Marine Construction & Welding

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Module No. # 01
Lecture No. # 09
Wing Tanks & Duct Keels

Today, we will be starting with duct keels. Wing tanks, we have talked about it yesterday. We had been talking about the keel plate, bottom shell plate, they are the central plate at the bottom shell, was the keel plate.

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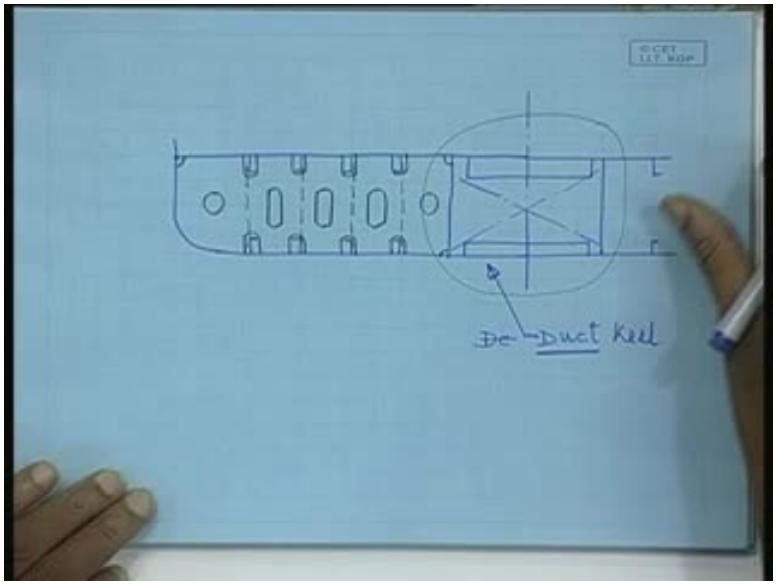

Now, here is some concept called duct keel. As you can see, in this figure, this particular assembly is the duct keel that means this one - the one which is encircled (Refer Slide Time: 00:58). That particular construction is referred to as duct keel construction. It is nothing but, it is part of the double bottom, we are separating it out. We have talked about double bottom that you can see already, this part of the thing is familiar and there we have the plate floor, the inner bottom longitudinal stiffness. Here, instead of a centerline girder, I have two side girders. Previously, you have seen that one central line girder and a keel plate below. Here, what I have been done is the centerline girder, as if

as been replaced by two side girders and rest everything is remaining same. Only one half of the thing we have shown, does same thing is on the other side also. This arrangement of two adjacent side girders near the central line that is referred to has duct keel.

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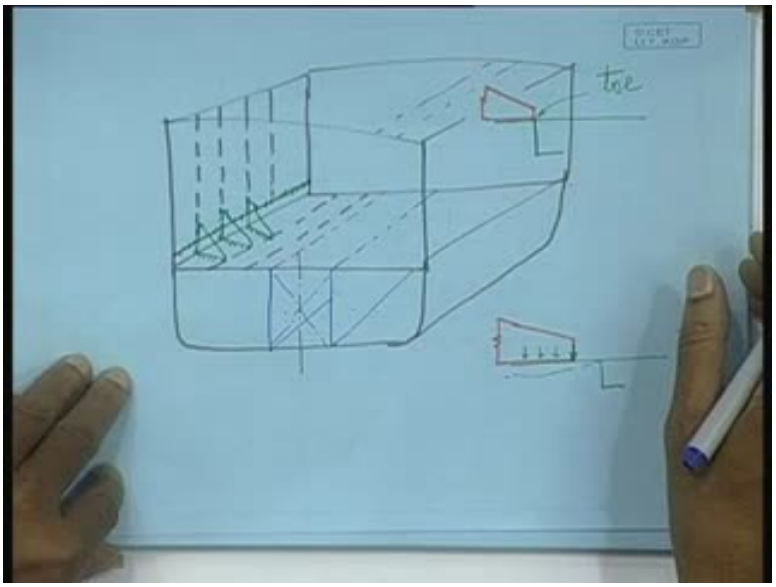

Duct keel arrangement is nothing but, it is forming a duct. This space as you can see, is forming a clean duct, this is running all along the length of the ship, isn' it? It will be to some extent in this fashion, as you have applied to show it here. They are the two side girders running along the length of the vessel; it is only in one box.

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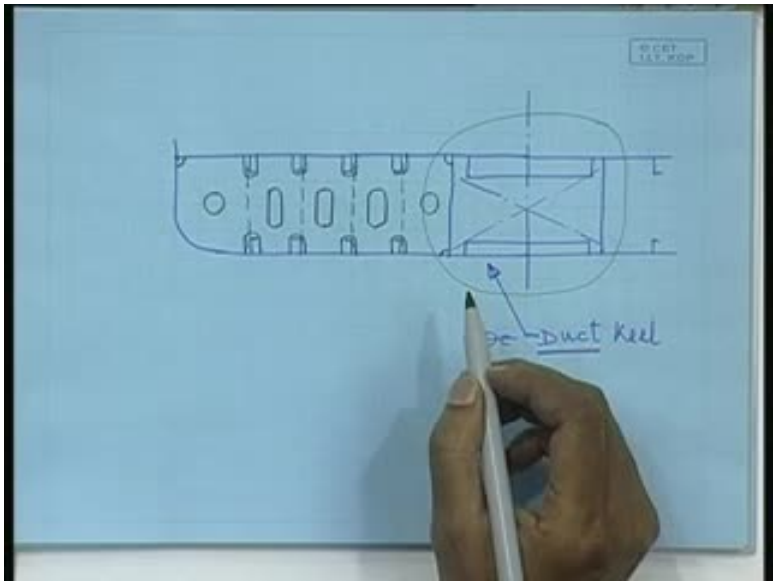

We are showing here. These two are water tight side girders, so this space becomes a protected closed duct. What are the great significances or great use of this arrangement? Well, one definitely provides a much better support for the ship structure; we had been talking about putting the ship on keel blocks.

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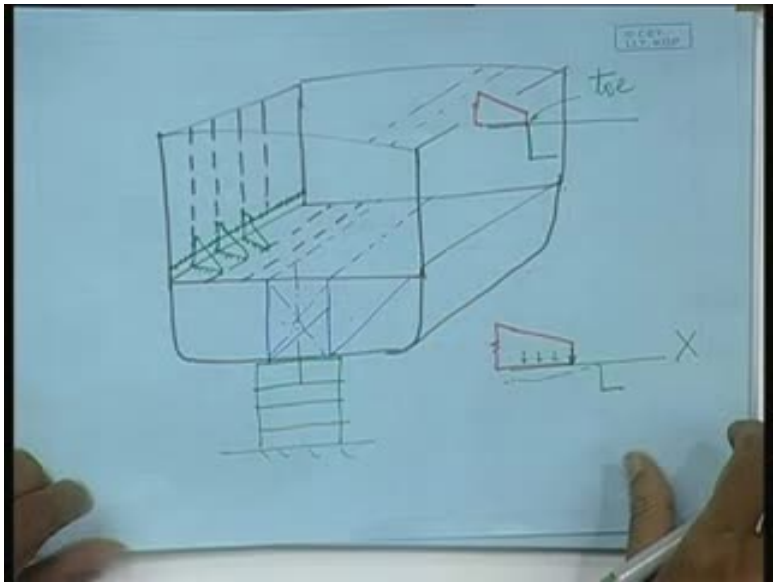

There we have talked about the centerline girder, there you have the keel plate, below that you have the centerline row of keel blocks. Here, the keel block, if I put it, so it gets an even better support.

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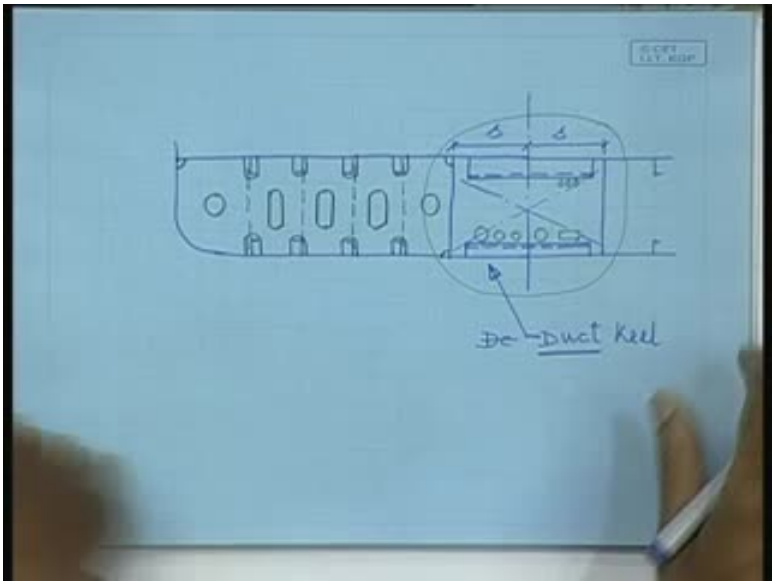

Here, the vessel gets much better support, isn't it? Because, it is not whole load is being shared by two girders, instead of one by two girder, so that is one advantage. Second advantage obviously, instead of one girder, I have two of them; instead of one centerline girder, I have two of them, so obviously it provides for higher longitudinal strength. Thirdly, which becomes very effective that this particular duct can be used for so called laying the pipes or various kinds of ducts, whatever, cables, because all along the length you will have all pipe lines will be running, electrical cables will be running. Otherwise, had there been no duct keel, they would have run through this double bottom space somewhere.

In some places, they would have been totally - I mean, if the double bottom that particular space is being used for ballasting, should have been submersed in water all the time, whenever it is ballasted condition. Whenever it is empty, it is fine, but here what happens, they get a very neat and clean environment. So that way the maintenance of these pipe lines or cables becomes easier. The possible corrosion of the pipe line is also less. Otherwise, it would have to pass through spaces, where you are carrying fuel oil or carrying fresh water or carrying ballast water something like that.

So that way this space not only it helps in providing better strength, but also provides a good space for passage of these pipes, cables, etcetera. If there is anything else needed,

some ducts, some ventilation duct, ballast pipe or drainage pipe, various kinds of piping systems are there, so that space can be used.

Now, as well as the structural details of that is concerned, as you can see, in this part, the rest part of the double bottom it is longitudinally stiffened, but here we have drawn transverse stiffness (Refer Slide Time: 06:32). This is a transverse frame, in this; at the bottom also, is a transverse stiffener. Instead of having any longitudinal - because we are not getting any longitudinal - why? There is the frame spacing, this is one frame space.

Generally, the side girders will be placed one frame space (( )) that means that size of the duct will be twice the frame spacing. If it is twice the frame spacing, then either you provide a sort of centerline - I mean at the centerline, some bottom longitudinal or inner bottom longitudinal here are providing transverse stiffening member. Here, transverse stiffening member, there is a preferred stiffening arrangement. Because, in that case, what happens? Over this you can lay the pipe lines, you can lay the cables.

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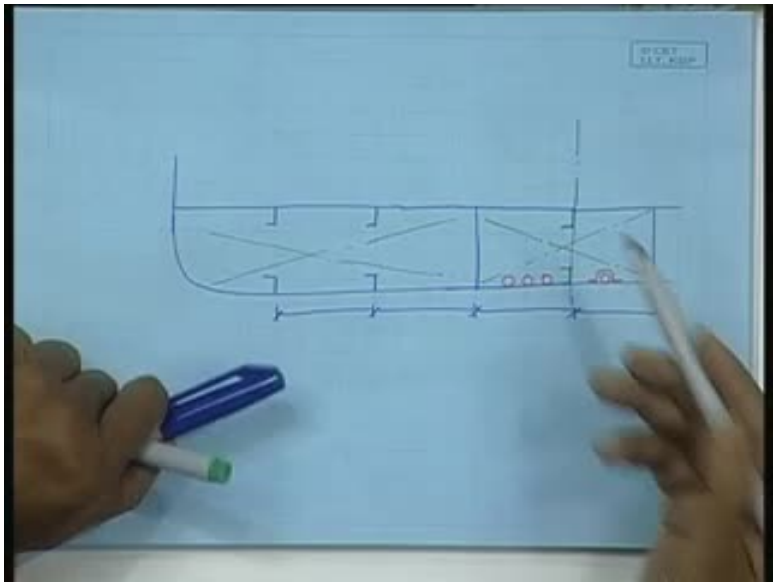

What happens is, we have talked about that longitudinal framing system, is better to adopt, isn't, because of his superiority in terms of buckling strength. Now, here, what we are doing? We are little bit deviating from that I am just drawing this part; only the duct keel part (Refer Slide Time: 08:08). Well, the stiffness is like this; this is my frame spacing, they are equally spaced. Here, the unsupported span of the tank top plating or the inner bottom plating, as well as that of the bottom shell plating is becoming twice the

frame space. Because, here you have the two girders spaced, one frame spaced apart. So, naturally you have to have a strengthening member like this, because low point giving another centerline girder here, then the whole purpose is lost. If I provide like this, it is also feasible solution one can provide, then what happens? I will have to keep the - I am saying that this space now is becoming available to me, I can as well keep it empty, I can as well use it for ballasting, I can as well use it for fresh water anything, but for that all these spaces are already there; so what happens? This space is gainfully utilized for passage of pipes, cables, ducts that becomes convenient.

If that is so, then I will have to lay the pipes; for example, how do I lay it? Because, you cannot just like that keep the pipe just on the floor, you will have to tie it, clamp it. Then what happens? You will have to keep the pipes on the shell, which is also preferably not a very good idea, because how do I then clamp it? Means well, then it has to be clamped to the shell.

So, I will be uneasily doing some welding here, which may not be a good idea, why? Because, in the all these pipes, sometime or other will need some maintenance, you will have to open it, replace it, repair it, then every time that you welding this have to be cut, re-welded and that is not a very healthy thing to do on the shell plate. Because, by way of doing welding, you may import some flow there, this eventually can cause some further damage to the structure. So, instead of that it will be better if you have some platforms and support over which you lay the pipes like this.

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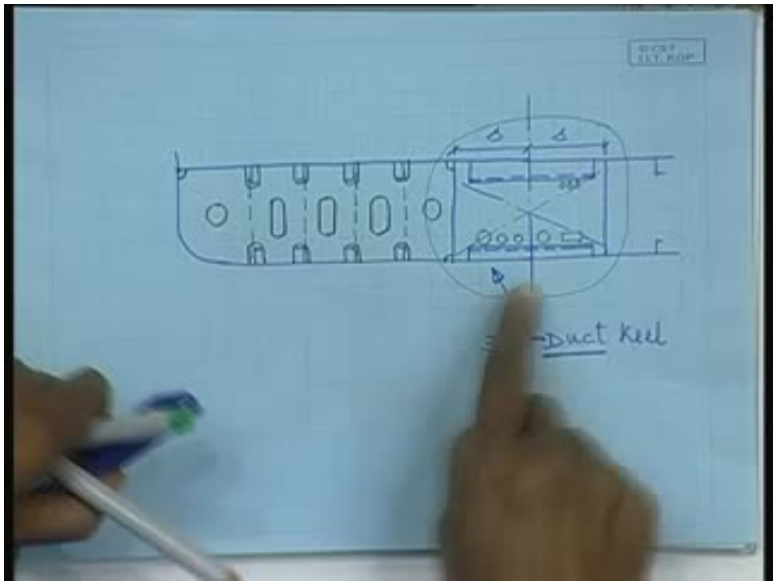

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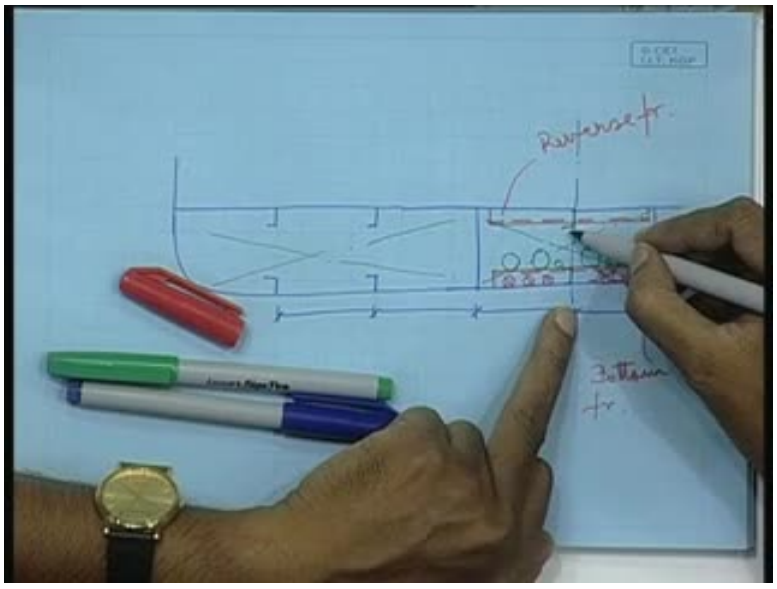

In that case, what you do? Instead of having longitudinal stiffener here, we have transverse stiffener. These pipes are no more there; that means, at every frame space, you put transverses like in this plain, you have the floor, similarly the transverse stiffeners, but they will go for every frame space like this. Well, this frame is referred to as bottom frame - bottom frame of the duct keel and this is referred to as the reverse frame of the duct keel. You know, all members, they have some name, so that is what is the name, is the bottom frame of the duct keel, there is a reverse frame of the duct keel.

So that is how it provides necessary strengthening to the bottom shell, as well as to the inner bottom plating. Also provides now sufficient space you have, as well as proper means of laying your pipe lines, cables and all other things, utility services; whatever lines are to be taken, it can be laid there.

Main purpose is for stiffening this unsupported span; main purpose is that. While doing that I get simultaneously as a byproduct, a good surface or a good support, it does not give a surface as such, because you have the frames at intervals, but I have one horizontal plane, where I get a good support to put this pipes, cables and etcetera.

Main purpose is providing stiffen, to provide strength to give the required section modulus, because if this stiffeners are not there under load, this will deflect, isn't? Because, it can sustain an unsupported span of only the frame space; mention, it is not a question of better or worse here, because if I provide longitudinal frame, well it is supported, is it transverse frame, it is actually better supported.

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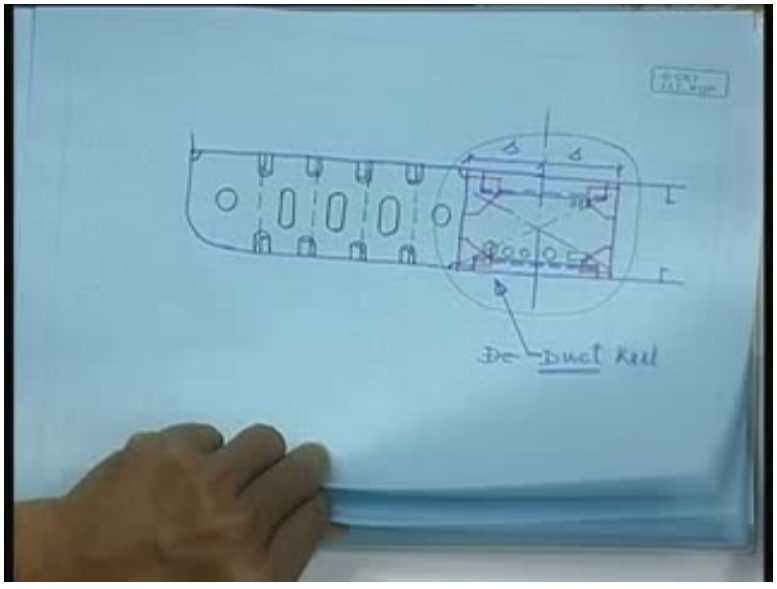

Because, then what happens? The entire plate is supported here and I am providing at every frame space. Only thing to provide is the proper load path, you will have to put the brackets like this, with this side girder, now it is bracketed; so brackets are provided. There is no more need for longitudinal - this longitudinal is not there, this construction is like this or a cleaner version - let me draw, I will show you.

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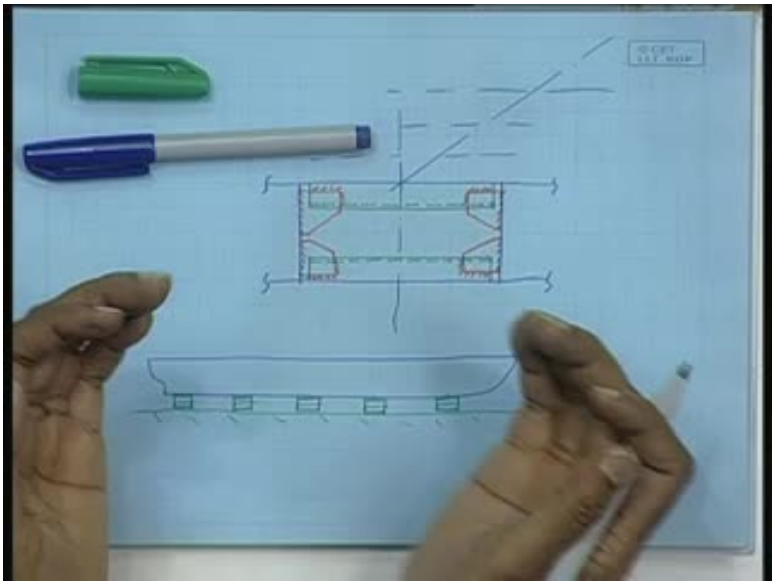

What is happening is you have the - this is my bottom shell plate and the inner bottom plate and then you have one side girder, the other side girder. Then, you have your well, let us draw by different color, it will be visible better. So, this is reverse frame, significance of this dotted line what does it mean? This dotted line I draw, what does this signify? Not that there is a flange; that is a very particular angles, it can be also a bulk section, but not t section, had it bent section, this line would have been continuous.

It is a flanged stiffener that flange can be a flat bar that of an angle section or can be a bulk section. If its bulk section that is also a kind of a flange that is also shown by dotted line - dotted or firm line. Dotted line means, it is on the other side of this plane. Why? I have shown in dotted, just to show the bracket in full lines; that means the bracket is on this plane. Had this dotted line of this stiffener, I would have drawn a firm line, the bracket is on the other side, this is a simple thing, but these are important, because you see where you will put this.

Let us first draw the bracket, then will come back to this. The bracket is something like this (Refer Slide Time: 16:56). So, this is welded and obviously, the other leg of the bracket is welded to the girders. This arrangement is repeated at every frame space along the length of the vessel. What happens? This is very well stiffened, I mean to take any load whatever is coming on the deck on the tank top, as well as when it is being put on

the keel blocks, because what happens is, the keel blocks, as we have told you that they are not - I mean they are only at interval.

Obviously, it is not a continuous support, this is my ground level and you have the keel blocks like this. It is a block of woods, stack of woods, particular dimension over which it seats. There can be three such rows of block, over which the vessel seats, because how you built the vessel? When those we have talked about units and blocks, those blocks are to be joined together, how do you do that?

These blocks are brought and placed over such blocks - keel blocks, they are aligned properly and welded. Entire hall is welded and then all the necessary structural connections internally are made, all the pipe connections, cable connections, all continuity are done. Once that is computed for the entire length and then this whole thing has to be lifted and put in the water. Is it really lifted and put in the water? It is either slide down or floated up; one of these two.

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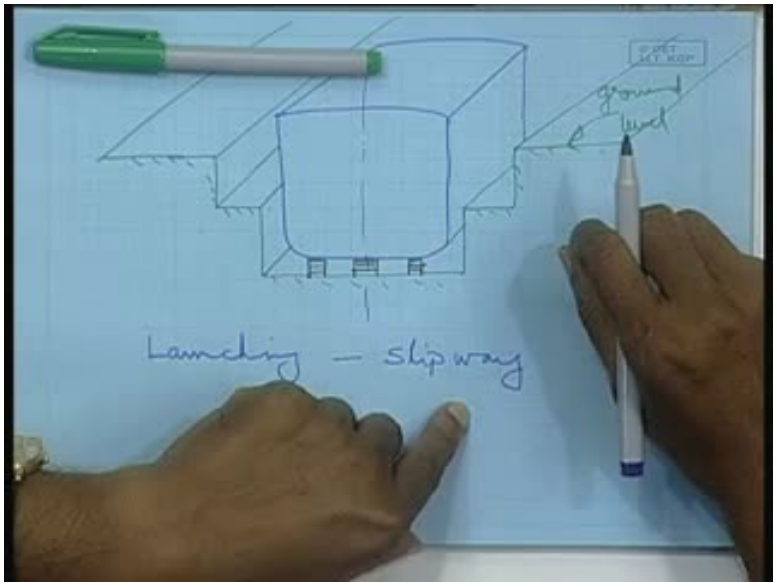

Little bit we are deviating from us thing, but still may be that is worthwhile to know. There are two ways of doing it, say it can be something like this. When we were talking about keel blocks that becomes more relevant, in this case, this is the case, this is a cross section what we have drawn is that of it - what is it? What do you think? It is I am tried to draw.

Is it not telling you anything? This is the ground level. What is this? Say, a ship is built, it is delivered its serving purpose, then say after 5 years you will have to bring it back and do some underwater repair - I mean underwater part of the hull, the painting has got spoilt or some small damages have taken place or whatever. Even if nothing has happened, there is a mandatory requirement that you will have to bring, make it dry and do thorough inspection. Whatever flows you find, you will have to do necessary repair, how do you do that? You will have to bring it to the shore, isn't? You have to lift it up in the shore. How do you lift it, is it physically possible? Then, what do you do? Dry dock; this is a section of a dry dock; this is what is so called a dry dock.

What happens to that dry dock, it extends to the water found and there are gates vertical gates. So, this is the duct you have the vertical gates. If you open the gate water will come in, if you close the gate, pump out the water it becomes dry that is how.

Anyway, for taking in water you do not open the gate; you rather pump in water and then open. Because, suddenly you open, everything will get - you cannot do that and neither, you can open it, the amount of force it will be.

In any case, there is a dry dock. In this dry dock, one of the different things is about - I mean when we have been taking about the various characteristics of ship building industry, this is another important phenomena. In this particular industry, for any other industrial product, delivery to the customer is not a very big issue, physical delivery to the customer - I mean, when we talk about the industrial product of, so called nature of what can we refer to as commercial nature or consumer nature - not commercial, consumer nature, then it is even the customer him selves take care of the delivery. Means when you buy a television, you generally go to the shop and bring back the television.

Mechanism of the delivery is, the seller puts it in a packet, which is comfortable to handle that means one can lift it, put it in car, whatever. When you take a delivery of automobile car, you just drive it out from the showroom. When you take delivery of an aircraft also same thing, you just drive it out from the hanger, but when you take delivery of a ship, you cannot drive it out, you cannot lift it and put it in your car or any such thing. It has to be first made water bound, first you will have to put in the water and then only you can drive it out.

An aircraft will remain on ground of its own power; you can drive it out and fly off, if you have an airport nearby of course. So, this is very peculiar, I mean this particular product you have to first put it in water and that putting in the water itself an exercise. Because, the size is such that it cannot sort of lift it and put it in water. It has to go of its own weight, using it is own weight slide it downs that sliding down. So, this process of putting this vessel in water is termed as launching. So, it can be launched through a slip way.

Launching means putting it in water, because the trouble is you cannot go on constructing it while a float, you can and there is nothing that you cannot. You can, but it makes your life much more difficult. Instead, if you have a static, because on water what will happen? It will keep moving. Not everything you will be able to do, say the hull work.

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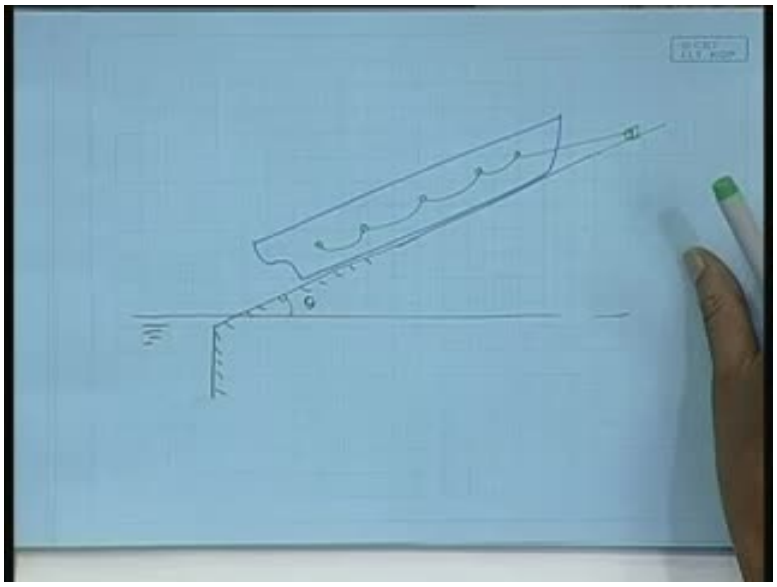

You will have to do on shore, doing it on water also it is possible, but that will be a much more difficult task. You put it in, it has to be on shore, so once the whole thing is built, it becomes so huge. So, putting it in water itself becomes an issue that one way would be through a slip way, you slide it down. It sounds very interesting, slide it down - I mean sounds like this. Of course, I am drawing it in a much exaggerated fashion.

This angle is never this much, this is referred to as declivity, so this my water level, so what happens? It slides down, when it is sliding down what is the guarantee that it will

not go and plunge in water. The way I have drawn isn't appearing - that when it is sliding down, it goes like this. So, thing is that it has to be so designed, the whole process of launching that when it goes and it floats up. Almost the moment of this pen it would be like this, it will go in water, at certain point, it will start turning like this and became a float (Refer Slide Time: 27:58). If that does not happen, what happens? It goes an opposite, stead goes. Because, this will be the built up space, if this happens that means it is going in water and then it should float up, what does that mean? That means, it should go on getting buoyancy, develop sufficient buoyancy such that a movement will start working and putting it up.

So, this movement - going down movement, which is called dipping movement. Difference between these two putting up movement should be positive, I mean higher. So that means it matters where the series is isn't? Otherwise, what will happen? It will go and it will just plunge in water like this. So that is what it is called anti tipping movement. Anyway, you can see this itself the whole process, is tedious, not only that it will go, float up and will not remain steady, it will keep on drifting. You imagine that you are river with - I mean where you are launching, suppose you are launching on a river, whatever is the width, not sufficient, say 800 meter.

So, it goes in water and it will keep drifting, so go and hit the other side, you cannot stop it. Had it been a car, you could have jump the brakes, here what you do? You cannot run the engine, because when you put it in water still the engines are not fully installed, because ships are put in water from slip way in a semi complete condition. Semi complete means, all the steel work has been done, but many of the fitting out works will be done elsewhere. Why because, this slip way is expensive thing.

Because, like a house, you built, you erect the walls very fast, but then a substantial time goes for fitting, for the plumbing, electricity all that; same thing in ships. The erection of the hull that means the hull works - steel works is very fast, but then putting the machineries, laying the pipe lines, the cables, means fitting out work, all kinds of auxiliary machines, everything it takes much longer period. So, it cannot keep the slip way busy engaged on that because that can be done while the vessels is in a float. In the float condition also that is possible to do, because you will be working on both the vessels inside the vessel.

No problem if that is outside water or if the vessel is floating and making some movements, no problem. So, that is why it is launched. Why it is launched? Obviously, propeller, shaft everything is fitted on that condition. You do not have power, so you have no mechanism to break, so then it may go and hit then, what is the solution?

You will have to have arrangements for breaking. There are ways of - you have chains connected, which are clamped on the shore. Now, if you really correct it in such a fashion that the vessel goes, you can imagine the momentum. Either, it will break the chain or it will tear of the plate where it is connected, so purpose is not solved.

So that is what very interestingly done. These connections are such that slowly it will float in the water, gradually the tension is coming on this chain one after another, will start failing in a sequential fashion. So that will absorb that momentum in such a fashion, it will fail that it will not cause harm to the hull, but only to that connection where it is connected that will give away one after another that is very interesting, it is done.

Another solution is - but, still there is a risk, if you do it very wrongly, your hull gets damaged. You are too careful to protect the hull and then the breaking distance becomes ineffective, means you go and hit the other side.

What is the other solution? Side launches it. You know, instead of launching it, end launching, this is called end launching, it launch, it goes and hits, I launch it sidewise. Then what happens? The breadth is much less than the length, minimum 4 to 5 times less - minimum, it can be 6 to 7 times less.

If I have a width, I have ample space to, it will automatically stop. Not only that when it goes along the length, so the resistance is minimum. So, whatever momentum it is getting, with that momentum it will go on flying, but if I launch it side wise, huge resistance – huge, so it will just launch and stop of its own; it will not go, but the problem of dipping is much more, so that is a very tedious job. All these operations were very clumsily and very difficult - I mean tedious, I would not say difficult, tedious.

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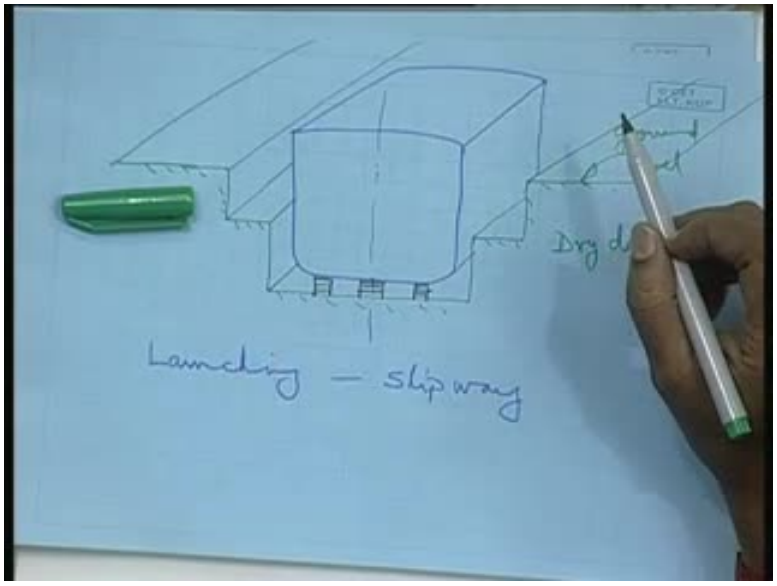

Best is, you built it in the dry dock. So, what do you do? In the dry dock, the dock is dry, means the gate is closed. Here, the rows of keel blocks led, depending on your handling capacity, either you start installing the subassemblies here. Generally minimum thing installed is the units, means that say with the double bottom you start and then bring the side shell erect. If I have more handling capacity, this entire block is fabricated in the shock floor; from there it is transported here.

Hanging in a crane you can do - I mean, while from the shock floor you will not bring it hanging, you will bring in transporters. There are specific heavy duty transporters, which can carry such loads. So, you bring it, from that with a crane you put it on the keel blocks. So, there the functions of the keel blocks come mainly. When everything is completed - here the advantages is, you complete everything and then start taking in water inside, release it, so it will float up automatically and goes out.

So that is how well that - I mean when it is on slip way, this case of keel blocks are not there, is a different kind of support, but when for construction or for repair or for maintenance, for dry inspection, you will have to put it in a dry dock.

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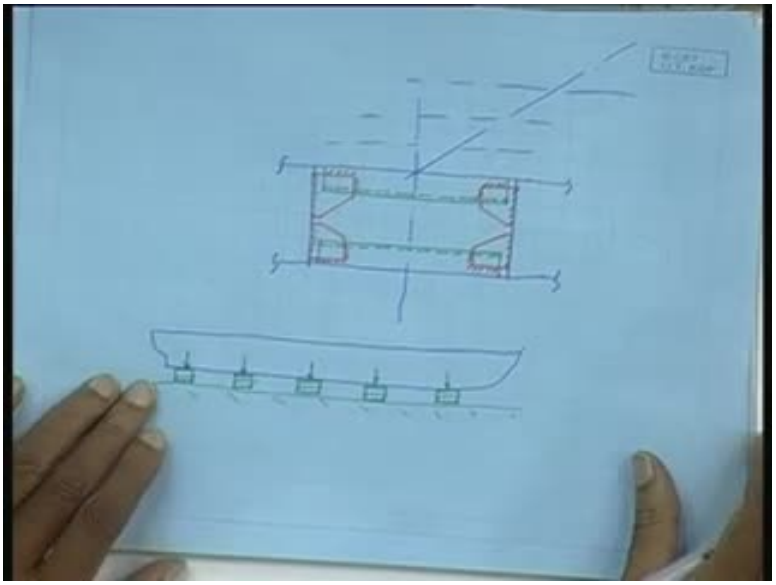

This is a dry dock, where it will sit over this keel blocks. The load on this comes - so, you can see the entire load of the vessel, will be supported only at the certain points. Sort of 3 rows of blocks - I mean 3 columns of blocks and certain number of rows, there will be some sufficient gap between them. The entire weights of the vessel are supported in these points, so naturally the structure has to be very strong.

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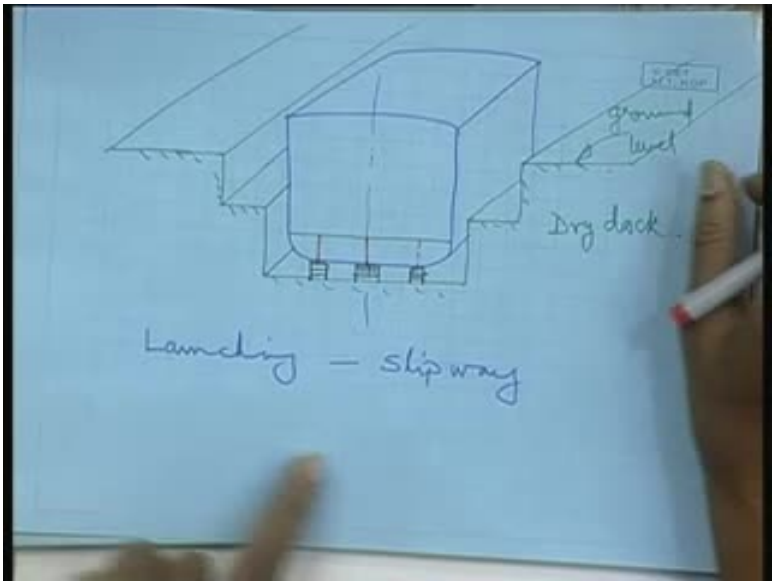

How this keel blocks will be led? That also will depend on - I mean, if you see inside what is the construction, you will have to have, where the keel works have to be spaced,

you will have to have some heavy stiffening members there. You cannot keep the block somewhere here that place will get tended isn't?

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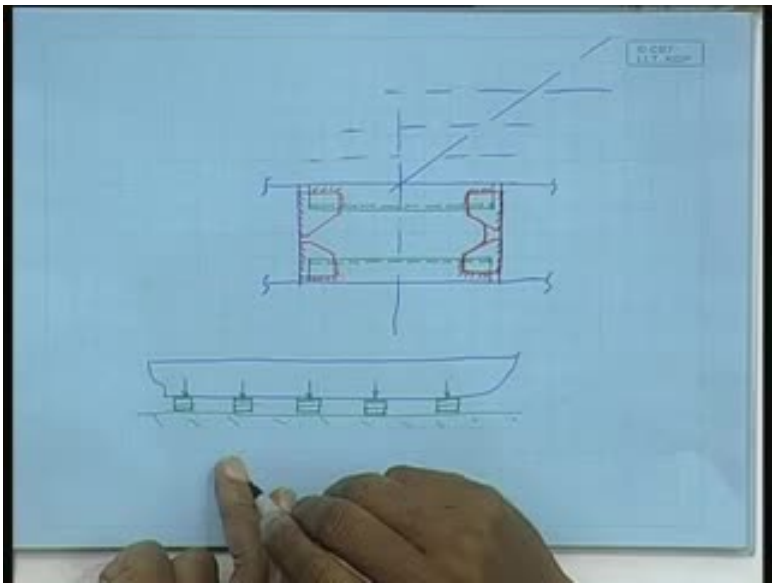

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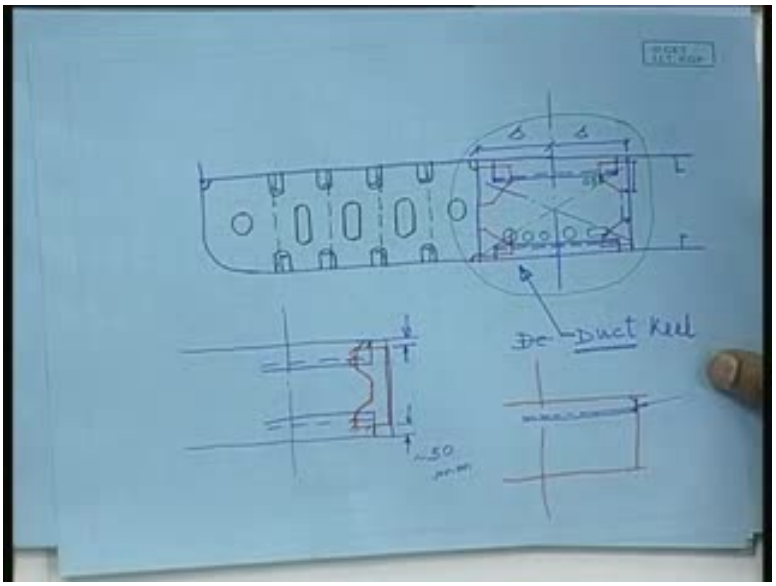

That is also one aspects of the stiffening member; that means to support the load, so that is how. What we see is the duct keels, the function here. Here, as we see that the connections are with brackets, so one can have this is the simplest way of doing it. That means you have four separate brackets, so the alignment problem is not there at all or it

can be converted into one piece like this. This is just one piece of - also it can be converted like that.

That means, here you have the bottom shell plate on one side, this is the reverse frame, you have the bottom frame and you provide a bracket of this shape that is also possible then, what happens? In addition to its making, the functions of brackets are to provide for the end connection; proper end connection, proper - I mean to provide for adequate load bearing area. Because, if I have to - instead of proving the bracket, if I would have to have a extended frame and welded only on there that means, you have the side girder and I just extended right up to the end.

This corner I cut it off, then is, needs to be cut off because of the fillet welding there, so I get only this much of welding area, the welding area is much less, isn't? By providing a bracket, I am increasing the welding area so much; that means the load support is increasing. If I do it this way, as far as the reverse frame and the bottom frame is concerned, they are perfectly fine, but what about the stiffening of these girders? Because, they will be there at every frame space. Either I have to provide a stiffener here additional or I make it is a continuous piece. One simple single piece does both the job, because providing a stiffener again, the question of end connections will come.

It may so happen, has we have drawn the way that depending on the depth of the double bottom and the size of the brackets, there will be small space left. Providing another small stiffener, it should have continuity within the brackets connections, so that may took to be difficult alignment problem, because not all will be correctly spaced. The problem is even if there is a 5 millimeter; it is out of alignment that it will be the thing, will not fit.

Instead, one single piece can be taken, which can have a sufficient play in this direction. If I put it little upwards or little downwards, it does not matter, because I have sufficient clearance in both the sides, these are my clearances, isn't? There is clearance; they are generally of the order of 50 millimeter.

Why not 25? Why 50 again, why not 100? The reason is it is not 25 simply because and then what happens? The space will become very narrow. That clear space becoming narrow means it becomes difficult to maintain that point, you will have to provide painting; otherwise, there can be a possibility of corrosion. Once the construction is

done, each and every nook and corner has to be accessible for painting purpose, this painting is necessary unless that is done again, it will led to corrosion. So that is why it cannot be small, keeping that in view, we can keep 100 millimeter, then it will be more comfortable to paint.

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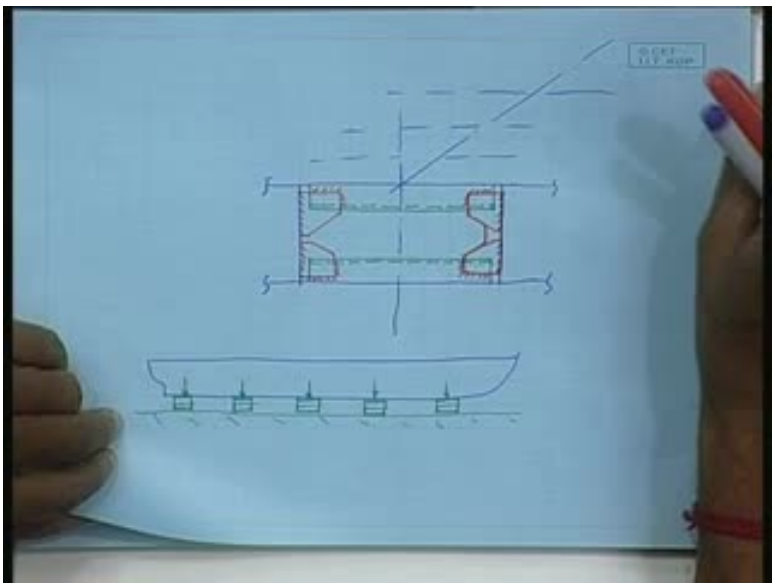

Again, what happens? Your bearing area becomes less. Suppose your depth of this is 200 and if I keep 100 millimeter gap, then this becomes only 100. So, support area becomes less. So, has to be some optimum, generally 50 to 75 millimeter is kept, they are the simple logic. So that is how this duct keels. Here, this entire thing - taken this entire construction, is referred to as duct keel, because it forms a duct.

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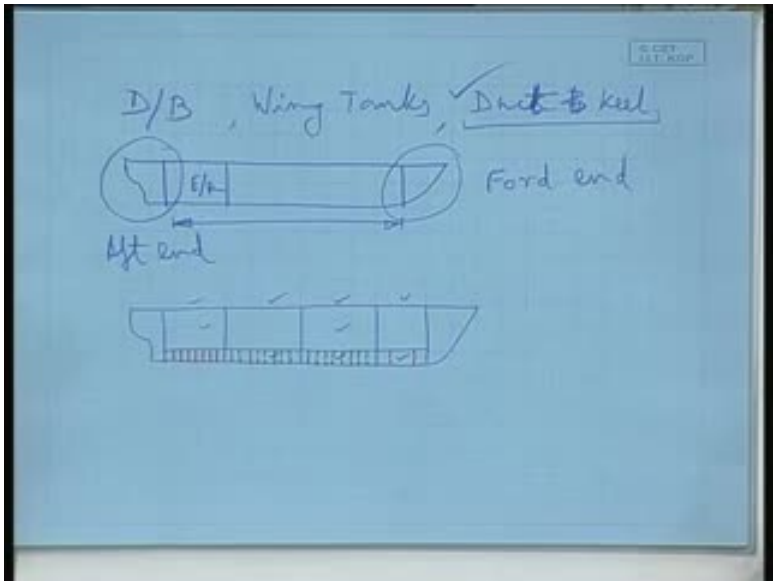

Now that way we looked into what do you call double bottom construction. Wing tanks, well wing tanks are not there in all shapes, the bulk carrier mainly, but all shapes will have double bottom construction - the construction philosophy same. Duct keel is also not a must, but it is preferable, it is a good design practice to provide for a duct keel.

Well, if the vessel is - I mean sufficient space is available, if the vessel is very small, say a river barge. River barge means, who are carrying capacity, say 300 tons, 500 tons, so they are probably providing a duct keel kind of arrangement, double bottom all this things may not be there at all, so the question does not arise.

In any other ocean going vessel, whatever is the size, possibly it would be a good practice to provide for duct keel always. That may add marginally to the cost, but in the long run, it will be beneficial for the ship owner. Simply because, possibly he will see much towards maintenance of his utility lines, because in ships there are various kinds of pipe lines, fresh water line, sea water line, bridge line, firefighting line. So, many pipe lines will be there, cables - electrical cables will be running, so maintenance of those becomes easier and better. Then, as we see, the vessel - these two parts: this is Ford end construction, aft end construction.

Rest part of the construction with in this zone, they are generally identical, only difference is in the engine room, the difference is like this. You have the holes, you have the double bottom. All construction - what you have talked about the double bottoms, all

this double bottoms will be identical. That means the same methodology will be taken, inner bottom longitudinal, bottom shell longitudinal, floors, bracket floors, plate floors, solid, water tight floor all this things will be there.

Similarly, in the side shells, the decks will be same identical. By identical, I mean identical arrangement, the dimensions of the stiffeners so called scantlings of the stiffeners or the shell plating thickness they may be different, but the arrangement, deployment of stiffening members, all these things will be same. In engine room also, the decks shells will be same, only difference will be in the double bottom.

What is the difference? That here, we have floors at every frame space, rather I would say plate floors at every frame space, whereas in other places the plate floors are at intervals. In between, we have so called a bracket floor that is the difference; otherwise, mostly everything remains the same that is how the greens are at the say brackets floors. That means will have the bracket floor arrangement, only the two brackets supporting the bottom and inner bottom longitudinal, and the center girder.

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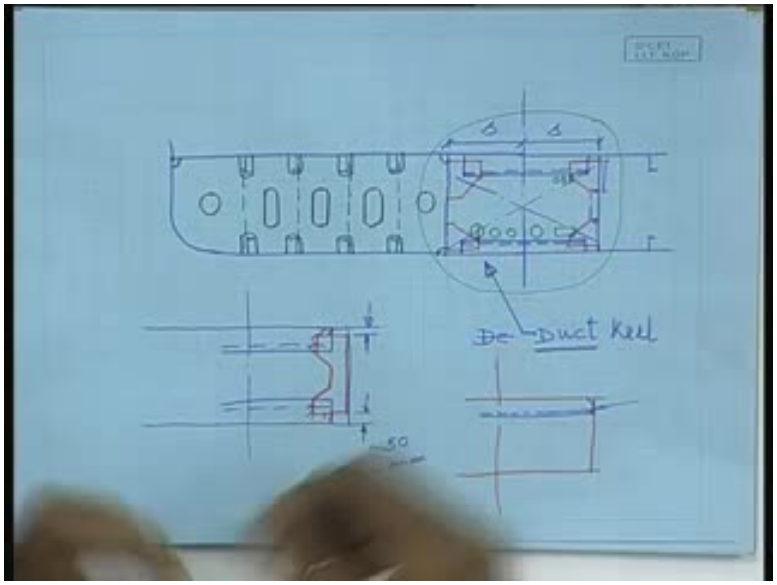

If I have, what do you call duct keel arrangement? Then also the same thing - then also the same thing; in case of a bracket floor arrangement, this part of the plating is not there. This three lightning also I have drawn that means this part of the plating is not there, only this plate and this. These two together they will be taken as the bracket floor that means this basically a bracket, what it is doing? It is connecting the bilge plate with the

inner bottom plating, the immediate stiffeners longitudinal, so a connection is being made.

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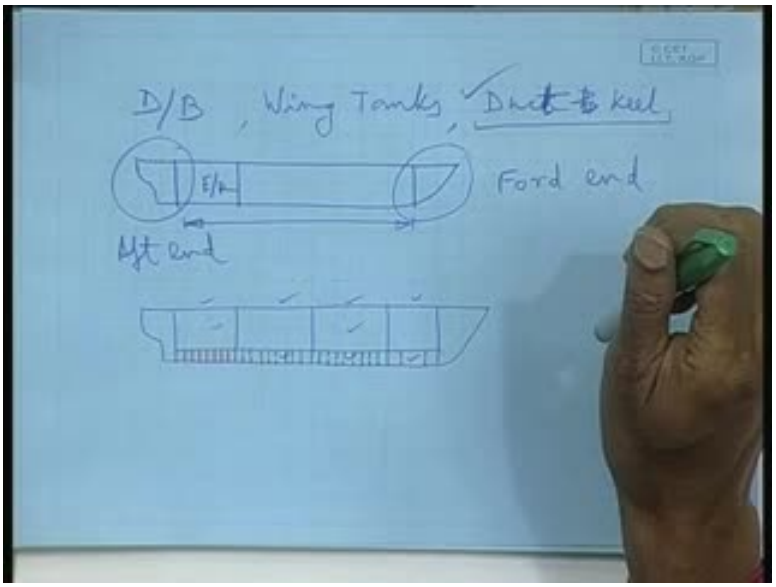

Similarly, here, the inner bottom plating, the bottom shell plating and the one of the side girder, so that is what it is the bracket floor, but in engine room the difference is all frame space, will have this kind of plate floor arrangement - this is a plate floor arrangement.

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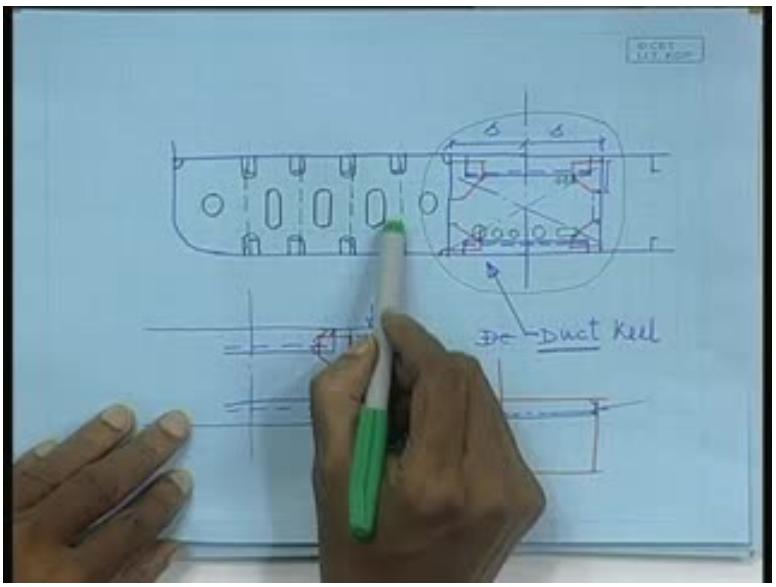

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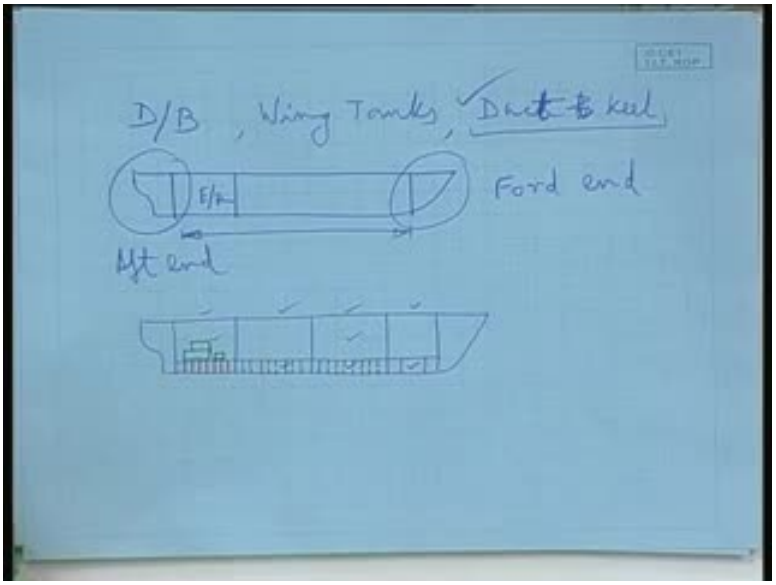

This is a plate floor arrangement, it is done because they vary, may concentrated loads at there, the main engine are there and the various auxiliary machineries are there, so on. That is why, I mean putting a solid floor or putting a plate floor, you see solid floor also called as plate floor that does not mean that it is a water tight floor, just the name like that.

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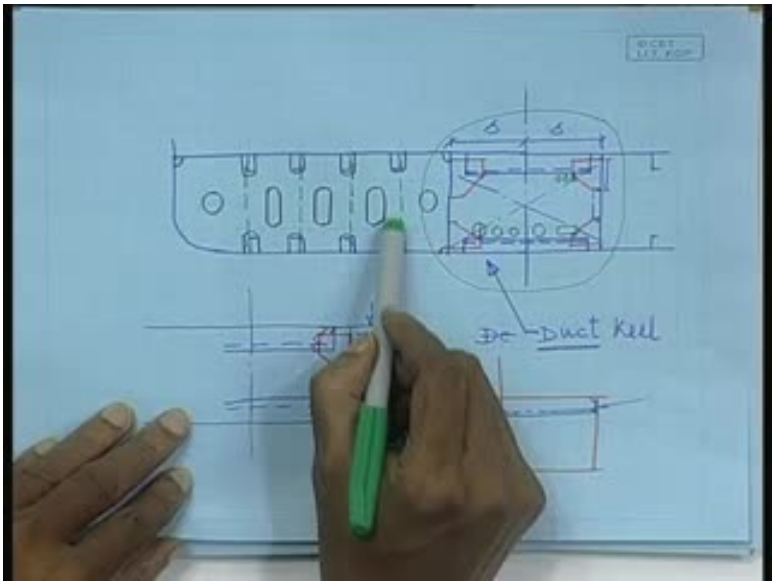

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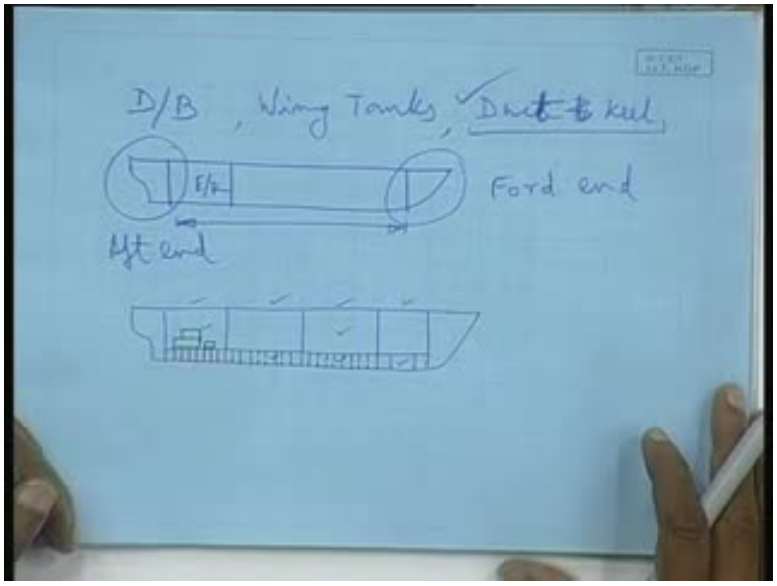

So a plate floor is obviously a much stronger arrangement than a bracket floor, so that is provided, because to support many concentrated loading, which may come in the engine room that is number 1. Number 2 is by providing additional rigidity it changes the frequency of vibration of the structure and as such it brings down the natural frequency of vibration. So, here, engine will be there, it is moving machinery, so it will generate or it will provide for an exciting force for vibration.

What would be the frequency of that exciting force in the engine room? The engine room structure, it may get subjected to vibration, you know. Like when you sit in a car, when you switch on the engine, you feel a vibration; that means, where from the vibration is coming? From the engine, why it is coming? Something is rotating there, something is happening, what is happening? Something is rotating that is getting transmitted.

Now, obviously, the vibration is too much, you would not like it from the comfort point of view. Secondly, it may lead to what? What it may lead to? A fatigue failure, because vibration means, what vibration is? What is the different between vibration and oscillation? No, vibration also - I can say if it is being excited by a sinusoidal force continuously, so about a fixed base it will go up and down. Imagine a situation, it is going up and down, it is vibrating - I said know it is oscillating.

Oscillating is a rigid body motion, vibration is an elastic deformation taking place, the body is elastically deforming and oscillation would have been this. In oscillation, the

rigid body motion is taking place; well, always we tend to show like this, why? When you talk about oscillation, think of pendulum.

When a pendulum is moving, it is oscillating about that centerline, there is no deformation taking place. When the ship is rolling, it is oscillating; the whole rigid body motion is taking place, it is not deforming, there is no deformation taking place, but thing is vibrating, then actually say this plate vibrating; it will make motion like this. See, it is actually, what is happening? Elastic deformation - the deformations are within the elastic limit.

It had been plastic deformation, it would have remain like this, deformed and raiment. Deformation is taking place, but it is following, the Hooke's law remaining below the yield point. It is sort of - I mean, when the exciting force is removed, it comes like to its original shape. When the car vibrates, you switch off the engine, it becomes steady and there is no physical deformation noticed anywhere, so there is a difference.

Vibration is a result of elastic deformation that means an elastic deformation is taking place. What is happening in the process? That means, the metal is subjected to tensile stress, compressive stress, is not? When it is going like this, the top fibers are intension, when is going below, the top fibers in compression, so being subjected to a cycle of loading or cyclic loading that may led to fatigue. Means, you have seen if you want to break something, you do like this and it breaks, why? So that is what may happen that means that may initiate a crack formation some were here and may led to failure. Worst is that vibration amplitude if it increases resonance. To avoid resonance, you have to make it more rigid, more stiffened, such that the fundamental frequency of vibration of the structure falls below the exciting frequency.

Exciting frequency is nothing but the r p m of the engine and its multiples - r p m of the engine and primarily it is multiples, the number of propeller blade on that. So that is the difference here, in the double bottoms engine room, rest other things are same. We look into the ford end construction and the aft end construction; little bit we had already talked about, ford end construction we will try to see little more in detail.