Elements of Ocean Engineering
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Lecture - 36
Fixed Offshore structures (Contd.)

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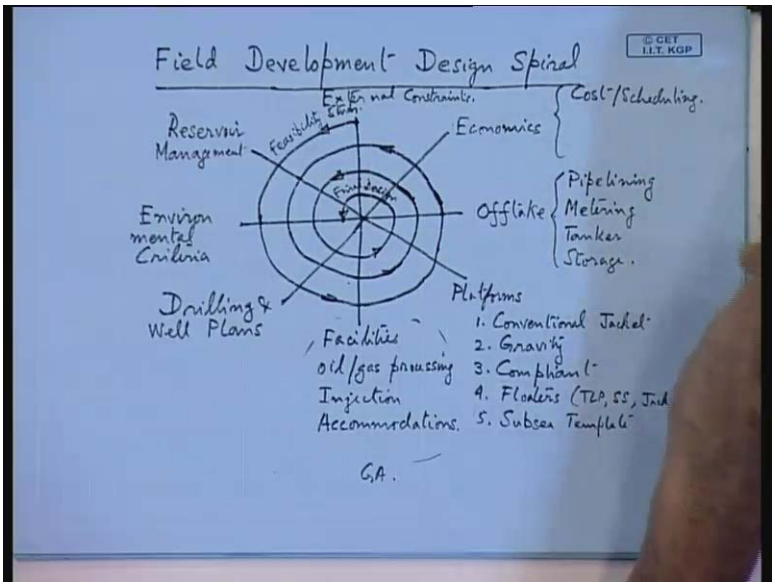

So, we were discussing the designs spiral before the ((Refer Time: 00:58)). So, the number of spokes in that is called field development design spiral. Now, this is a design spiral. You will find that the platform itself is a part of the design spiral. So, it is one of the spokes of the design spiral. So, here actually when we offshore field this is called the field development concept or field design spiral, the platform is a spoke. So, I think if you see; that means this is what we had constructed last class. So, we will start from here, either we can start from the inner most ring or the outer most ring.

So, it starts with the feasibility study, then it a goes to this extent, and then it will go on with the number of iterations. So, this is one iteration. So, you will perform number of iterations before you come to the final design. So, that is the concept of the design spiral. So, it goes on like this. So, you complete this is as soon as you come here. So, this is 360 degrees. So, one alteration is coming. So, like this you keep on doing. Now you know what will happen in your ship design you only perform the design spiral for a ship, but

unlike in this case you have to do the design spiral for the whole field. So, that is called the field development design spiral.

So, here you start and go here. Then it comes like this and finish off here. So, this spokes we have already defined. So, already we have four spokes and you can have one more. So, these are called the spokes that is the design elements. So, here you start. So, the spokes you will find these are the external constituents we have defined. This you begin your feasibility study out here. Feasibility study starts from here, and your final design will come somewhere. This is your final design. Now in between you have to pass through a different spokes. So, here you have external constituents. Now this in last class I have already told you. So, I am not going to repeat.

Now here we have reservoir management, then you have environmental criteria, then drilling. So, you can see the job is if you go to offshore the job is must more difficult and requires lot of planning and more vigorous than your ship design project. That is because you have to do the total field development facilities and you are only here this platform. So, what type of platform you are going to select, and this is your aft take; the other one is economics. So, I have discussed all these hints; now only three are left, is it not, economics uptake and the platforms. Now here the facilities I have already told you these are oil and gas; you should have some knowledge of oil and gas possessing, why? The reason is we have to know what are the equipment that will come on to the platform.

You know ships actually if you do the deck out feed you should know what is the windlass, then wheel chairs, then you have cargo handling gear. So, this will come in your GA. So, your oil and gas processing facilities will come in the GA plan, because it is a deck arrangement. Basically your platform is a deck design, is it not? So, all your facilities are going to be on the deck.

Now remember if you go on these facilities design as never agreed you should have some idea, because the last class I told you how to segregate the different areas. So, that is the job of the naval architect, how to make the GA plan, how to segregate the areas, because there is some horizontal and vertical separation, is it not. And in between you have to bring some firewalls, copper dams and all these things because of the risk of fire. So, that is your oil and gas.

Next you have injection; what is this injection? Injection is sometimes they inject a steam inside the borehole in order to a jack up the pressure. So, unless there is a certain pressure in the reservoir your oil is not going to come up. So, especially if you have oil the amount of oil goes down in the reservoir, then you have to inject steam. Normally they inject steam, and there is the safest gas. This is called injection, and sometimes in the blowhole in order to stabilize the row you have to inject cement also. So, all these are the processing facilities, and the last one is your accommodation. This is just the basic minimum requirement.

So, these facilities have to be laid out properly on the deck, and you have to do the horizontal and vertical separations. So, now in your platform you have number of decks. So, how you layout each deck? So, you have to do it in CAD that is called layering and interfering between the different zones. Now you have to connect all these spaces by means of an access plan, your piping and all these things you have to do. So, this is your main work that you have to do as this is essentially your GA general arrangements, okay. So, this is the one part of it. Now platform is another part of the whole story. So, now, what type of platforms you are going to install? So, this is the conventional jacket.

So, conventional jacket this is a fixed type of structure remember that, and then you have gravity; that is gravity also comes to some extent under fixed platform. Then you have complaint; complaint I have told you because of the mooring boyars these are called complaints, then the other is here it is floaters. But on the floaters also there are many different categories like your TMPs, then you have semisubmersibles, then you have jack-ups, etcetera. So, you can see the design of all these things is just only part of one spoke of your design spiral. So, if you have n number of floaters then all these if you have floaters then you have what is called a subsea template.

So, this is called the well head assembly. It is on the seabed where your casings are connected and also it comes down. Now aft take also here the major part is your pipe lining. Now since you have to do lot of engineering work you see in coming to the design and construction phase, as an engineer if you go, you have to do lot of engineering, and pipelining is one aspect of offshore engineering. So, this we will talk about in more details in your offshore technology class. Then you have metering; if you have pipelining you should have metering is how much of gas and oil you are getting out. What is the measurement of flow rates and all these things you have to do.

Storage is in tanker a shuttle tanker, and if you store inside the platform then you also you have storage inside the platform, and economics is part of cost. Then cost is scheduled. So, this briefly I have told you how to do scheduling, yeah; scheduling is the simplest method is conceptualization of a bar chart. So, I do not know you whether you have studied all this or not, but if you go for all these engineering you will require, first you require all this. This actually is not part of the whole story. Now you just brush up your funda on this bar phi chart. This is called production planning. Now those of you who are going into the ship building and offshore engineering, you have to do production planning.

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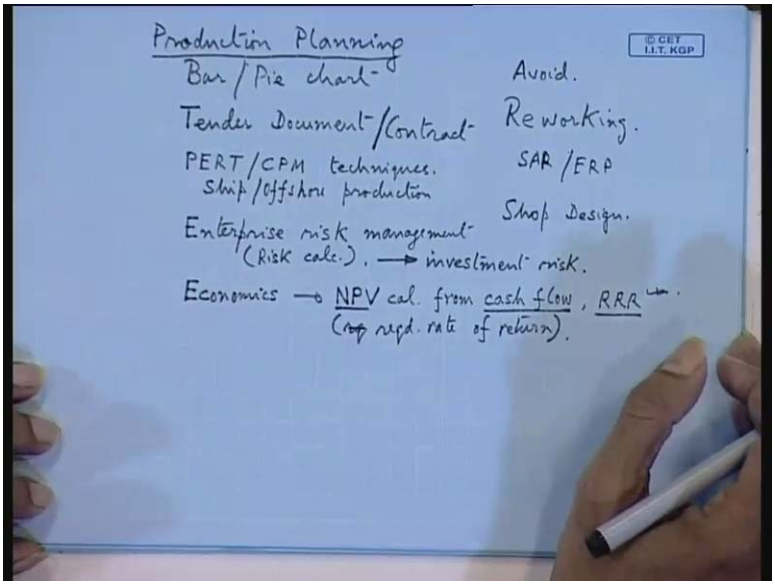

And if you go to your shipyard you will see they have a different designed department and different production department, okay. So, the design department will perform all the ship design processes, just I told you making your lines drawing, then your general acknowledgment drawing how you layout the facilities and all. Nowadays all this thing is done in AutoCAD and you have to be very efficient in your AutoCAD 3 D modeling and all these things you have to do. Because once your final design goes to the shop then it is final, you cannot change it; otherwise, they have another thing that is called reworking.

Now reworking is very costly in ship building and offshore, is it not, because in offshore if you go, that means, you have made the whole program of a pipeline which is going

under the sea. So, basically if you want to change the path of the pipeline there will be huge cost; we just cannot think about it, okay. So, in ship building you always try to avoid this reworking. So, this problem, yeah actually in olden shipyards which they are not progressed they have done lot of automation. Nowadays shipyards have become highly automated you see; they have implemented GRAC and all they have implemented SAP and all these things. You have PSAP and all these things are there, okay.

So, all the data processing and data management is done in your design and planning office. So, you have to be very much conversant with the IT environment in your design office. So, these are some of the things which we should concern. Now some of you will be posted in the design office and some may be in the production planning zone, production planning in this thing. Now there also you will be asked to make this bar and pi chart. So, bar and pi chart you first segregate the different stages of production, okay, like your hull shop, the main hull fabrication, how much of this thing design fabrication in the shop. So, again then you have to interface with the hull shop people.

So, he will tell you that I have so much of drainage facility, this much of block assembly I can do at a time, this much time it will. So, lot of data is required from your shop; shop data has to be analyzed properly in the design office, because why it is being required, the main problem is we have to give a proper scheduling if you have dogged a contract and previous to that. So, buy and pasture is part of production planning. Now here also you will be asked to make a tender document for those new ships. So, tenders and contract, preparation of tender document; now how you are going to prepare a tender document? So, this itself is a large activity in the planning office, the planning stage.

So, tender document preparation first there are two aspects. One is your technical side; that means what is going to be your functions of your ship or offshore structure what you are giving to the client. So, that has to be specified in quite detail in the tender document. And remember tender document may be a tender document is very crucial, because this is where you have the major profit of the shipyard is going to lie. So, you cannot give any arbitrary or something which is misplaced; this is not required in the tender document. Otherwise, you will be caught, because tender document is a valid legal document.

It is a contract; it is the part of a and remember if you want to go offshore this contract, there will be number of parties in the contract unlike your ships. When you are ordering you just come across one client, but here actually the contracting parties will be not one but will be many. Probably your government and number of private contractors and venders will be there. So, signing a contract in a tender document is very very crucial and very important, because the profitability of the shipyard is here. So, how much profit you can gather from govern from the contract, remember any clause in the contract which is going against you. You should not put into that; you should not sign that, is it not. Otherwise, you may be caught on the wrong foot.

And there is lot of penalty clauses, you will find in ships if you go for a contract; one of the favorite penalty clause is a ship. Suppose a ship if it is carrying a cargo and is not going at a particular speed then the owner will sue you in court, is it not. Then you have to be penalized for not giving the proper speed. So, that is part of the naval architects job. So, after seeing trial he has to see whether the ship is giving a particular speed or not. So, here in the offshore actually what your platform is suppose to deliver certain amount of oil that is called production rate. Now it fails on that then you are penalized and penalty review comments probably it is some thousands of dollars per day, is it not.

So, that is your naval architect has to prepare a valid tender document with all the realities and technical specifications. So, this will come in tenders and contract. So, this is your production planning ship space where simplest form is your bar and pi chart. Now after this I do not know whether you have studied this, whether you should study if you have some knowledge of PERT, CPM techniques. So, here this is critical this is I think production review technique this is called, and this called a critical PERT method. PERT, CPM technique is another, way you pet subject of your the planning engineer. So, the planning is this is one of the techniques, but other techniques are evolved.

So, these are if you try to get some knowledge in this or you got to exposure in ship; this is normally used in ship production, ship same thing with offshore production techniques. So, because you have to properly point out at what particular point of time the shop is going to deliver so much amount of a work. So, that is called production planning; you have to do lot of production planning in the planning office. So, this is the PERT, CPM techniques are employed, and then after this a new topic has come; this is

called enterprise risk management. So, offshore structures are very risky. So, you have to have some risk calculation.

On enterprise risk management you have to do risk calculation whether it is going to fail or not, whether your investment is having some risk. So, risk calculation has to be done. So, these are all management studies, and the other is economics. These are typical, and all these are the planning process. Now in economics you have to find out what is the net present value of your project that is called NPV. Your NPV yield calculation you have to do; this is normally done from cash flow. So, you have to formulate a cash flow diagram for the whole project, right from your inception. So, after 25 years the life of the platform, so so much money has been invested, and how much return I am going to get from the project. So, that is called required rate of return.

So, these are the two things you have to calculate. So, remember these are some of the basic management and production concepts which you have to know. I do not know whether you are doing any production reading any production subject or not, but these are the things which are required. If you go in your professional life you will be asked to do all this. So, these are one, two, three, four, five items. Economics you no need to go into the whole gamete of economics; you just study NPV. This is called net present value, and RRR is the required rate of return cash flow.

So, any project before you sink money into it you should calculate the required data, why? Suppose you required rate of return is less than the bank interest then nobody will like to invest money in that. Bank is giving, say, seven and a half percent and you have calculated with rate of return; it is coming to six percent. So, that means then why I should invest money in your project. I can myself as well keep it in my bank where it will give higher rate of interest. So, this is what they do all this RRR business. So, anyway you will study; these are quite in detail excepting the bar and pi chart. The others if you want to go into details there is separate subjects are there. So, risk management. So, this is your investment risk.

So, normally the students who are employed by all these banks and all these things in our case they calculate this investment risk then. How to calculate the investment? Actually two or three tools mathematical tools by which we can calculate that. So, that is covered in this enterprise risk management. So, this coming to the design spiral. So, that is that.

Now after this, what you do there is number of stages, and in your case what will happen is after your design stage you have to strike upon a concept design. So, what are the different stages of design?

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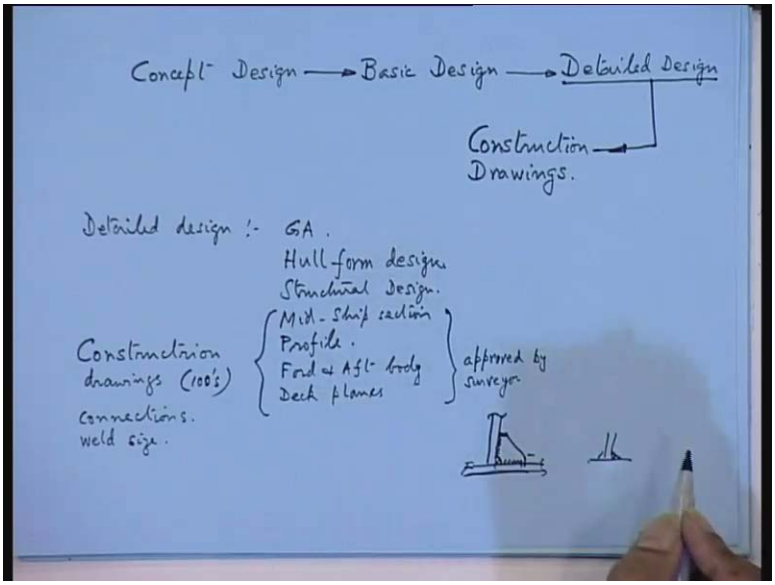

So, the first you strike what is called the concept design. So, that means after from your preliminary studies you have formulated what should be your requirement analysis. It will come as a concept; sometimes this is called an artist impression because in your pen you just measure sketch. Now after this you go for a basic design. Now basic design is this is a bit more complicated than concept design. This is little bit more in detail. Now after this basic design you make a detailed design. Now a concept design you start here; that is in the feasibility study, we will start with this concept design and end with the final design. So, that is the design process. So, detailed design is your final design.

Now even after this you do not stop. Detailed design is, that means, you have prepared what is called the detailed general alignment drawing, but if you given a general alignment design to a shipyard, say, hull shop will it be able to fabricate your shipper office structure; you will not be able to fabricate. So, you have to prepare what is called working drawings or construction detailed design, construction drawings. So, that means, say, in this detailed design you have made, what are the detailed design drawings that are required? Detailed design you will be asked to produce this sort of drawings. So, the

general alignment is one of the drawings, then what is called the hull form design that is your lines plan or form selection.

And this is of course in ships and aft ships design. So, then you have structural drawings. Structure drawing is the most important work; structural drawing is your mid-ship section. Then you have what is called the profile. Then you have forward and aft body. Then you have deck structural design, deck plans. So, these are some of the structural design which have to be produced, and anyway these structural design drawings these are approved by surveyor. They will go for surveyor approval. Now from these drawings you have to produce construction drawings. So, drawing is an engineer's language of conveying to the shipyard or hull shop how a particular item is to be built.

So, you have to prepare a large number of construction drawings. So, here you will only use three or four drawings, but here you will get in hundreds. So, now you have to explain all each and every detail in the drawing to your, say, hull shop manager or your supervisor; otherwise the shipyard will not be able to fabricate. Suppose you have given a deck yard but you have not given the construction detail. So, you have to give all your detailing, say, bracket; so like this is the bracket. So, how much will be the cut out, how much will be this length, how much will be this length, this length, all these dimensions have to be given. What is the plate thickness of your same, ball plate thickness of your flow.

All these detailing have to be given, and your connection details have to be given especially connections. Now this actually you have to do in your hull shop connections and what, weld size. So, just giving two plates a drawing like this is not sufficient for ship yard to fabricate because you will get the dimensions because you have to give what type of welding you are going to use, what is the size of welding? So, if this is a, say, t joint. So, you have to specify the root and palate, root and troth thicknesses have to be specified. Now whether you are going to continuously weld around the bracket or give intermittent welding that also has to be specified; otherwise, he is cannot build the structure.

So, all information relating to building your hull has to be there in the drawing. So, these are called construction drawings. So, this will go as far as your structural drawing is concerned. Then your whole set of drawings have to be produced for your ventilation

and piping, and all these drawings have to be interfaced. Suppose you make a weldment of a part of a ship, so obviously you are not just bringing the harbor. Nowadays they make everything together and then they weld the weldments together. So, those things have to be prepared anyways, so those are all the construction scenario. Now after construction what you are going to do? So, your construction phase is over.

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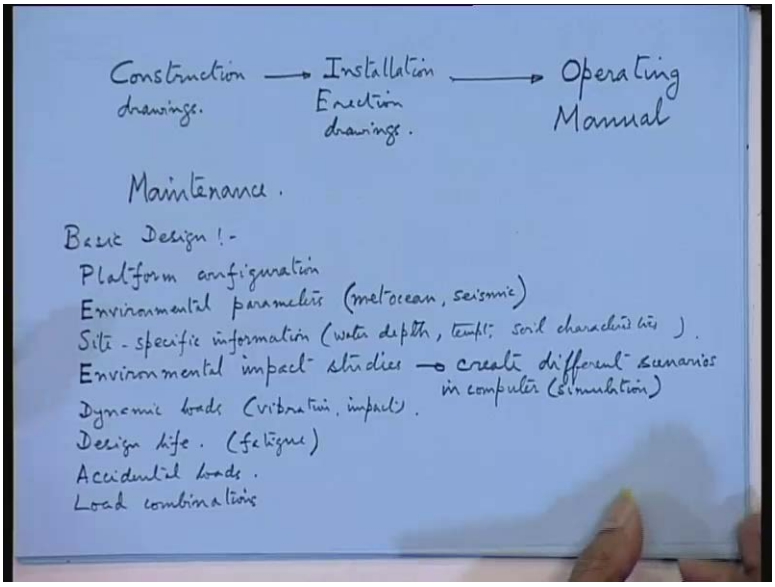

After construction then installation; this is also very critical especially in offshore. How many deck modules you can construct, and in installation the two basic methods I told you. One is the hookup method, the other is what, floating method where you take the deck loaded on to the truss, but then I think that is called the floating method, the other is the hook up method. So, which method you are going to use? I have already told installation erection and reaction drawings. So, here also you have to fix installation erection drawings, construction drawings. These are to be produced, and last is what after this? We have to produce an operating manual.

How you are going to operate the platform, what are the sequence of operation? Operating manual maintenance. Now all these documents have to be prepared. If you go to your shipyard doing ship building or offshore engineering you will come across all these stages. So, these are some of the scenarios. Now before you go into the structural aspect figuring all these design stages you have to fix up. Then field development I already told you and basic design is. So, this is already known. Now when you come to

this stage the basic design, there are number of aspects which are going to be covered, because basic design is just coming before your final design.

Now here you make you decide on platform configuration. Now here actually you are now fixing up whether it is going to be a floating platform or a jacket, and then you calculate loads; we are going coming to the structural design. So, this is very important. So, this comes under a separate branch of study that is called met ocean seismic if you use for fixed structures. So, this will come. Ice of course we are not much bothered. Then the other is called site-specific information. Now besides met ocean I told you this is returned; the measure is water death. Water death is a very important design criteria; that is the size of the structure would actually depend on the met ocean that is wind waves current and water death.

Here that is actually the ground. So, water death and all these things are there. Then temperature soil characteristics, etcetera. Now these are some of the measure. Then I am not writing then you have. Now this is a very important although it is not there this is called environmental impact studies. In any measure this type of offshore project if you go, you have to make what is called an environmental impact studies. So, what influence the structure has on the immediate environment? Suppose there is oil pollution there is leakage of oil. So, now, in the nearby there is a big city is there.

So, obviously, there will be lot of pollution coming onto the beach and all those thing, then if you yet, say, dam. So, I am just talking or I say gravity platform or some fixed structures. Then how it is going to influence your flow rate in the sea; that is there will be inundation in one place and there will be siltation in one place; for dams actually this is very crucial. So, all those things have to be studied. These are called environmental impact studies, and here you have to create different scenarios, scenarios in computer. So, this is called computer simulation. Here you have to do lot of simulation studies. In computer you can generate nice graphics with combinations of environmental loads that is waves with current, waves with a tidal current.

They say a large number of scenarios are created and their influence on the immediate environmental studies. So, these are called environmental impact studies. So, in any measure not only in offshore in many major civil engineering works you have to make an environmental impact study. And then of course so these are some of the loads, and then

the dynamic loads are also I will just give you the description in detail why this comes. Dynamic loads from impact vibration studies; vibration impact and all these things you have to study. So, then you have to find out what is your design life based on fatigue. So, this is you have to calculate this, then accidental loads, load combinations. Now what is the other things damage stability?

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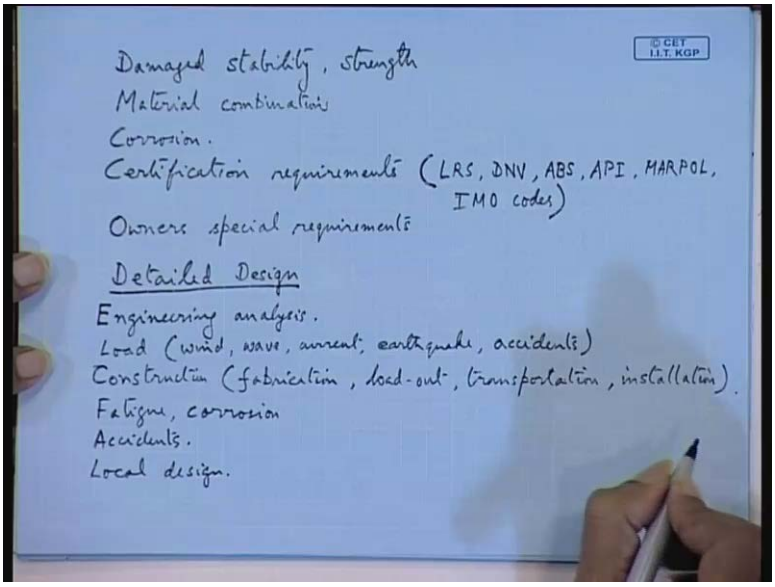

So, if yours is a floating platform then you have to make rigorous damage stability calculation, damage test stability, damage stability strength; how much is your remaining strength? Suppose a column of a platform has broken. So, what is going to be the situation? Whether the platform is going to survive that damage or it is not number broken, basic number has broken. So, all these studies of damage study the strength you have to carry out. Then of course material is more or less known, material combinations, high strength steel and mild steel, then corrosion.

So, all these studies will come under basic design, then the certification requirements. What are the certificate requirements? Here we have to see whether your design performs to the requirements of LRS, DNV. Normally offshore structure you will find last under ADS, DNV. Then you have API, MARPOL, IMO codes. This is very essential. You go to the design office; you have to consult all these codes, why? Because ultimately those you have to produce the certified drawings. So, your surveyor will only

certify those drawings, we just follow these codes. So, he will ask you which code you have followed or not? So, this you have to make a study.

Owner's requirement, owners special requirements. Now you will find ships and offshore structures. They are actually tailor made objects. They are not like your Maruti cars, is it not? So, there will be specific owner's requirements for a particular design. So, your owner will require say instead of, say, forty people accommodation hundred people accommodation. So, you have to provide that. So, there are specific owners requirement. So, those have to be created too; that is you are making a building, okay. So, that has to satisfy the person who will be staying there. So, what are the specific requirements? So, all this will come under the basic design phase.

Now after this you go to the detailed design. Now detailed design is more important because this is your fabrication stage is coming. So, here you have to do a lot of accurate engineering analysis. So, here loading you have to find out, this is wind, wave, current, earthquakes, etcetera. Then you have accidental loads. So, you make a thorough assessment of all the loads, then construction. Construction basically is your fabrication; what else is there? Load out will be there, transportation will be there. These are after the fabrication stages.

So, for this actually separate document have to be prepared for all these with your drawing and all the literature, remember that, then installation at sea. So, this has to be done. All these detailed documents have to be prepared, fatigue, corrosion, etcetera will come here. Then you have accidents, local designs. So, at a particular locality what are the designs, trusses and what you are going to deal? So, those have to be calculated.

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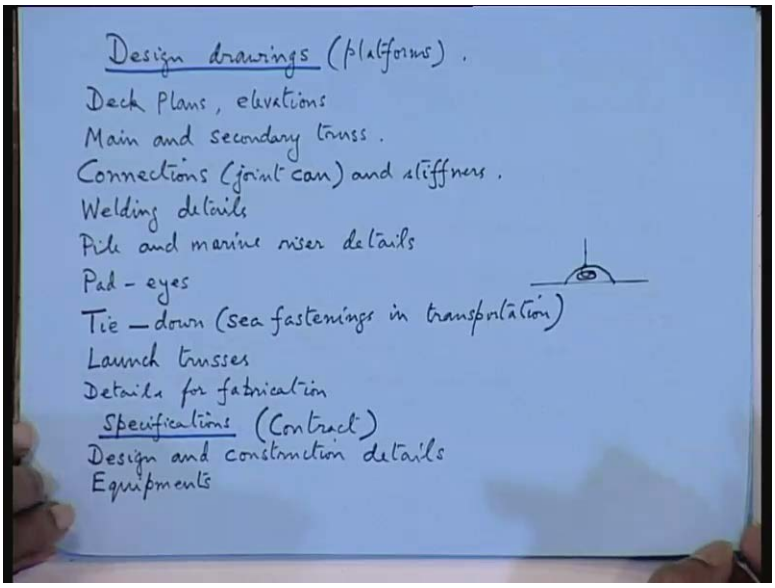

Then you have to prepare I told you design drawings. Now these are very important, because they are not similar to your ship drawings. So, platforms; first I told you, you have to prepare deck plans, elevations, main and secondary trusses. What is your main truss? Main truss is basically your undersea that is template that is the main truss. Secondary truss is your deck supporting truss that is called a secondary truss. Then you have to prepare connections, drawing of connections. They are called joints, or sometimes these are called as joint can and stiffness, welding details; this I told you. Now whatever things you do in ships.

So, this will be more rigorous. Piles pile and marine raiser, your riser details, other details is you do not mix up marine riser with pile; better you write them as separate. The other is pad-eyes; what is a pad-eye? Pad-eye is a lump which is welded to a particular structure like this. This is called a pad-eye. Now here you put a lifting hook. So, where you are going to position this lifting hooks. So, those are called pad eyes, and for transportation you require tie-downs. Tie-downs I have already explained to you. So, these are also sometimes called sea fastenings in transportation. So, these are typical offshore tie-downs, then the launch stresses or launch girder for jackets, then details for fabrication.

So, these are your design drawings have to be prepared for this, and specifications you have to prepare. Now drawings are not enough you know, because if you want to make a

particular object you have to prepare what you are going to give to the customer. So, these are based on specifications. So, under this you have design and construction details, offshore platforms, what you are going to offer to the customers. So, that will be included in the specifications. Specification also will be part of contract; normally it is a part of contract.

So, very important, then what equipments you are going to give the customer? You have to specify equipments such as pumps, cranes; what are the capacity. I mean the technical specifications you will give; all the technical specifications have to be given in this document called specifications or contract specifications. Say, you are giving a certain crane, then you have to specify what is the lifting capacity? And what is your laughing arm that is called the reach of the crane; all these have to be specified.

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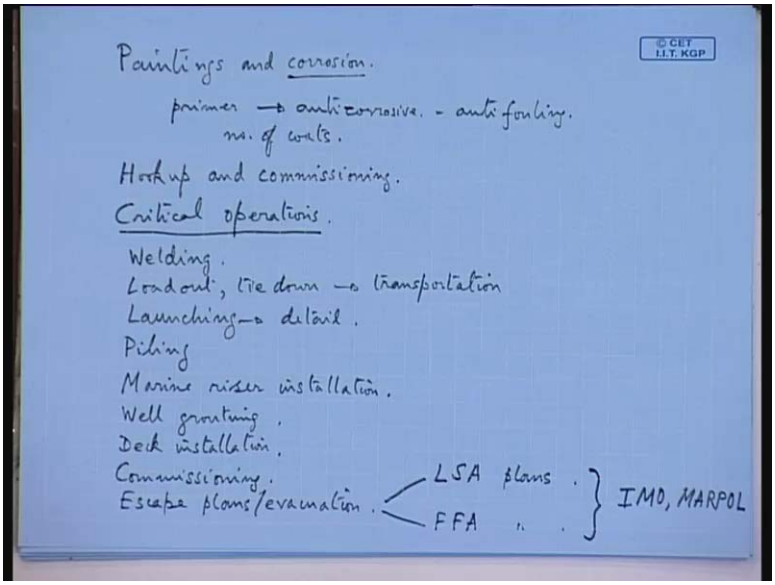

Then painting plans, paintings and corrosions. Now painting is very important, why? There are two aspects of painting; one is because it gives aesthetics and the other is it prevents in our marine these ships, because in large extent it prevents corrosion. So, you will come across, I do not know whether your studying corrosion in detail; you will come across a paint which is called. There are two types of paints; you will call anticorrosive and antifouling paints, and howl on the ship. So, painting plans have to be prepared starting from primer how many coats.

So, this is primer. Then you come to antifouling, anticorrosive; for this number of coats have to be the specified. This is your painting plan has to be prepared. So, this will come under specifications, then the hookup, how you are going to install the platform and commissioning. So, this will come, then critical operations. So, these I think we have mentioned earlier, but the other specific areas it can cover are welding, then load out, tie downs. So, these are already covered in transportations, but this have to be given in detail apart from your basic design. This you have to prepare lot of detailed calculations, launching in detail, then piling; how you are going to drive piles, sequencing of piling. Then you have marine riser installation, then well grouting, deck installation, then commissioning, then last is escape, evacuation.

So, in marine if you go for all these marine structures, what they escape is a crucial area. So, in ships you come across this what is called; in ships as I say normally prepare this LSA, FFA plans. Now how you are going to prepare this? Suppose you are employed in a shipyard or in offshore component, you have to normally call, LSA is called life saving appliances, FFA is fire fighting appliances. This will adhere to IMO, MARPOL. Now they are separate drawings; for ships we have to prepare separate plans means drawings.

Now if you want to prepare those drawings the number and the capacity of all the fire pumps, extinguishers, you consul consult the IMO. IMO is you have to consult solar, solar requirements, solar comes under IMO regulations; MARPOL is for pollution. So, these are some of the jobs you have to do before you go into the actual structure. Now after you have done this then you will get the detailed load that is coming on to the structures.