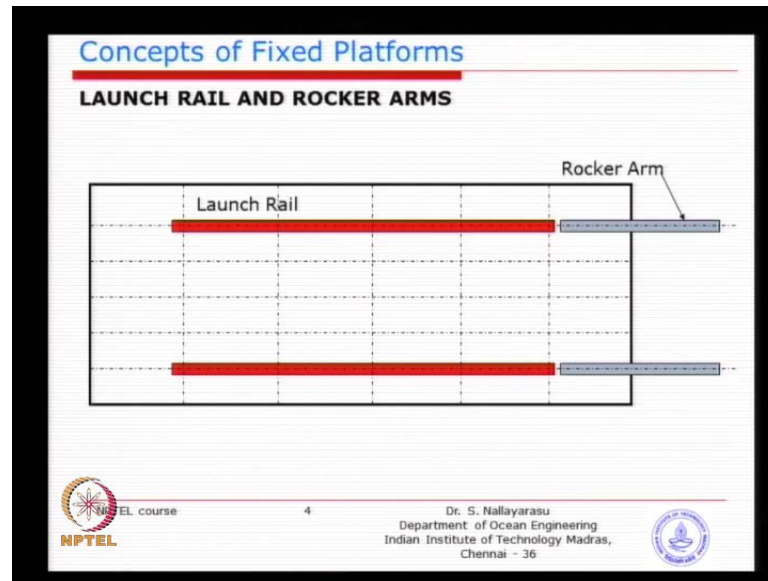
installed by means of lifting not by means of launching. So, jacket will be launched, so that it can go to water.

So, basically typical barge, so what you see in this picture is a rectangular pontoon length width and the depth of course, little bit of smarming in the bow side and stern side, just for towing purpose otherwise it looks exactly like a rectangular pontoon. Divided into several compartments each of this ink mark you see here this kind of marking is one compartment is divided into several subdivisions. The idea behind why we divide this into several subdivisions is basically to make sure the barge is stable, even some of the compartments become damaged, for example, one of them may leak or may have damaged due to several issues during the transport time or corrosion. So, that is why you divide the barges into various sub compartments.

You see here here I think almost ten times four I think, so forty compartments are there. So, the the damage happens to one compartment means one in forty is the probability of failure. Whereas, if you do not have a compartment once in simple pontoon, what will happen, any damage to one location will actually failed the whole barge. So, that is the idea behind the ship design, any floating structures design even jacket design. We will see later when we do complete jacket every member is buoyant, but in one member if it is floated due to damage that jacket still will be able to float, because this is only a small portion of total system, so that the redundancy which I to create.

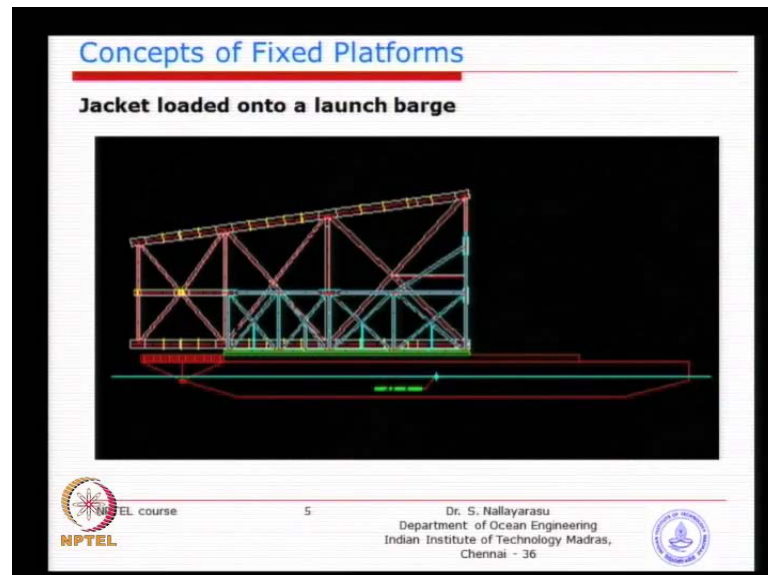
So, if you look at this barge is forty compartments, and also yesterday we were seeing the ballasting remember one of the barge carrying the crane on one side and another side we want to do ballasting. So, if you have compartments, controlling the location, and precise amount and quantity will be easy to manipulate. So, that is why this compartment business is very useful. So, as you are getting introduce to floating structures, you should be able to differentiate between fixed structures and floating systems. How the stability is achieved. So, typical launch barge what is the difference between a launch barge and the cargo barge means cargo barge means cargo barge means it can only carry cannot do a launching. You will not have this parallel skid rails that is a difference; otherwise, the barge is a same for both purposes and that is parallel skids allow to jacket to be slider away without damage that idea is you have nice skid arranged in such a way that the jacket can slide without much of damage to the structure.

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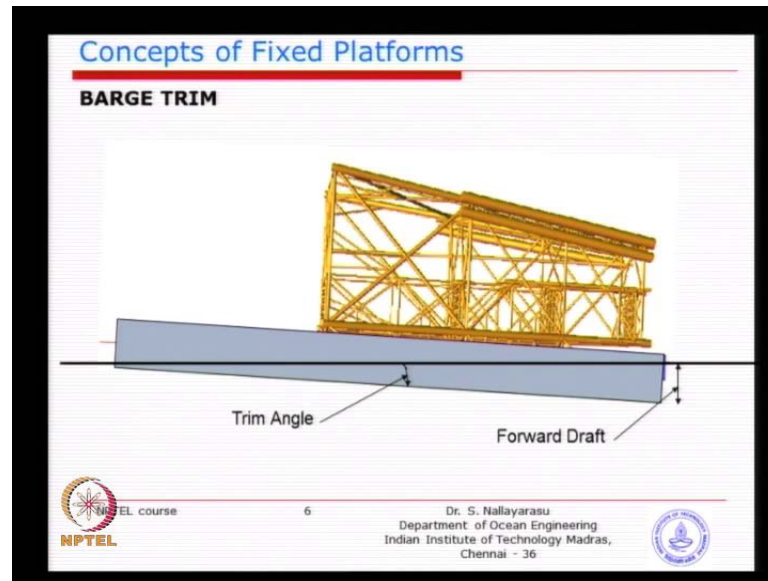
You know slightly different arrangement, you can see here that red color is the launch skid or launch rail or the parallel arrangement through which the jacket will skid away. The right side the grey color, which is called rocker arm, which can rotate as the jacket moves towards the end.

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We will see from the next few pictures. So, you can see in this picture that the triangular portion is basically pivotal about this point as the jacket moves down forward it will be trying to rotate, so that the you do not see sudden failure.

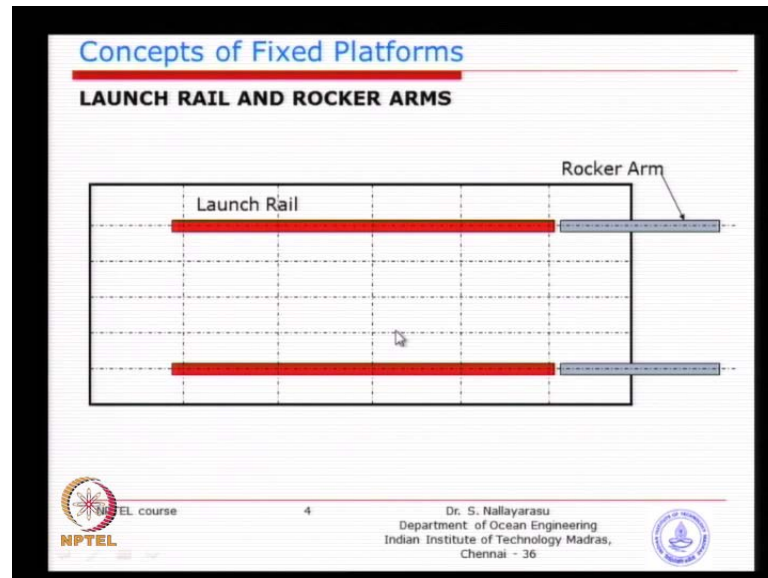
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So, how do we make the jacket to slide away, very easy. Several ways of doing it, either you can push it physically by doing by a device, which will be requiring to be pre-installed at the back-end of the jacket. For example, if I want to push it from this end I can do that by some hydraulic jack. So, I can rearrange the hydraulic jack and then give push. But normally when you have a horizontal in this kind of plane, what happens is pushing that becomes little order, because you have to make the overcoming of static friction. So, you may need big capacity jack.

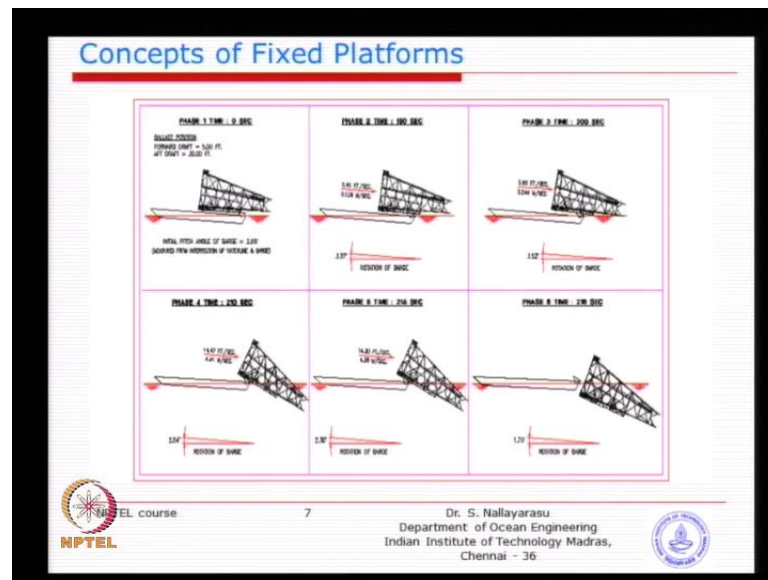
So, in order to reduce the requirement what we normally do is ballast the barge in the forward end. In this case, it is actually a stand end you know. So, you ballast few tanks not all the tanks, few tanks in this area, we saw several tanks, but there know, so you just float them. So, the barge gets deleted, sometimes if the barge deleting itself will allow the jacket to slide away, because of the inclination. If still the friction force between the jacket and barge is higher than we can actually give a external push either by means of winch; sometimes we do actually have a winch to pull it and it can actually slide down or you can give a hydraulic jack at the back-end. So, the jacket sliding down has to overcome the friction between the jacket and the barge. So, how do we minimize it that is the idea behind.

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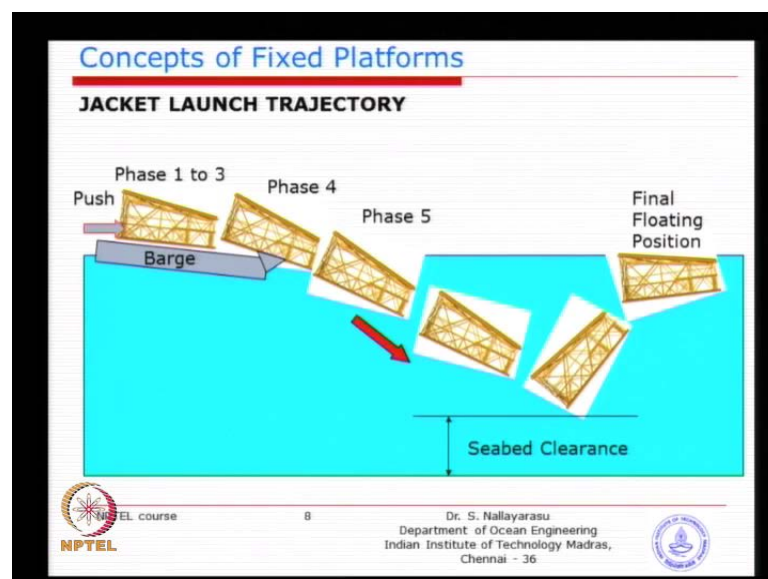
So, you actually can lubricate the skid way what you saw here, the top surface of the skid way can be nicely lubricated with lubricants. So that when you actually trim it, the meaning of trimming is nothing but making the floating of some of the compartments in the forward end of the barge, so that the tilting along the longitudinal direction will allow the jacket to slide on its own weight, you understand idea know. So, basically this is called a trimming or trim angle, this angle typically about two degrees or to four degrees. Imagine if you trim this to 50 degrees, what will happen, the barge will cap size. So, basically that is why we need to limit this trimming or sloping of the barge along the longitudinal direction by minimum like two degrees to three degrees maximum four degrees.

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So, this is what is going to happen when you actually allow the jacket to slide away and trying to trim the barge, still cannot then you give external kick or push by means of mechanical device which is prefixed at the back end of the jacket. And you see here, there are several sequences, sequence one, two, three, four up to six, you could see that the stage six, jacket and the barges already separated; that means, you will be moving away in the opposite direction because of the displacement of the water. The barge will move backwards, the jacket will move forward.

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A typical picture, you see this is the critical condition where the jacket is partly supported, partly very little on water and fully supported under jacket, but at the same time it is on the pivot. So, the jacket is trying to rotate because of the gravitational forces; imagine if that rotation part is not there, what will happen the tail end of the jacket will fall on the barge itself, as it moves down may damage severely both barge as well as... So, in order to prevent, we have got this pivotal arrangement, so that the back-end of the jacket is lifted of above the barge surface.

So, that it can just nicely dive into water without damaging both jacket and barge. So, at the end of the day what we require is the jacket needs to come down without in the seabed and go up and float horizontally reasonably horizontally this will only happen if we have sufficient buoyancy you do not have sufficient buoyancy you may lose the jacket as it goes down it may actually hit the seabed. So, the momentum during this diving is very important we need to calculate what is the dynamic forces the resistance coming from water because of the viscosity effects in respect to the jacket surfaces and you need to evaluate what is the weight what is the buoyancy and then find out whether it will go and heed the seabed or not.

So, the simulation we need to do simple simulation we need to know the centre of buoyancy centre of gravity and the forces arising from the diving time basically the velocity of the jacket is low you can calculate the rivers forces exactly apposite to the hydrodynamics you know the structure is stationary wave is coming on generating forces in here structure is moving, but the static water exactly apposite same wave theory what we are going to study in apply here and then calculate that the forces during the time of diving now why we need this want to float horizontally why not we just simply allow the jacket to go and then sit on seabed upright you could actually design a jacket to to go and make vertical position when it is diving that is what your normally when you dive into a swimming pool you try to come up vertically by making balance of your buoyancy and the centre of gravity is down.

So, you can design a jacket instead of floating horizontally at the end of this launching we can make sure that the jacket floats vertically upright if you have the position of central of gravity position of centre of buoyancy designed a suitably, but that is called a self upending jackets we do not need any additional effort to make it vertical in this case

we make it float a horizontal than manually we try to make it vertical that is depends on the design.

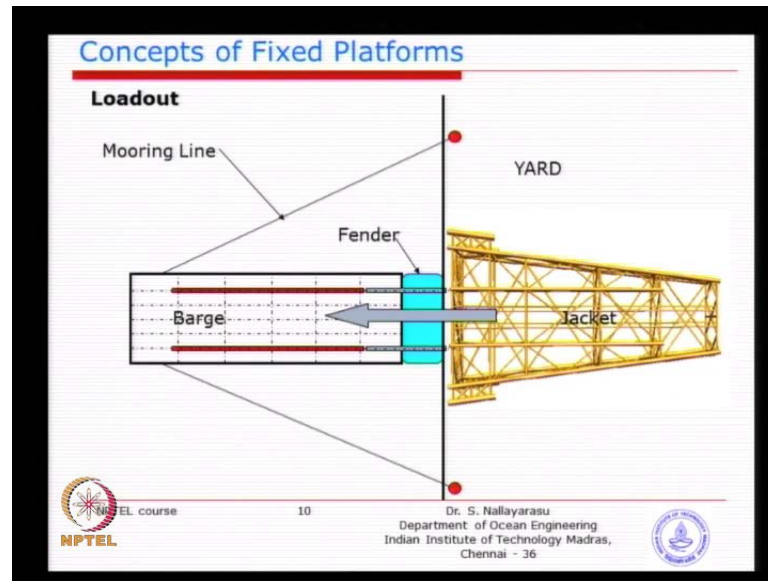
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So, what we require is something like this at the end of the day we need the jacket to float nicely horizontal, but visible above seawater. So, that do not need to search for it, but if it is below water something is wrong you do not know where it is might have already gone down to seabed. So, basic idea is you need to see the jacket number one you also need to some portion of this jacket visible above water.

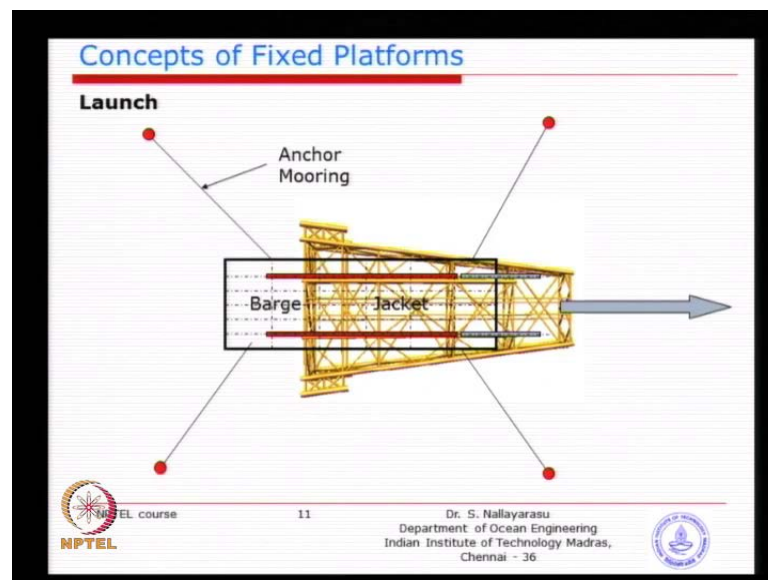
So, that you know see here there is a platform some small platform is arranged there because you using this platform only people can go there and collect this war ropes to crane otherwise you would not be able to access the jacket. So, there is a small platform provided and top of this. So, that the crane will come on that location and then try to lift it off to make it vertical because without a crane you cannot make it vertical. So, that is the idea behind why it has to float horizontal for example, if you does not float horizontal float inclined what will happen nobody is able to go on the climb above the platform what is available here. So, that is why we need to make it reasonably horizontal one degree two degree is not a problem, but if it is forty-five degree there is becomes a serious business.

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So, you can see from this picture we do load out in reverse direction the big end of the jacket or bottom of the jacket goes first you need to see the difference the bottom end of the jacket goes in to the barge first.

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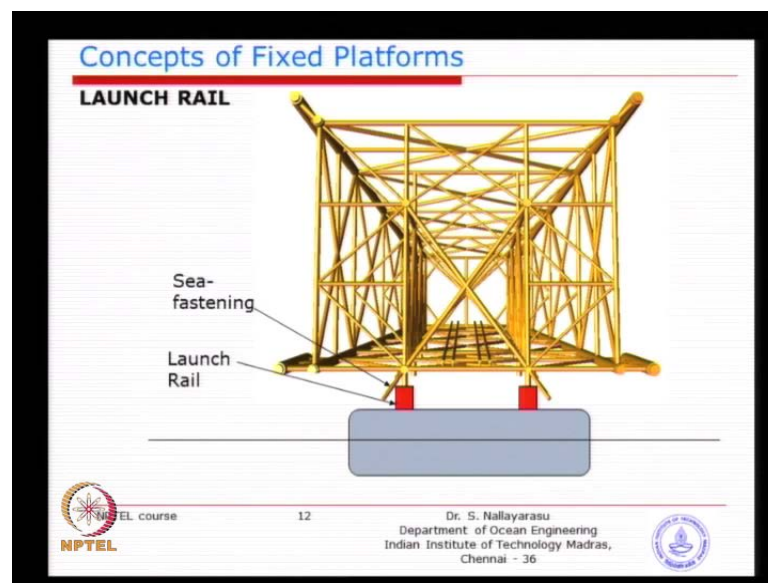


But when it is launched the exactly opposite the launching is done from the front-end of the jacket goes into water first. So, the sequence needs to be carefully manipulated before you fabricated because you fabricated in a wrong direction when it becomes a reasonable typical task to launch. So, when you want to do launching of a jacket during

the fabrication the orientation of the jacket should be in such a way that the bottom end is facing towards sea.

So, that you does moving backwards and then during launching you can you see the the idea. So, that you know when you're actually designing things in the yard when you become a site engineer or yard engineer.

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You should know which things go first typically when you do transportation time on a launch barge you see in the red color the launch rail. So, basically is the is the skid nothing, but the fabricated plate girder I think most of you will too familiar with steel girders snow steel girder very strong enough to support this full structure and top of them and you may actually have welding to the barge by means of additional members. So, that during transportation they do not fall down sea fashioning you know otherwise what will happen during the sea voyage jacket might slip away into water.

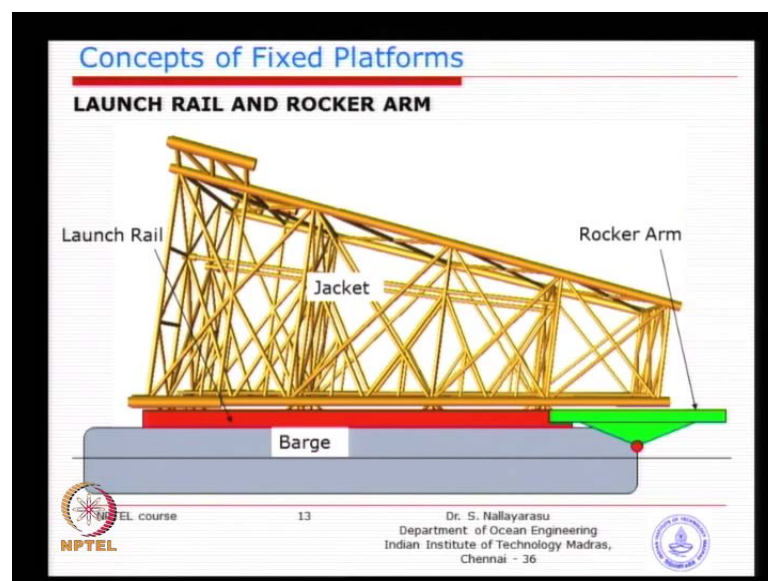
So, basic idea is when you do transportation using flat bottom barge something like this you will have trying members normally when you see the capo going by a barge's or buy ships you see that wire ropes holding down sea fashioning to barges here we use structural members because the loads arising here will have both compression as well as tension. So, you need to have structural members to connected to barge as well as to the structure. So, basically of the terminology sea fashioning is nothing, but if they tie down

to barge and launch rail is again nothing, but a simple girder provided with arrangement such that the skidding becomes easier.

So, lubricated surfaces is normally the top surface will be provided with timber most of the launch skid we use timber, but on top of timber you may have a barring pads, which will reduce the friction like teflon pads are available with friction between steel to steel is how much steel to steel is greater than point three whereas, if you use the teflon pads you can reduce to you know what is static friction right. So, basically less than point one.

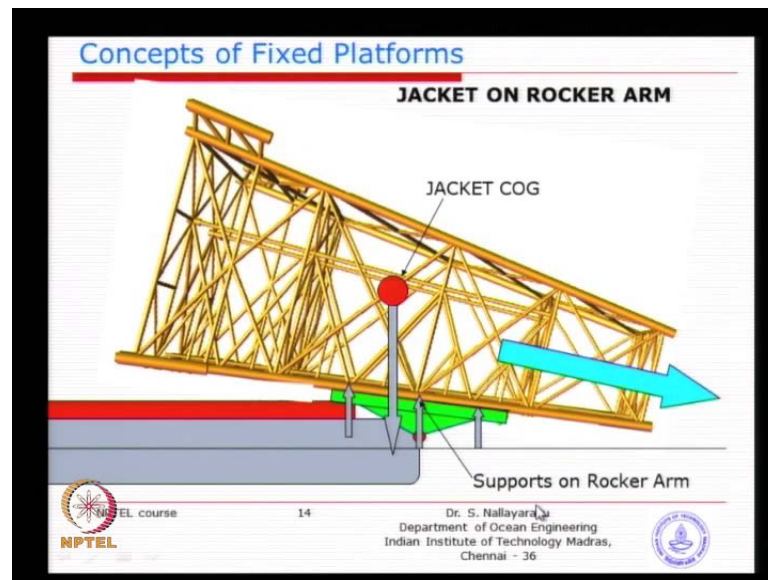
So, if you proper lubricated surfaces can bring down less than point one the reason why we need to reduce the friction typical example of a jacket for example, if it is a five thousand ton jacket if the friction's point three the amount of effort required to push the jacket is thirty percent of five thousand. So, you imagine it is more than thousand tones where do you get thousand tones capacity jacks if the jacket is not moving down. So, that is why we have to reduce the friction. So, that the effort required to launch the jacket is lesser sometimes if the friction is more even after trimming three degrees jacket will stay there because of frictional resistance is higher than the component of gravity coming down in the inclined direction. So, that is why we may have to do this kind of manipulation.

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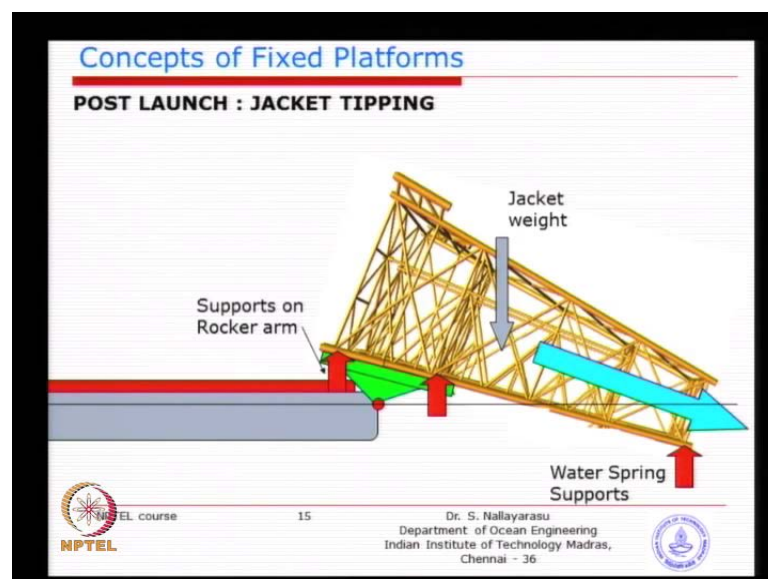
So, another pictures showing the the the location of rocker arm basically that is pin jointed which actually can rotate.

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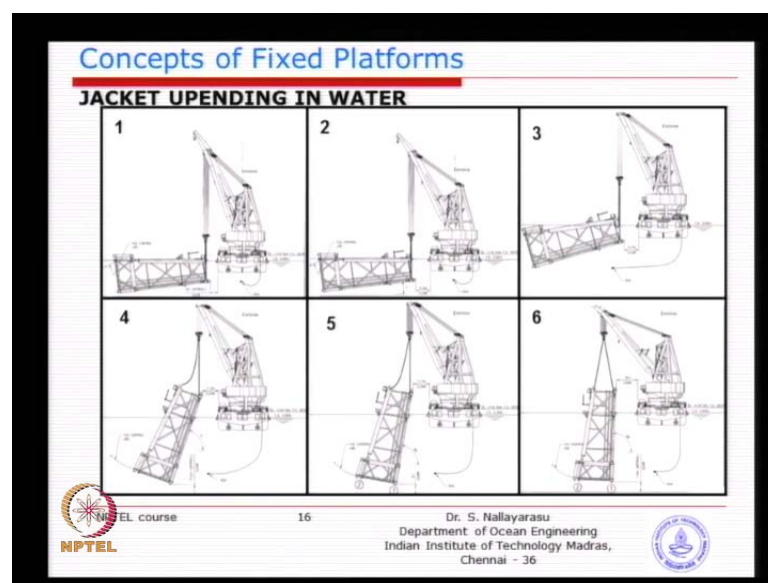
And basically will provide. So, this is the situation when the whole jacket is getting supported on this rocker arm. So, you can imagine this pin jointed connection to the barge means to be designed with full load transport to you know the the pin joint. So, that is where you will see that lot of designs checks it should be done on the barge side also does this rotating. So, as long as the centre of gravity as this on the left side of the rocker arm the jacket will not slide. So, as soon as the severity moves down right side of the rocker when immediately starts to slide down into water.

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So, that is the condition we need to see and once it is already in water part of the jacket is in water part of the jacket is on the rocker arm and in this time the bottom of the jacket will carry heavy load because this anywhere right side is not. So, buoyancy will provide additional support there is on the left side there is no buoyancy, but full load is coming on the jacket members. So, these are some of the scenarios you may have to check during the launching process once you do the launching and you get the jacket floating in this fashion. So, what we need is to make it upright. So, how do you make it upright is a very simple idea.

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So, if you look at this picture there are six stages just typically given here for information purpose. So, for example, the first stage is still floating horizontally. So, you bring a crane in the near vicinity connect the crane to the jacket members are the pre-defined points we already have fixed certain points where you can attach the cables now when you start lifting what will happen the jacket will come above water, but you would not be able to make it upright unless you bring the centre of gravity downwards. So, what we need to do is we need to flood water at the bottom and as you lift so; that means, the jacket members some of them larger enough to hold larger volume of water. So, you need to have prearranged pipes such that you fill up water or open a wall. So, that the bottom portion becomes heavier otherwise what will happen if you if you do not fill up water at the bottom you lift it off and then leave the crane jacket will come back to its original horizontal position.

So, what we need to make sure is as you move upwards the top portion you also need to flood the bottom portion. So, this process of manipulation of centre of gravity and centre of buoyancy is called upending. So, as soon as you reach near vertical you can see here we need to make sure that at that time every time the jacket bottom portion is not hitting the seabed and minimum clearance needs to be maintained this is not half meter one meter minimum we need ten percent of water depth if the water depth this fifty meter we need to maintain clearance of at least five meter because you see this is open sea condition and when you're doing this operation, if the jacket is going to up and down it may just accidentally go and hit the seabed.

So, that is why the clear rates theoretically what you're predicting needs to be ten percent of water depth or five meter if it is a hundred meter water depth you have ten meter the minimum is five meters. So, typically about five meter is a number that you need to maintain five meter is a lot because if you have even a three meter wave height during the oscillation you may not get five meter heave moment.

So, that is why this upending operation is a little bit of a difficult procedure because remember you have two open a valve for a bottom of the jacket how do you valve nobody is able to go there. So, we need to have a remote control devices why adopt to the control room before we launch the jacket this is one of the difficult task because the wires will break away during launch isn't it. So, what we normally have is we bring the wires all the way up to the top of the jacket and terminate and with a control panel.

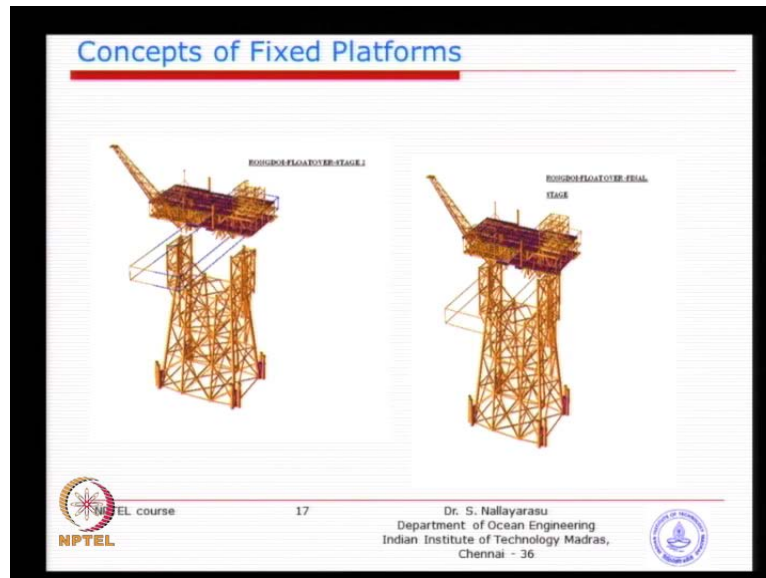
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So, and when the jacket is launched and it is floating in water you see in this condition the wires would have already got to this point already bring and then tried of their now we will take one more cable from this point to the barge control room. So, you connect it then then you start operating your control devices. So, that the valve on this part will be able to open take the seawater inside is just a simple device nothing, but a pipe with the valve fitted at the each of the section of the pipe and basically once you have such provision that control room on the barge they can operate each of the compartment valve opening water will go inside as the water goes inside say for example, since the compartment as the water goes inside you need to hold the the crane and start lifting otherwise what will happen because of the momentum the jacket will start go in the anticlockwise direction go and hit the seabed straightaway.

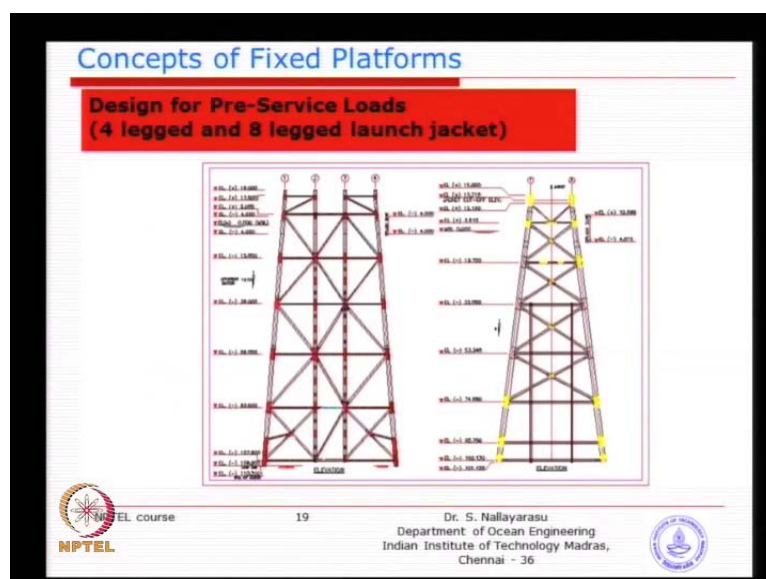
So, we need to just lift. So, this sequence needs to be worked out what time I open the valve what time I lift. So, this operation is called upending and upending in water. So, basically this once you do this and when the jacket is almost near vertical and make sure that at that time still clear message available and start lowering gradually and just shut down and seabed as long as the the weight is more than buoyancy the jacket will definitely sit on seabed. So, positive or the downward post must be higher otherwise to still it still float. So, very simple idea buoyancy is greater means will not be able to go down.

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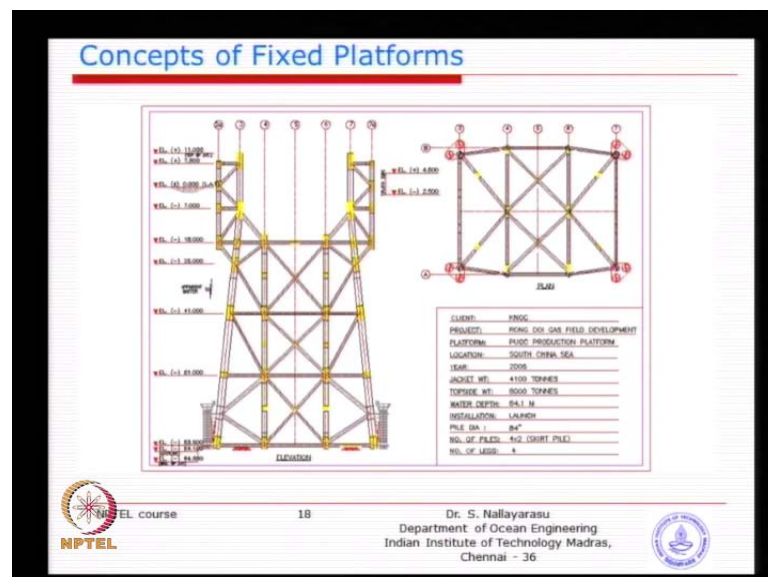
So, this you see this jacket one of the jacket for float over operation we will see four or five types of jacket configuration . So, now, you could see that the jacket when it is planned for launching you have parallel skid arranged. So, you see in this picture we have one one member another member arranged in a parallel way in addition to the four corner members which are actually supporting the super structure. So, this this arrangement it is not necessary if the jacket is not launched you know basically we inserted this additional members just only for the purpose of just making parallel skid way.

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So, if you go to another jacket you can see here on the left side is actually called four leg eight legged jacket, but two of the legs were purposely made parallel whereas, on the right-hand side is a four legged jacket, but the inserted additional two parallel skids only for the purpose of launching. So, either way what we are require for launching is basically two parallel legs. So, in this case automatically we got two extra legs because the jacket was planned for larger foot print area. So, when you want to design ah jacket for say sixty meters by forty meter you can plan for eight legged jacket because sixty meter by forty meter you can plan for eight leg jacket because sixty meter you look at two legs. For example, the spacing will be to large designing a girder or support structure first superstructure could become a typical proposition that is why can see here four leg versus eight leg you could see a difference.

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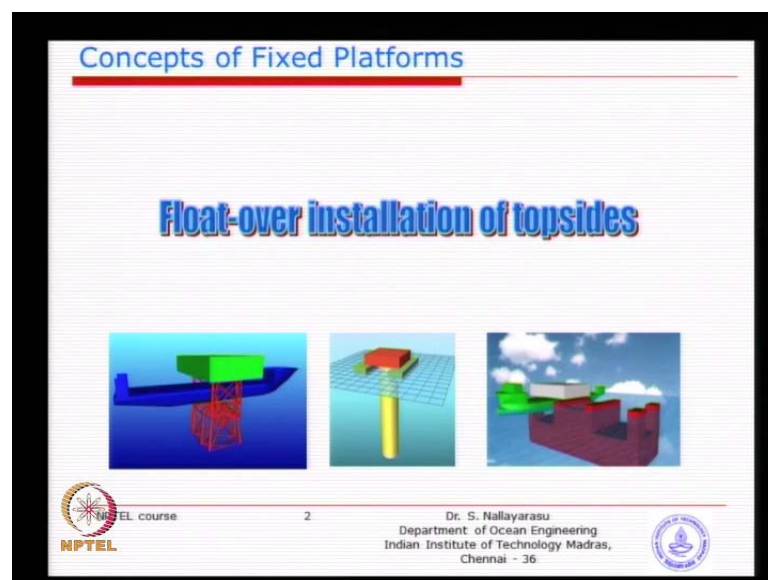


How the arrangement for launching is made whereas, if you look at this previous jacket this is purposely made for slightly different installation we will this one tomorrow the float over installation basically how the top tradition start and basic you you see see the legs are made slant and the heads are corner legs the inner legs are actually terminated at the certain level below seawater because later you will see in the previous picture barge is going to bring the the superstructure without the head of a crane we can actually dock the structure on top of the pre-installed jacket this is called a float over policy that details ah tomorrow probably you can even continue today. So, this float over operation you will just see how the take this installed.

So, once the jacket is launched made vertical and then we could bring and install the superstructure by lifting only because you you have to make sure that the superstructure is not become bed number one number two is you should have sufficient capacity to lift the superstructure and put it on top of the jacket which is installed previously now there are two ways of doing it one is by simply lifting and installing on top this can only be possible if you have sufficient capacity of the crane you know. So, if it is not possible what normal is done in the past is to break the superstructure in the several.

Subcomponents may be two or three or four depending on the capacity of the crane and assemble one by one which is commonly used for. So, many years successfully only problem is the interconnections have to be done offshore for example, you have module one module two which does it purpose one of them can be power generation module another one can be process when you actually install this thing separately the cables and pipes connecting them structures interconnecting you may have to spend a lot of time offshore sometime become very troublesome. So, in order to avoid this new way of doing installation without the head of a crane which you saw just now a picture the structure is broad by single piece by then it goes by means of a decking which is called a float over operations.

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So, we will just see that comparison something like this you see on the left side picture jacket is already installed and basically the ship is bringing the top sides completely

fabricated tested and everything is done in the yard and it comes in between the two portions pre-arranged in the jacket and then comes inside and sits down because while coming in it comes at a slightly higher level and then balances down the barge or the ship gets seated on the jacket it is easy to say, but what you can see the hydrodynamic interaction between the ship the structure and the wave. So, we need to see how difficult is it. So, basically that operation is normally done only for large top sites like if you have top sites of ten thousand tonnes and you want to install by lifting you may have to break down into several pieces like five pieces ten pieces if we make the installation time longer. So, that is why this option is introduced in the nineteen eighties and has been growing in number of installations for a long time.

So, many times because it is very cheap compare to the other installation only availability of such semi submersible vessels this type of vessel is supposed to be little difficult because number of them available in all over the world is about may be less than ten. So, getting down for more project could actually be a potential treble.

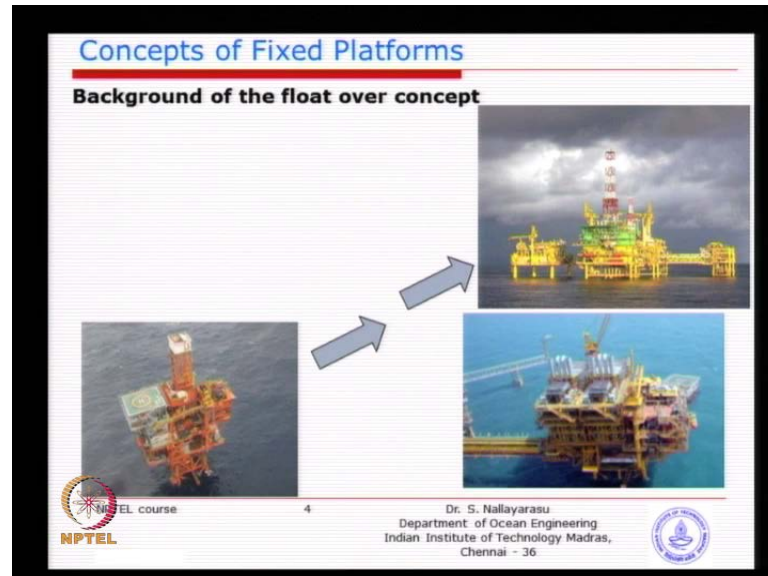
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So, you see one of the picture transporting at full top side is full superstructure in single piece and this is the mother vessel which is basically a semi submersible. So, that you can actually submerge the whole thing substantially in to water. In fact, the full height can go down except the small portion in the front and back. So, that the idea behind. So, basic idea is vessel needs to be specially design not all the ships and not all barges can be used

for this purpose we take a flat bottom and do this it will cap size you need to have specially arranged vassal which has got this.

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Submersible capacity think the idea is basically every time when we have offshore platforms the platforms becoming bigger and bigger it is not that the earlier requirements that is smaller and present requirements are trigger its basically depending on the capability see earlier times I think on the day one I was shown you few pictures of several platforms in one location you know one by one you arrange those days the capability of installations where. So, small that we wanted to put only small platforms add one more and add one more.

Now, you can see a capacity for installation is. So, large that we want to economize instead of putting ten platforms you make one platform together to produce larger quantity and make the platform size bigger and that exactly the idea behind to economize number of structures are getting reduce in one platform you put probably three platform production lines. So, you can see that the weights are increasing and that where we can see this picture you can see the congestion you know this fully background you would not be able to actually see through it if you go there it willfully fitted with equipments and pipes and cables and stuff.

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Concepts of Fixed Platforms

Background of the float over concept

Large topside decks
+
Limited availability of offshore heavy lift capacity

↓

Multiple modular lifts offshore

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So, the limited availability of offshore lift crane is a bigger problem you know most of the cranes in the viscosity in this region probably from middle east all the way up to east china you can see that may be three thousand ton is the capacity available whereas, if you go through europe or to maybe gulf of mexico you may see that ten thousand tones is easily available, but the one of the popular ms bringing in the crane from that side to here becomes too expensive the mobilization cost will be very high. So, that is why we should survive and use the cranes are viable in this region.

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Concepts of Fixed Platforms

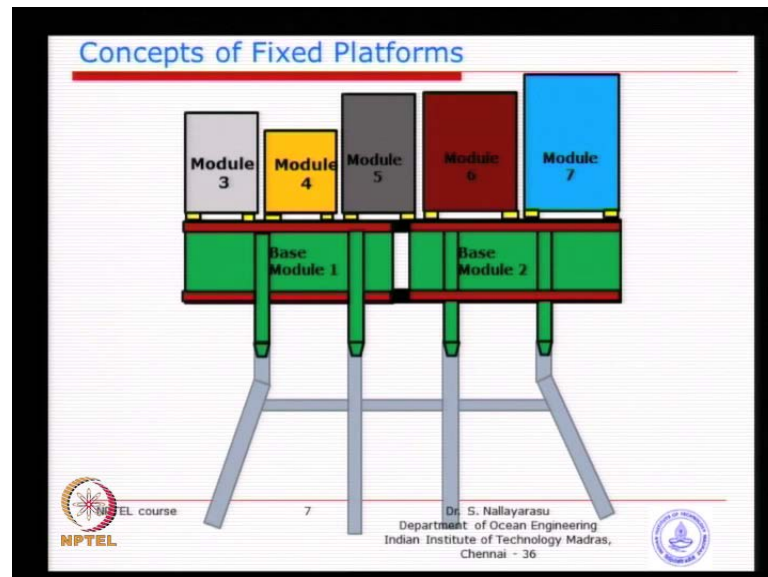
Modular Installation

- Large Topsides – The topsides weight for the process platforms are ranging from 10000T to 30000T depending on the platform requirements
- Small crane capacity – Many lifting cranes available in the region has a lifting capacity is in the order of 2000T to 3500T
- Thus the topsides will be split into smaller logical units (module) and installed on the jacket one by one. This is to be carefully worked out depending on the weight of the module and its location.
- The disadvantage of the modular installation is long offshore time for installation, hookup and commissioning.
- Several occasions the design of sub-assemblies and the integration becomes a major task during engineering.

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So, ten thousand two thirty thousand ton is that type of number nowadays most of the platforms are capacity is that much of capacity like twenty thousand to thirty thousand. So, may crane capacity we may end up ten pieces the ten basis integration offshore becomes really troublesome.

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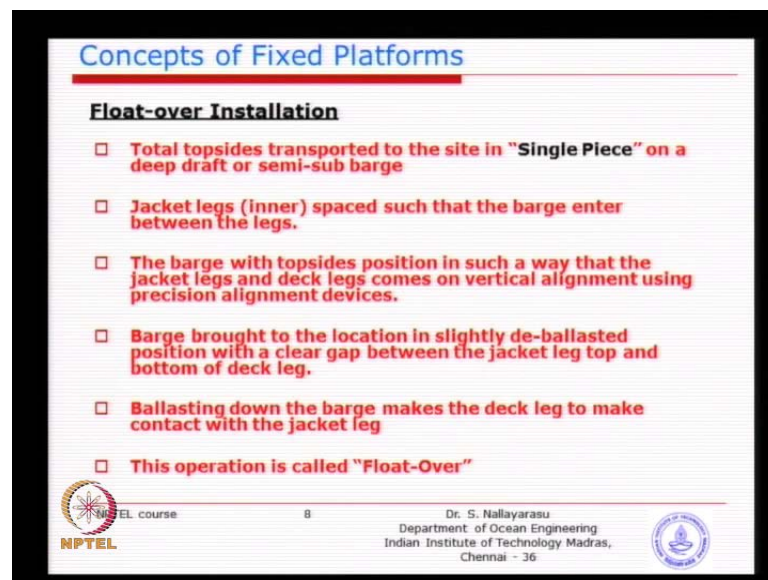
So, you see here how the module are installation for the last forty fifty years we once the jacket is installed and you see here this type of installation is feasible only if you have eight legs for example, if you have four legs, but I want to have two pieces installed is it possible maybe not visible then when it introduced to more dummy legs which may actually make the jacket bigger. So, that this that is one of the ore if you do not have that module to legs you would not be able to split the top sites into two pieces it still have to install in one piece. So, you see the reason why constant thinking of the design is all about installation offshore structures all about planning how you will install if you imagine yourself that can it be installed using the machinery that I have that is the question that you have to ask yourself then you design. So, the design is fully governed by such activities to the great extent.

So, then you split horizontally right now into two pieces also additional connection is given. So, that there become structures together and then you can see here you place the other modules of you know arranged prearranged in such a way that there become self-contained only the interconnection will become necessary if there is a communication if

there is a electrical system or if there is a process. So, basically you have to do this kind of pre-connectional idea. So, that you make them black boxes of each capability one could be process other could be power producing other could be living for example, you may have a living module where people will be something very similar to quarters you know, but not one two probably hundred people can live in that building. So, you just make a building module and put it separately. So, this we could see that this is looks nice idea is good,, but one of the problem is installation time and the integration time offshore could lead to a three to four months of our which you can save if you do the other way of simple single float over technique.

So, that you just after installation in few days you can start the platform whereas, in this it may take at least three to four months to do the offshore interconnections and then you start up by the time it may be too late and that is how it is going on and the disadvantage is we need a minimum eight legs to split otherwise or will happen the bottom portion still will need to be single the top area you can actually go for split one by one. So, this idea have to be worked out depending on what is the configuration of jacket what is the consideration of your superstructure and weight then decide.

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Concepts of Fixed Platforms

Float-over Installation

- ❑ Total topsides transported to the site in "Single Piece" on a deep draft or semi-sub barge
- ❑ Jacket legs (Inner) spaced such that the barge enter between the legs.
- ❑ The barge with topsides position in such a way that the jacket legs and deck legs comes on vertical alignment using precision alignment devices.
- ❑ Barge brought to the location in slightly de-ballasted position with a clear gap between the jacket leg top and bottom of deck leg.
- ❑ Ballasting down the barge makes the deck leg to make contact with the jacket leg
- ❑ This operation is called "Float-Over"

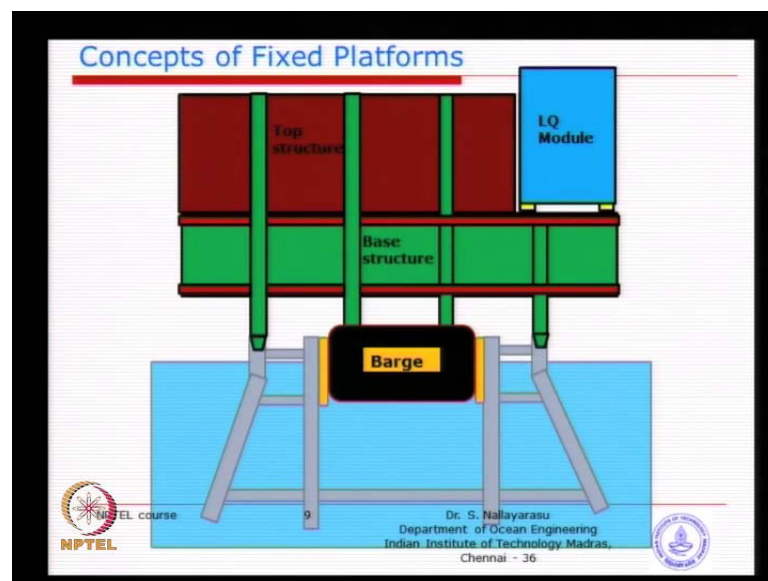
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Chennai - 36

So, float over is basically on that is. So, having discuss the difficulty of that installation people have desire to produce this offshore time. So, as early as nineteen seventy-six I think one of the float over, but not for the largest weight it was actually for three

thousand ton only and at that time they were trying to devise this idea how we can actually bring and drough this whole structure very similar to load out you know load out we had a trailers going on underneath lift it off and then move to the bars and then set it down here the the ship is going to take this bit weight and travel to the sight and then in the floating condition is going to bullas down by means of filling water and then set it on top of the structure which is already installed.

So, that idea is very very interesting only thing is it is done in open sea compare to trailers or unland and then salted water. So, that where we need to just do that idea now the second idea is jacket legs are spaced such that the ship can go in between. So, that is that is why you once you decide to do float over now you can realize the jacket design is changing you cannot have a conventional that a design where you are having all the members everywhere now you go to split the jacket into two parts left side right side middle part cannot have any structural members.

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Something like this you see here original design you might award a bracing system like this isn't it big members holding them together whereas, now it is gone. So, the jacket becomes may be two cylinder isn't it. So; that means, these members is to be designed appropriately. So, that is where the difference comes you can see here now you see this whole topside is fabricated in a single piece completely one piece integrated and tested ready for occupation you know offshore you bring it and basically and when you bring

this bars with the structure you need to bring it at a higher elevation; that means, a bottom meter higher than normally it should float. So, that when you come to the location jacket is still on the side. So, if you go to this picture there is a enough gap enough gap when it is arriving otherwise what will happen you cannot enter it will kit. So, bring it at a higher level and then once you match the legs then we can actually shut down.