Marine Construction and Welding

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Lecture No. # 02
Characteristics of Shipbuilding Industry

So, continuing what we have been doing in the morning with ship types; ship types, we have seen various types of ships, both inland and ocean going, and then we will talk a little about the other component, that is, the offshore structures. Offshore structures - we can see that the advent of offshore structure started sometime from early seventies.

For oil exploration, offshore oil exploration, at that time - I mean till mid-seventies, the offshore structures used to be primarily only in the fields where the depth of water is less - at the lesser depth; now, as time is going on, people are exploring all the oil, out and further, going in the deeper and deeper oil fields.

Today, it is feasible to take oil from a depth of around 3000 meters, that kind of depth; so, with that the offshore structures are also evolved over the years.

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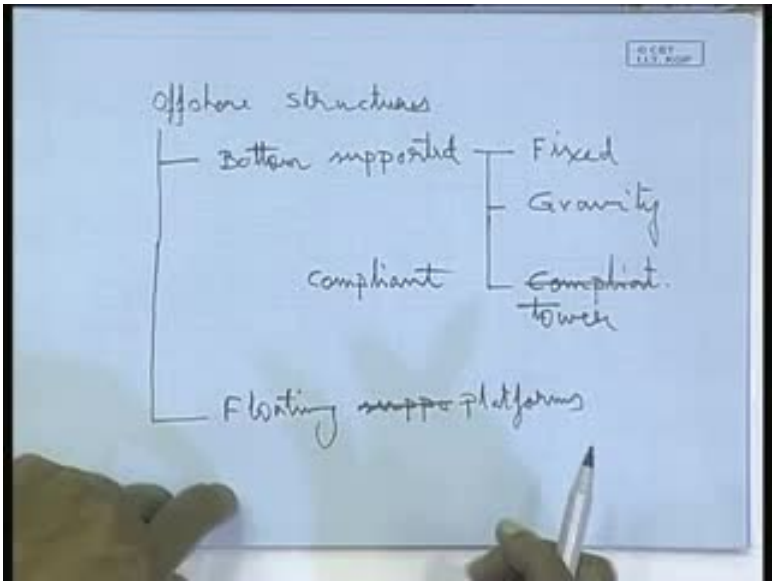

They are essentially classified in the following types: one is, what is referred to as, bottom supported platforms, and another one is floating platforms; so, the floating platforms.

Bottom supported ones means - which are supported, which are sitting on the seabed, so called seabed; the floating platforms are floating. Obviously, the bottom supported ones are the ones which are the shallow depth ones, which could be used only for a shallow depth.

Of the bottom supported we had various types: they are referred to as fixed platform, another one is gravity platforms, and there is another type which is referred to as compliant tower; fixed, gravity and compliant tower. So fixed platform, by the name only, they generally used to have a substructure and a platform – substructure, main structure below the water and a platform, and the platform can be - the simplest ones are with one or two platforms, and the more complicated or also to say integrated ones with several decks, with all kinds of drilling and exploration machineries.

Because it will depend on what purpose this offshore structure is being used - it can be for exploration, it can be for exploration, it can be for many other so called requirements; so, that is how the fixed towers were like - that it is fixed in the seabed, that means, the legs are grounded in the seabed.

The tower is taken to that site and it is literally fixed - cemented to the seabed, so that is how they are the fixed towers; obviously, they are generally very shallow depth, the order of depth was of the order of 15 meter - 20 meter, like that.

Then came the things which were referred to as gravity platforms. Gravity platform means, they are also heavy structures, the very function of the gravity platform is that they sit on the seabed of its own weight - that means there no foundation work is done; no foundation, in the fixed platform there was foundation work.

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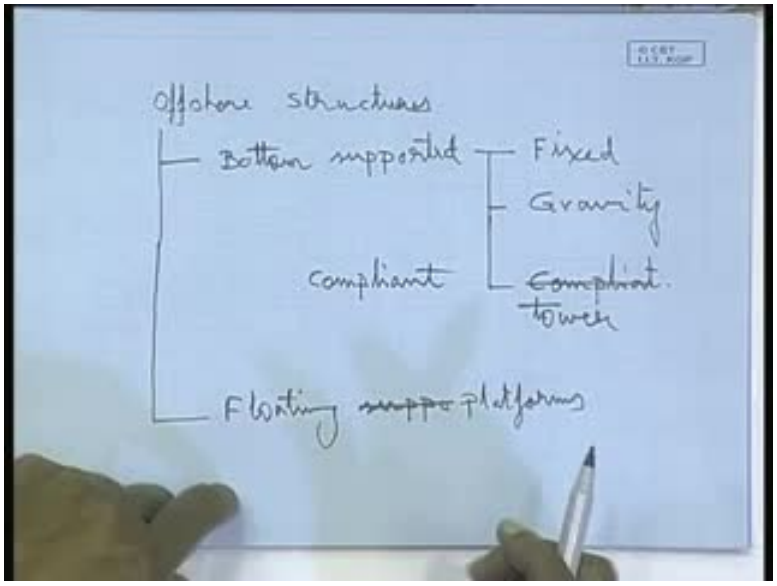

The difference between fixed and gravity is – in fixed, bottom foundation was done, whereas in gravity platform, it only sits of its own gravitational force. Obviously, that makes us calls for a requirement of a heaviness of the structure, many a time though, legs are of concrete, and also, another requirement of this gravity platform is, that it needs a fairly strong subsoil conditions.

If the subsoil is very loose, then as you put a structure it will keep on sinking, so that is also another requirement, that means - you will have to study the sub soil conditions - it should have the necessary load bearing capacity such that it can sustain the weight of the gravity platform and it sits in the desired location. So, that is what are gravity platform and the fixed platform.

The advantage of these two types are that can stay rock steady, means, they do not move with the waves so that your operational aspects becomes very easy; because if you want to do a drilling operation, your all the drill equipments should go vertically down. So, there are least bending movements or the forces will act in the drilling equipment whatever is going down; similarly, if you are exploring oil, the riser pipes also will have minimum forces. So, design of those things become easy, but it has the inherent disadvantage that you cannot make these for a depth of 1000 meter 5000 meter or whatever, even for 100 meters it is not feasible; so, for very shallow depth operation, these are feasible.

Gradually people looked, as I said, deeper and deeper seas, so that came the concept of compliant tower. Compliant towers, schematically, the whole idea of compliant tower is, this is also a bottom supported platform. Compliant - there is one n, I am writing this side; compliant tower, that means, it complies with the waves.

As I said, the fixed and gravity platforms, they are steady, that means the waves will come and hit on it. So, on one hand, we have advantage of it being rock steady, your all the drilling, I mean, accessories for pumping the oil, the riser accessories, their movement are less, but there is a heavy movement in the overall structure because it cannot move - it is fixed.

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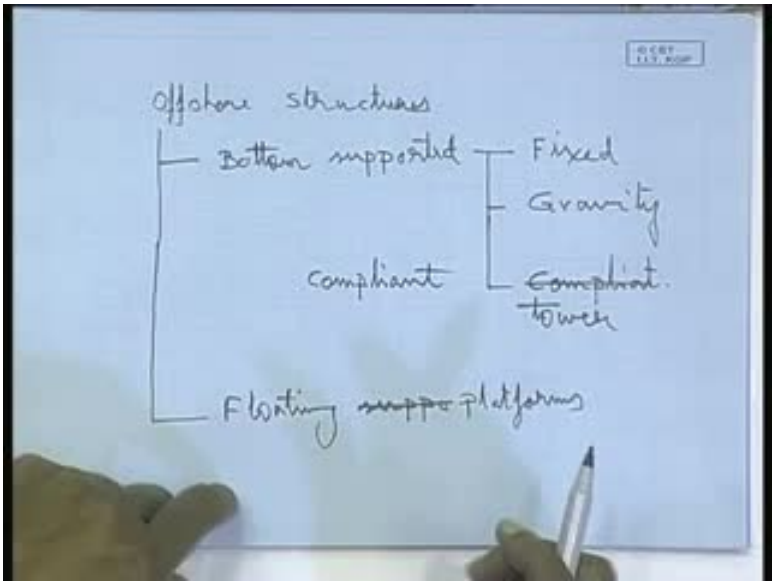

Also, the disadvantage, it cannot go down to a bigger depth; so, came the idea of compliant tower which has that freedom of movement with the waves, that means, if you imagine, it can sway like this with the wave as if the whole structure is hinged at the bottom and it is so.

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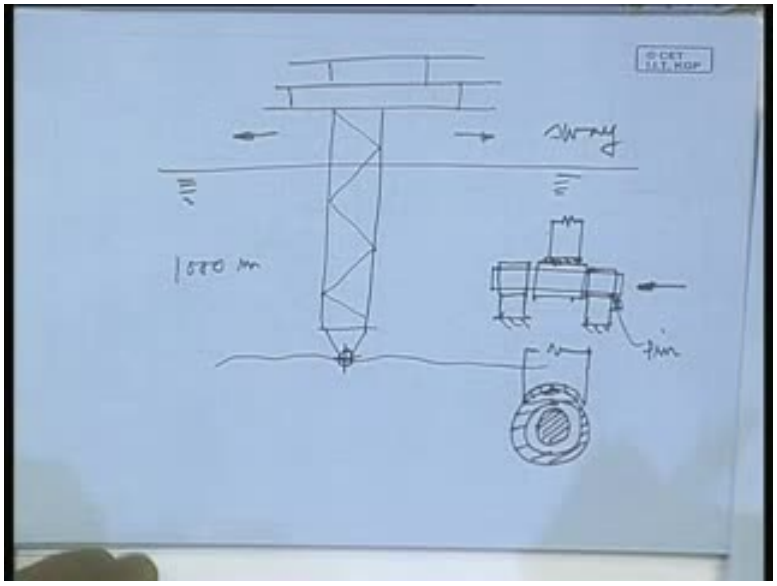

So, it is something mid-way in between a fixed structure and a floating structure. Floating structure is totally free to move around, it can move in all directions, as well as, vertically if it is not properly restrained. A fixed structure is static, absolutely fixed, but if I restrain the vertical movement then one structure has a freedom of movement in the horizontal plane, that means - a swaying movement in this plane or this plane or whatever - means in the horizontal plane, a swaying movement.

So, compliant tower was conceived, that is, schematically it would look something like this. Suppose this is my sea level, water level, this is a structure, a tower like structure, which is hinged at the seabed. It has a freedom of movement, as the hinged has been drawn, in that fashion, in this direction only it can sway and this movement is called sway. That means, in this way, the whole structure has been made lighter, the whole thing is the entire platform or the platforms, the decks because these are the decks; those decks will house the required machinery, equipment etcetera. So, that is mounted over a tower and the tower you can make it much longer, much taller, so that you can go to a greater depth and it is hinged at the bottom so that it has a freedom of movement. This very schematically drawn; yes - it is a hinge, means, you know it is literally a hinge.

We can explain in this fashion – suppose, you have the, there is a imagine in a shaft, over which you have, this is one part connected to a, say the central part is connected to the, if you look from this side, you have the shaft in between or the pin hinge pin and then, this

is outside, that is the outside small cylinder, they are same, it is free to rotate about the pin. (Refer Slide Time: 12:35)

This is my hinge pin, so to it I have connected, welded, the entire tower; say, this will be a huge one. It is connected to this, so that it can rotate about the pin; then you have other, and this one is grouted at the seabed. Either the pin is rigid, clamped to the seabed and over this cylindrical stop, the middle part moves; or the pin is rigid to the cylindrical stuff and these two bearings are free to rotate. It is simple hinge, the very miniature version of these are the hinge as you see in the door. The door rotates, so that kind of hinge.

This is very schematically and in very simplistic way, they are definitely not that simple because if it is free to rotate, you may ask why not it does fall down; so those restrictions are there, like if a door hinge - there are certain hinges, it opens only up to this much, it does not open up 180 degree, it is that way; so, obviously that is beyond our scope of how the engineering design of that hinge is, will not go in that detail. We are here only talking about the concept.

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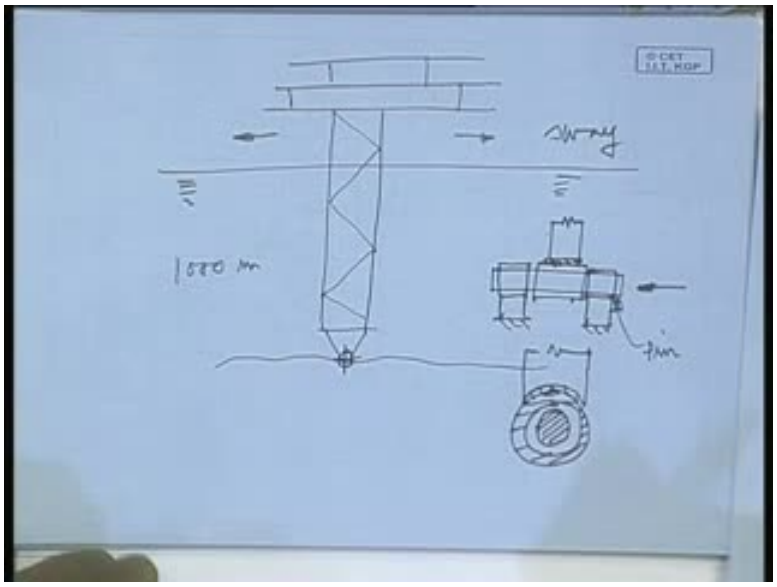

Our area of purview is essentially the tower structure, the deck structure. In the morning I was telling that they are essentially the same way as you do for ships, same thing will be for this also. Here, we are just taking a look at what are the different types of these

offshore structures? So, that is how this compliant tower concept came, and by simply doing this, one could go up to a depth of around 1000 meters.

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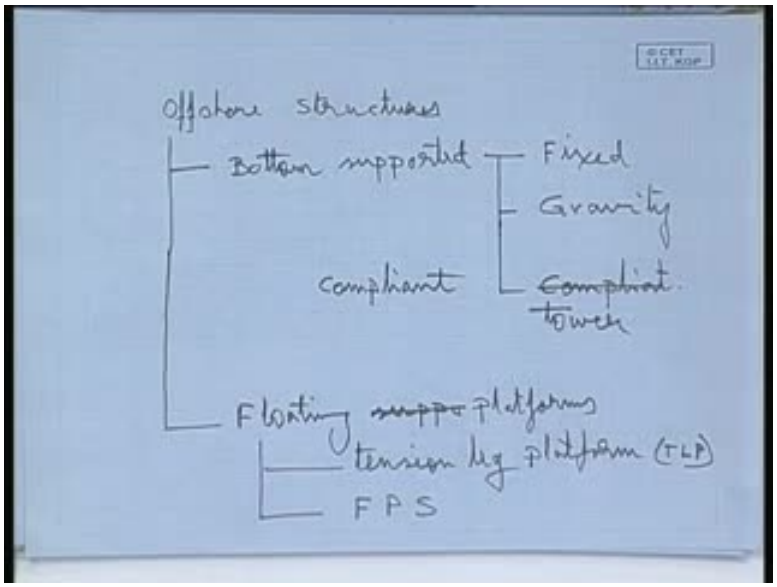

Almost 1000 meters, that means, that was a big leap towards offshore oil exploration, that is why, making this concept of compliant tower. Still further requirement of further depth, then came the concept of floating platforms.

The moment it become floating platform, it become absolutely free; then you do not have any restrictions of what the subsoil condition is, virtually do not have the restriction of what depth you are going to operate in. So, in the floating platforms we have two types: one is referred to as tension leg platform, another is floating production system, or also, floating production system, tension leg platform; in short, they are more inversely known as TLP, TLP is nothing but tension leg platform.

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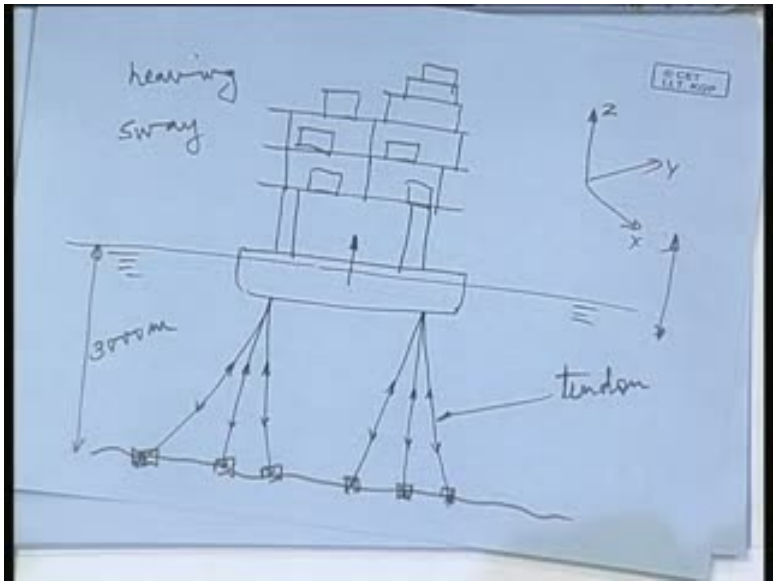

What is happening in this tension leg platform is - this platform is a floating structure; means that entire super structure - the super structure is called the decks, various decks will be there over which you will have accommodation also, you have all kinds of machineries and what not. It will be a very heavily equipped, sort of, place and this will be supported on some kind of floating submersible, some body which is floating.

Now, what happens if it remains just like this, then obviously, it will keep on drifting in the sea; that you cannot have, you will have to have one particular location it is located.

So, that is what is done by the tension legs, that means, it has a mechanism of connecting to the, suppose I am just schematically drawing as if three tension legs, this is my sea bottom, these are the tendons - that are referred to as tendon. So, what is done is, as if you tie the vessel, tie the entire floating platform with ropes down at the seabed; that means, at the seabed you have the necessary tying arrangement, also to say, hooks are grouted in the seabed - to that you tie it.

This will have positive buoyancy; positive buoyancy means - what is happening, I am pulling the thing. It is something like in a bucket of water, you take a tumbler and try to press it down, so you feel an upward thrust. If you just leave that tumbler in a bucket of water, the tumbler will float; you put some water in that, it will sink a little, but it will float nicely; but with that amount you try to press it down below further, so what happens, you feel an upward thrust; same thing, you think that instead of pressing it

down, I try to pull it down. So that is what being is done here, it is pulled down, that means these tendons are in tension.

Why? Because when you are pulling it down, it has buoyancy, so it tries to float up; that means, upward thrust automatically works, that is what positive buoyancy is. In the process what happens, there is a tension in these tendons, that is why they call tension leg platform.

Why these tendons are kept in under tension? What is the reason? Why it is so? It could have been neutral, but it is kept in tension; the reason is so that to minimize the heaving motion - this motion, if this is my z-axis. (Refer Slide Time: 20:50)

The motion along the z-axis is called heaving motion. In the x-y plane, the motion is swaying; because you see, the worst kind of motion is the heaving motion for the function it is going to serve. Because it is going to drill it and what is the drilling operation - you go one after another, sort of lanes of drilling; if I call a drill bit, you will have to go on connect it, because it will go down to thousands of meters.

If you want to pump the oil, you will have to drop pipes. If there is a heaving motion then what happens - I have a drill bit, so it goes on like this, you have difficulty in doing the drilling operation; whereas, when you have a very long length, then if it moves like this little bit, it can withstand that, but if it goes up and down then it becomes a problem.

To minimize the heaving motion, these tendons or these ropes or these legs - flexible legs are kept under tension - that is the concept.

Thereby heaving motion are minimized and as well as the deployment of tendons are done in such a fashion, that your swaying is also within a permissible limit because it cannot allow to sway it kilometers, definitely not, within few - whatever is the permissible movement is possible, it is limited.

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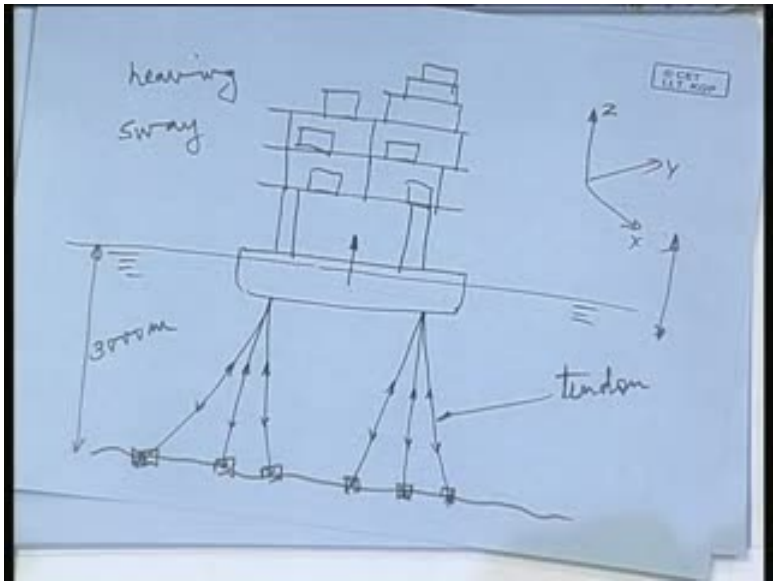

So that is what is essentially the tension leg platforms. The technology as of today - that it can go down up to almost 3000 meter water depth, it can be installed in such deep offshore oils for production of this, what do you call, crude; here the biggest challenge as such is, fixing the bottom seabed connections.

Making the seabed connections are the major challenge because the other things have become very easy, it is just like a ship kind of a thing - a floating thing, and over that it is all steel structured decks fitted with necessary equipment; so, biggest challenge is actually connecting the bottom, those so called clamps or the fixes wherein you are going to clamp the tendons; so that was TLP.

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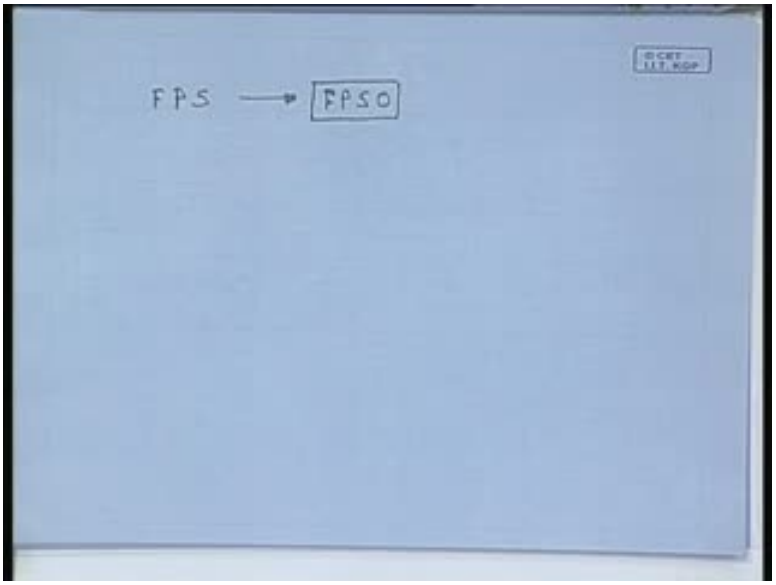

The next we talked about FPS; FPS is called Floating Production System and when we talk about FPSO then it is Floating Production Storage and Operation; so, these days this particular concept has become very popular - floating production storage and operation.

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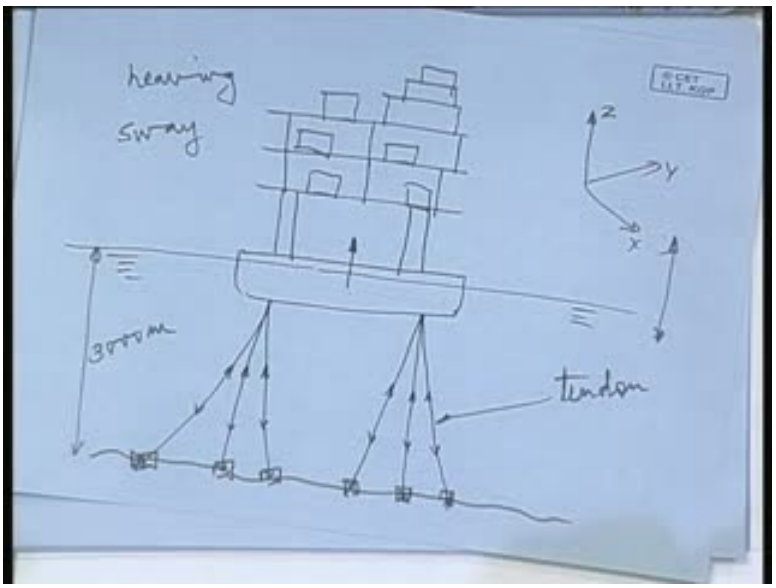

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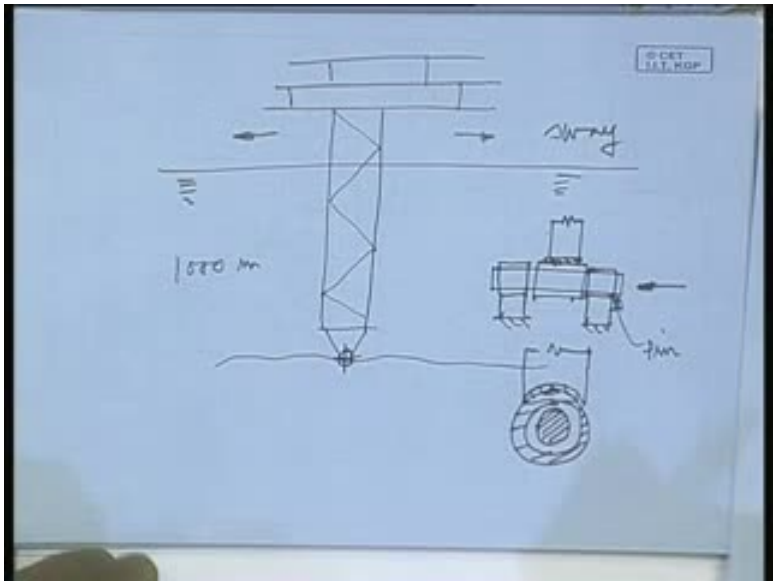

In all the previous offshore platform types, what we have seen - one thing you can see that all of them are location specific, they are fixed to the location, that means, when we are talking about the fixed platforms, it is literally fixed; there is no way you can move it.

When you talk about gravity platform, though it is not fixed, but for all practical purposes it is fixed; once you install a gravity platform in one place, when that oil gets dried up, you are not going to remove that platform from there because it will be huge job and totally unnecessary.

But in the process, what is happening - you are abandoning the entire structure; you cannot use it elsewhere. Similarly, with compliant tower it is difficult to unlock and take it elsewhere and put it. Same thing with probably tension leg platforms, but to some extent tension leg platforms - part of it can be recovered, that means, you cut that tendons, float it out elsewhere, again connect new tendons, so that becomes versatile.

FPSO is fully versatile, it is basically a ship - a production platform mounted on a ship; so, it has its own propulsion power, it can go to an oil field, do the oil exploration operation till you get oil; the day you do not get and you have struck oil elsewhere, the vessel moves to the new location. So, that is how this FPSO has become very popular, one can say, because the other ones - if one does a cost comparison, not necessarily, FPSO will be cheaper compared to the other ones; fixed platform will be a cheaper

option, obviously, they have other disadvantage of course, but for a shallow depth also you can use FPSO, there is no bar against that.

There is another problem coming up from the environment point of view - decommissioning of these offshore platforms, like, you commission, you will have to have a sort of a chalked out plan of decommissioning it, because they are becoming potential environmental hazards.

So, these days if you want to install a gravity platform or a floating platform or any such thing, you will have to show that how we are going to decommission it so that it does not cause any ecological disorder or environmental pollution and disorder.

But if you have a FPSO, that problem is not there; there is no question of decommissioning as such. When the life of the FPSO is over, you decommission it the way the ships are decommissioned, means, you take it on shore and break it in pieces and whatever, you do not abandon at sea; so, that is also an added advantage as far as FPSO is concerned.

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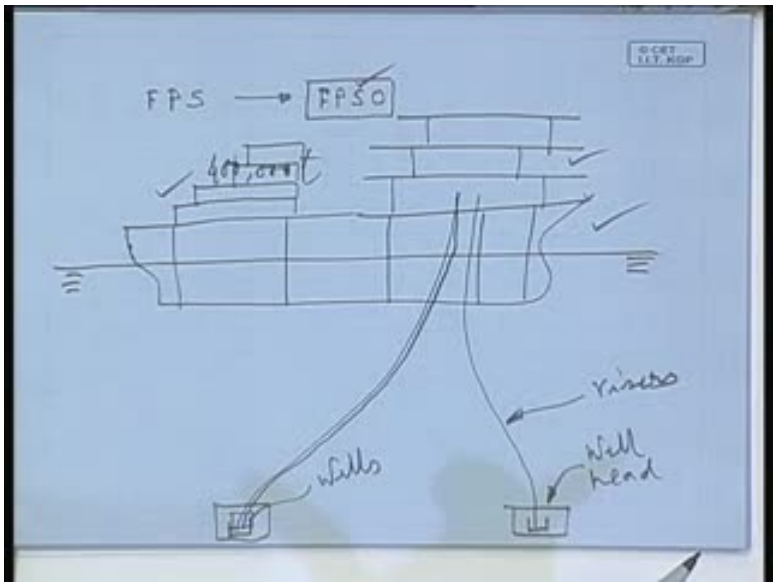

So, FPSOs are, essentially, floating vessels, ships; what many people are doing - instead of building a new vessel, they are converting the oil tankers, converting the huge tankers, because they are very huge; oil tankers are very huge - of the capacity of, the biggest tankers were built or around 400,000 tons dead weight - roughly half a million ton

capacity. Similar such huge tankers - not necessarily this 400,000 ton only, depending on the requirement - many of the oil tankers have been converted to FPSO because here you need storage. Because when you are using all the other offshore platforms, you will have to have a mechanism of pumping the oil and delivering it; it is not only you will be pumping, delivering; all the previous options do not have any storage facility.

That means, either you will have to have a side by side a crude carrier standing stand-by, wherein in the whole day you will take the liquid, it goes.

In case of FPSO, the vessel itself has its storage facility, so immediate storing is done and then from there it is dispatched; not to mention, the vessel will go and dispatch the liquid - that also it can do, but it can be - immediate storage is possible because it has the huge tanks already there, because a tanker has been converted. So, that is what that means - converting a tanker for this purpose is a low cost option; if one has to build a new FPSO, instead of building a new one, converting a tanker becomes an easier and more profitable option. So, that is what is the FPSO - it is a self-contained unit and it can be operated in any oil field without any infrastructure because it itself has everything, you do not need any additional infrastructure of storage of that crude.

Crude pumping is done through so-called risers; that means, the vessel is there it is generally. Schematically I am showing, here you have your conventional accommodation on one side - accommodation of the crew this side, and here you have all the gadgetries for your offshore operations (Refer Slide Time: 31:15); this is a huge vessel - it has several chambers wherein these holds can be used for storage. So, this is your wherever it is floating, and from here the riser, they are called risers - they can be one, two or multiple risers, this is a flexible pipe which is referred to as riser - they are connected to the wells, these are the wells below the seabed.

Here, again the challenge is, when you explore you find out a possible pumping site where you will get the crude oil, you will have to make these subsea arrangements, that means, those well heads; here, the well head are to be installed. It is something similar to that of - suppose a pipe line is going, you want to tap water from that, so you will have to have a connection there and from that to your house you connect, the entire plumbing work is done and you connect that to the main pipe line which is delivering the water supply to all houses, which is connected; so, that is the connection head.

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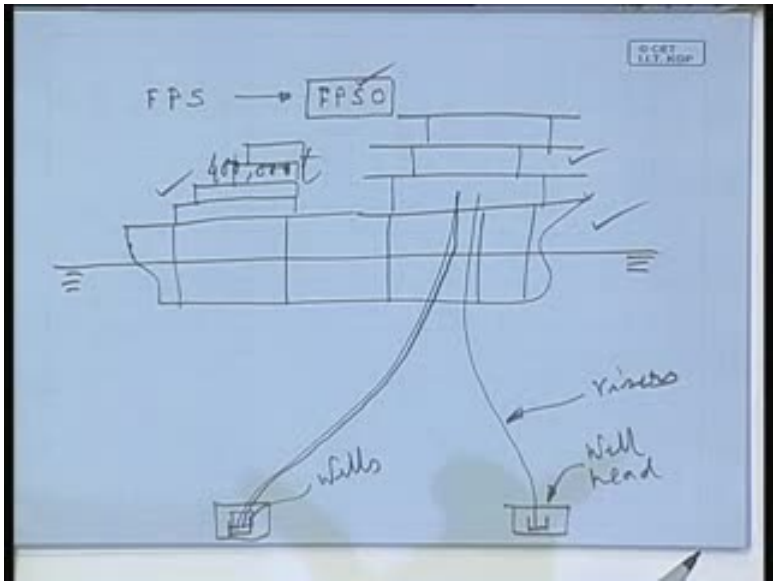

Similarly, this is the well, we will have some kind of well head, some kind of connection wherein the pipe will come and will be locked there; so, as far as this vessel is concerned, I would say that is not the difficult aspect of it, means, that is again the same as that of a building a big ship; whatever technology is there it is good enough, with that one can build the entire thing, but probably the more challenging technology is making this well head, connecting these risers to the well head.

Because these risers will be there, how do you connect? Somebody will have to go below and physically connect, because you may just drop the pipe, it will not go and fix here. So, those are actually the technologies, and also the other thing is, this FPSO is totally free - construction wise there is no bending movement problem, in all the other things there are some movement of the structure, so all those problems were there.

Here, it is only for exploration, you are only pumping oils so these pipes risers are flexible, but still it has to have some kind of means of anchorage, some means of position keeping, such that it does not move out, does not sway out too much; if it hits with the wave - no problem, because the pipes are flexible, we have enough length to take care of that.

As we see, for oil exploration FPSO is very convenient one which gives you all the flexibility and flexibility of depth; as you said, that this FPSO also can be, virtually to

any depth it can work, provided you have the arrangements for the well heads and connecting to the well head.

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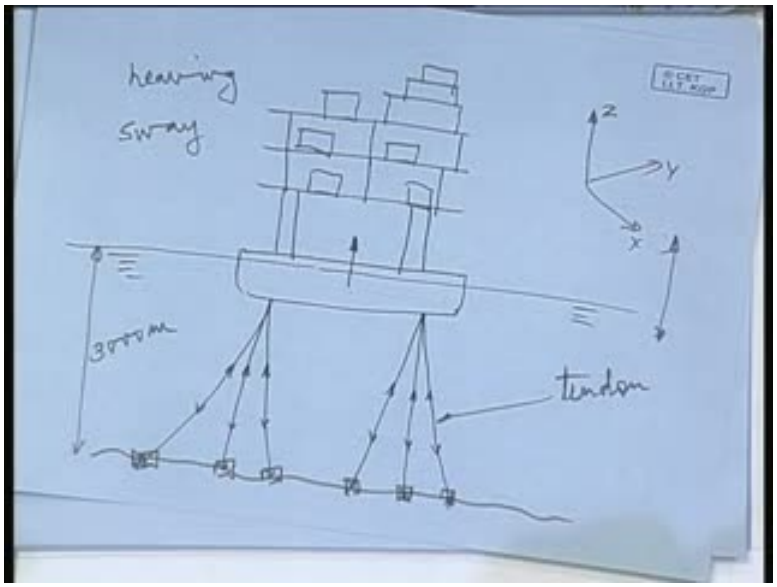

This is in brief about the various types of your offshore platforms, offshore structures. Now, as you can see in all the cases - the offshore structures, as far as the structure is concerned, they are nothing but something similar to the ships as far as construction is concerned, as far its structural components are concerned.

Offshore platforms are primarily comprising of flat decks - several decks over which you will install the machineries, only in case of TLP - will have a floating submersible, in case of FPSO, you will have a basically a hull, a ship hull; so, that is what about the types of ships and offshore structures.

Next, I thought of telling you about, now that we have seen what all kinds of products we will be dealing with, so take a look at the type of industry which delivers these kinds of product; industry means, the shipyard.

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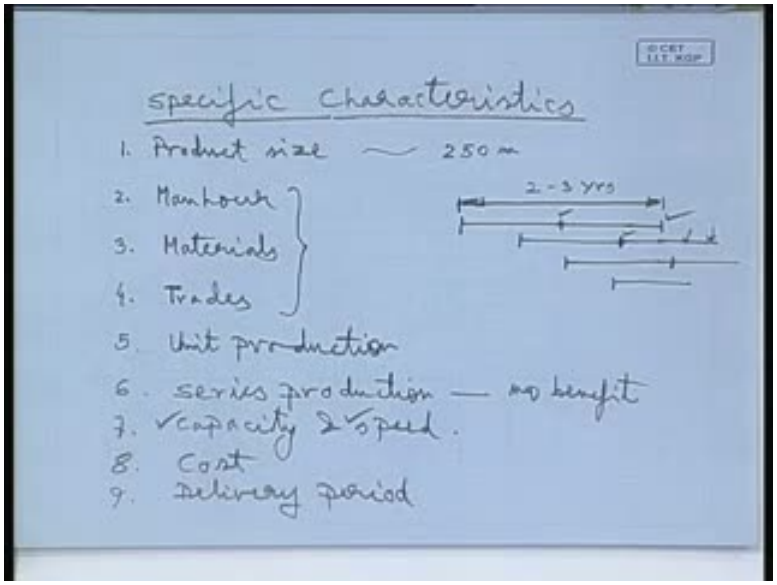

So, what are the very specific characteristics of the shipyard? What is so specific about it? Because what I feel, that before one embarks in designing or working on a product, one should have a good idea of the product itself. If it is an innovative product, then also one should have an innovative idea that means, so called, artistic impression because an engineer will basically engineer the product; so, what he is going to engineer he should have some idea of it.

You know it is not like a blind chase that he does not know what you are going to heat at the end of the chase, it is not that it is a very concerted conscious chase because I know my end product.

I know - what characteristics it should have? What functionality it should have? How it should behave? How it should respond? All those things are known; known means, those are the requirements - that is what I want. I want to design a car which will look beautiful - that is a characteristics requirement. The engineer will work towards that, so that is why in our first lecture we tried to look into what all types of products are there.

Now, we will take a look back to the industry where these products are made, if there is anything specific about it, any specific character? Because these products, that means, the ships or offshore structures, they are also industrial products.

So, if we systematically see - first and foremost, it comes to our mind is the product size. No other industrial product has this huge a size, you think of it, because the sizes can be the super tanker, I mean the FPSO we were talking about, or even a middle sized bulk carrier, say, capacity of 100,000 tons; the length of the vessel could be somewhere of the order of 250 meters - you can imagine 250 meters, so this industry should be such that it should be able to handle a product of this size; so, first and foremost is the product size.

The moment the product size is such huge, immediately comes the man-hour requirement for production - man hour requirement. Why man-hour requirement is important? That means, it is the involvement of number of workers and the period of production. If, say for example, a car is produced in every minute what does that mean? It means that every minute a car comes out of the production plan, but the seeds have been sown probably, God knows, maybe six months earlier - actual production time could be six months for a car, for the ship of this size - 250 meter long, the actual production time could be three years - from the day one to the delivery of the vessel, may be three years.

So, that is a long period. The moment it becomes a long period, there many uncertainties creep in - you do not know what the steel prices or some equipment price will be after two years, you do not know what certain political change may take place in the country or elsewhere - because this industry is not a industry which will only source everything from within the country, you will have to depend on many other things; so, the time can make a difference in the entire process of production; so that is how the man hour.

Next one would be wide variety of materials that is being used, like, even a cargo ship - general cargo ship, the main material of construction would be steel; but there you will have an accommodation region where the officers and the crew will stay, will have to give a proper facility, proper comfort, so starting from simple, I mean, good furniture to good window curtain everything will come; so wide variety of materials.

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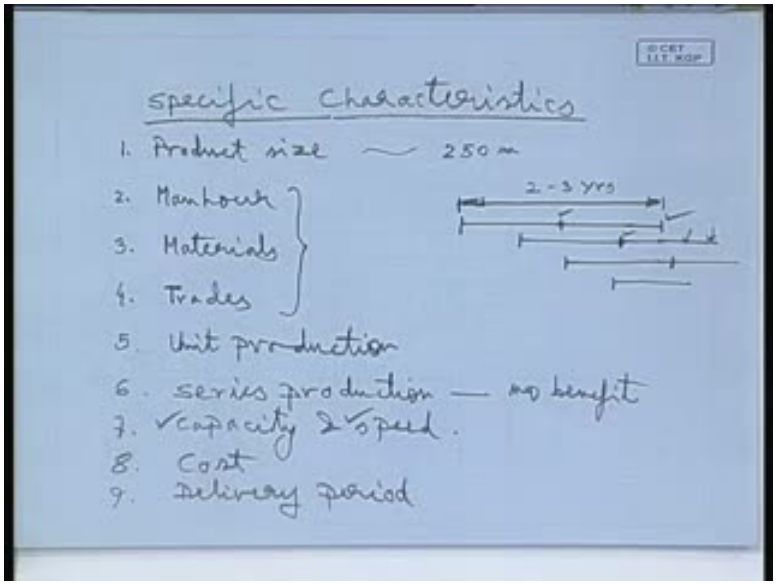

That immediately calls for wide variety of skilled trades, wide variety of workers, various trades - that means, people of various trades will have to work in unison there, I mean proper cooperation should be there.

Next, one of the more important thing, all these things – man-hour, material trades - similar situation we may find in some other industrial product also, say: automobile, car or an aircraft or locomotive or the railway coaches, you may have somewhat similar though the man hour requirement is of not that order. However, metal and trades can be there because in a railway coach also you need a welder, as well as good carpenter, and also need a good upholstery person who will fix the cushion and all that.

Next, very typical of this ship building industry is, it can be mentioned like this, it is a case of unit production. What does that mean - unit production? That means, here we do not have a mass production, a scenario of mass production; in any other engineering product - be it a computer or a television set or air craft, even they are generally a case of mass production. I am saying generally because I have included the aircraft in the list also; if I delete the aircraft and put automobile it is a mass production - hundred percent mass production.

So, what is the fundamental difference? The fundamental difference is - you can design the thing, test it thoroughly and then the design is frozen, then you just go on producing; so, you have all kinds of production advantages. What advantage? Say, you will produce

one million cars of one particular design, that means, the car body; so, you can as well have proper match die, Bled bending machine having match die, through which you bend the plates to get the shape of the bonnet, of the door, etcetera. They are expensive - making those match die, but the expense is well justified because you will be producing one million such pieces. In ships, you cannot make any such match die, because, probably, you will be building five of the identical types; the series here is of that order: three, five, ten. If it is a smaller vessel - a fishing trawler, we have not talked about fishing trawler in our classification, anyway - say a tug or fishing trawler, there might be requirement of fifty fishing trawlers of identical size, identical design.

But fifty, that is nothing in comparison to tens of thousands or millions; so it is more of a case of a unit production. That means, you do not have that benefits, advantages of mass production. Another aspect is, you may have a series of production, that means, say some cargo operator places a order for five identical bulk carrier of 60,000 ton each. Now, what happens is, when first bulk carrier you start building, when the designs are done, you start the manufacture of the bulk carrier; then after few months, you start the second one, this progresses simultaneously, again after few months you start the third one.

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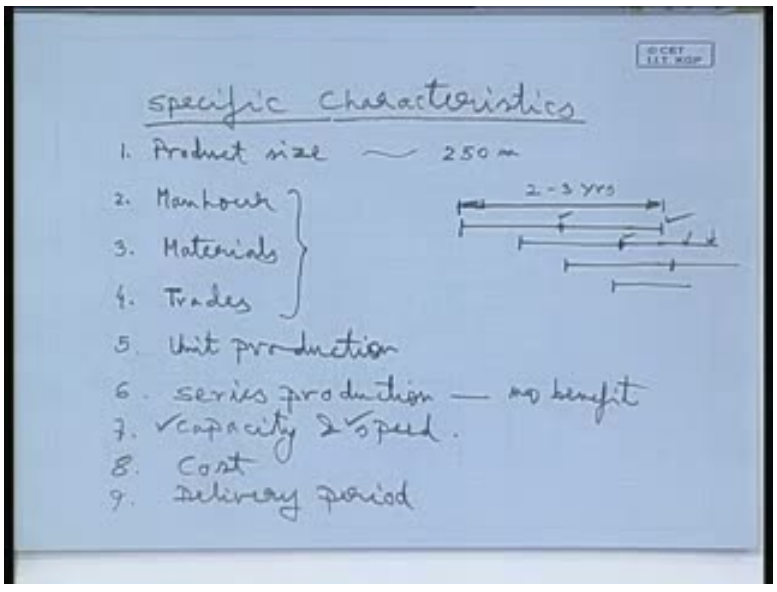

By that time, possibly, the first one is delivered, second one continues, third one further continues, and the fourth one you start, and so on so forth. So, this period could be anywhere between two to three years. What happens, some material needed at this stage

will be required for the second vessel at this stage, for the third vessel at this stage, and so on.

So, the requirement of this product, when first it is needed - say on particular date, the next one will be needed probably after six months or three months, I mean that is the thing. In a car, the car door will be needed every minute if the production rate is every minute a car is coming out of the production line; that almost means, almost may not be every minute, but every probably half an hour a door will be needed.

So, I can have a production setup for the doors which will go on stumping out the doors, but here firstly I need only five of them - the identical piece, so that five if I produce today, the last one will be used after 15 years probably.

So, what is the use of keeping that? Firstly, storage will be problem, it will get damaged and then the money I am blocking in that; so, the advantage of series production is also lost. Only advantage is there, some of the design things are; preliminary design is fixed, but what happens when the first one is delivered? You will have feedbacks from the owner, then he will say change these, change that - some of the modifications will keep going on; that means, it is not that the design job is over once the first one is delivered or production has started, so it do not have the benefits of series production; it is a case of unit production and no benefit of series production - this is no benefit, which in other industry you have.

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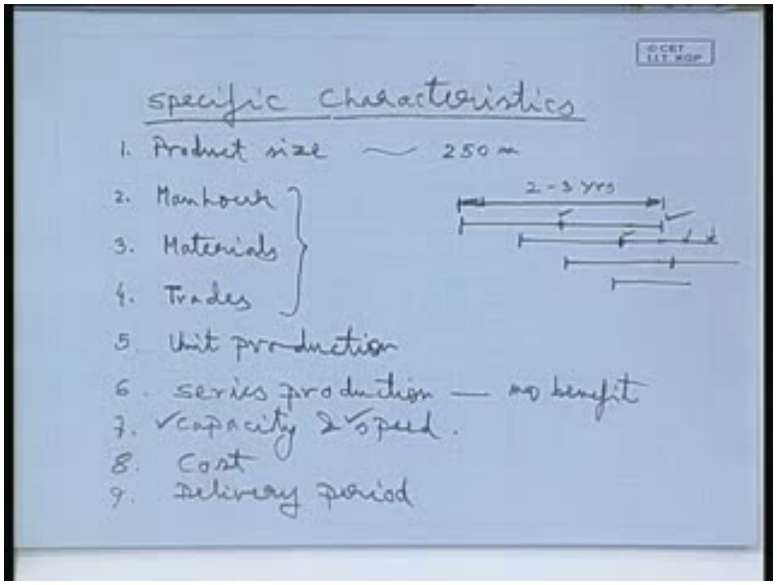

Take for example, television industry or automobile industry, locomotive industry, even aircraft - the series is small but their design is done means done, only minor changes of seat arrangement - somebody may say, I want 18 rows and somebody may say I want 19 rows, that is how, rest all remains the same. Here, it say, that is how one says, that it is not a showcase product - aircraft also you showcase it in the aircraft shows, the company is the Boeing or McDonnell Douglas, whatever, they showcase their product, automobile - they showcase their product.

We will have to choose from whatever is available; we do not say that I want this. Here, the customer says I want this, customer puts forward the requirement and you will have to comply to that; the one who can best comply, he gets the order. So, it is a kind of a competitive industry and you will have to comply with the customers requirement; so, that is how.

The next thing comes is the capacity and speed. We are talking about ships, so in ships these are the two fundamental things a costumer will ask for; he will say I want to carry 10,000 tons of cargo at a speed of 14 knots, his requirement is only this.

He will only say these two parameters, at best he may say, my route of operation will be from Madras to Sydney, that is all, so based on this three operation develop the entire product. What is most important that you will have to satisfy at the end of the day when this is delivered? It should be able to carry 10,000 tons of cargo safely - there is a capacity you guarantee, and also should deliver that 14 knots speed, that is very important. All this you are telling at the very preliminary stage when you have very preliminary, sketchy idea of the product, you have not done any detailing of it; because at that stage only you will have to say, and that is the tendering stage; then whoever gets the order, then only you will start working in detail.

So with that sketchiest kind of information, you should be able to predict the speed or you should be able to quote. That means, next comes is the cost; cost is huge, you will be able to predict the cost of the product, the delivery period you should be able to foresee that, well, within this period I will be able to deliver it, and the cost incurred will be so much, and the speed delivered will be as the customer wants.

All these based on very sketchy information, if you fail to do that you lose, you will pay penalty because speed you will have to show, unlike your car - there the meter shows off

180, but you will never in your life probably drive in 180; so, there is nothing to worry about.

You will be shocked to learn that we bought a new Maruti Esteem engine, we had some requirement of around 50 horse power, so we thought that Maruti Esteem engine will work very nicely because they claim it delivers 57 horse power. So, when you put that, the vessel is not functioning properly, what is going wrong? So, we took the machine, put in a test bed and found that it is delivering only 17 horse power. I do not know what is wrong, this is how if Maruti is cheating us, I do not know, only 17, one seven; but probably, 17 horse power is enough to push the car at a speed of 100 kmph and that is fine. Because you will not be driving at 180kmph, neither Maruti Esteem has said that you can drive a 180 kmph.

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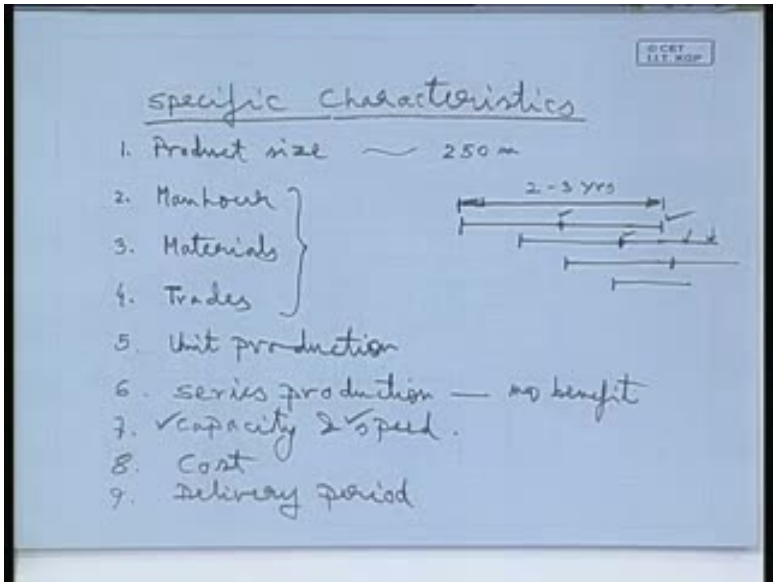

So, these are the very typical things of this particular industry. As I said, the delivery period that means the delivery schedule - when you say that I will deliver by after 36 months, three years, you will have to deliver at that time. You fail to deliver, you will have demurrage clause, you have to pay to the customer penalty, to the client; if you are on a very safer side and you calculate and say, I will deliver after 48 months, then you may not get the job because your competitor may say I will deliver in 40 months. So, in a speed to get the job if you say I will deliver in 39 months, you get the job and you cannot – so, not only you loose penalty, you lose credibility; it is a very competitive market.

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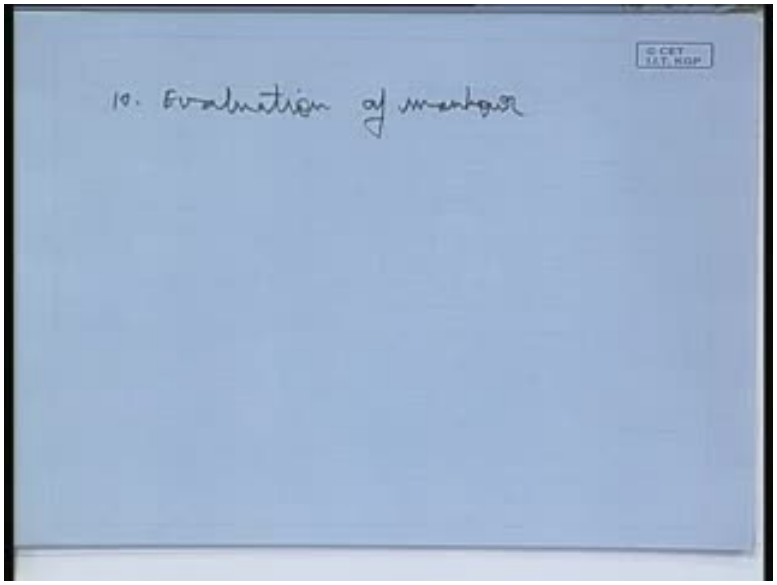

You lose credibility, next time a ship owner will not come to you, so that is delivery schedule and cost.

Then, exact evolution of man-hour. You have talked about it requires huge man-hour, now the question is evolution of man hours - why that is needed? Because evolution of man hour requirement means - because you need this data, once you have this data then you can form a data bank based on which you quote for the next, your newer jobs; suppose, you have to build a vessel of 12,000 ton capacity, now you have a tender enquiry of 20000 ton capacity.

You have to design afresh, you have not built that, but how do you then predict that I take 29 months to build this - based on your past data. That means, this evolution of man hour if you can do perfectly, then you know so much of welding take so much of time, so much of piping work this time, electrical work, plumbing, all kinds of work.

So that is easy to say, but that is what we are saying that here in this type of industry it is difficult to evaluate this. I am not saying it is not possible, but it is difficult to keep track of one particular job being done. Here, they say this pen is being manufactured, whoever is manufacturing, he can precisely say that what is the time taken to produce one pen, but to precisely say, what is the time taken to produce one particular steel panel, a particular component, structural component of a particular ship, it is not very easy. Because, the works starts, it will wait for some time again, some work will be done again, some

remedial work will be done depending on how much remedial work is being necessary, it is necessary in this panel so much, the next panel may be less and so on so forth; very complicated.

These are the typical features and finally I would say that the coordination of activities, ultimately it becomes a huge management problem, I mean, a management issue, I would rather say, because you will be not only dealing with huge work force, you are dealing with huge amount of materials, dealing with huge, I mean, high volume of materials, high cost of materials, all these things; management of all this items, the procumbent scheduling, the indenting procedure - if you do not procure in time your work will get stuck, if you procure too much in advance, then unnecessarily you are blocking the money, blocking the space in the store, chances of damage to the product, I mean, that component; so, it is overall a real management challenge also at the same time.

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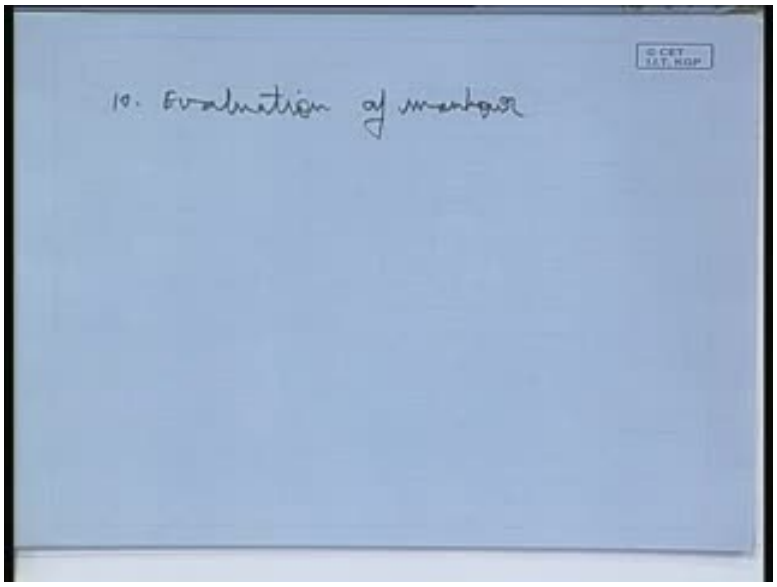

So, that is what the ship building industry is. We see that it has a very specific character in comparison to all other manufacturing industries where things are different, for that basic fact that, here the products are huge and production size - the volume of production per unit is very less, that means, same product only one, two, ten, fifty maximum.

We stop here today.