Marine Construction & Welding

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Module No. # 01

Lecture No. # 14

Container Ship

So, today we will continue with the mid ship sections, discuss about the container ship, container ship mid ship section.

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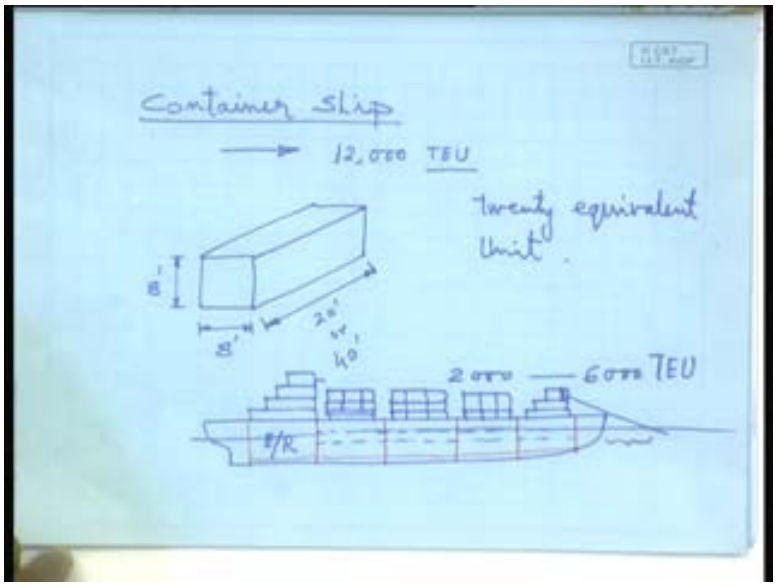

Well what is a container ship basically? As the name, you can see that it carries containers. Containers are somewhat of this type, somewhat means, they are essentially a rectangular container. As you can see, the dimensions are they have a cross section of 8 feet by 8 feet, and length either 20 or 40 feet, they are in feet; this is the universal standard, means all the containers which are used in the container ships, they will be either 20 feet long or 40 feet long.

One nonstandard in between is there, that is 35 feet long. But not a very, I mean, that is not used very commonly or popularly for the simple reason. Here you can see it is a multiple 20 or twice that 40. So, in place of 140 feet container, I can load 220 feet

container. That is possible, but if I design it for 35 feet, then I have problem. Any ways so these are the two most widely used.

The whole concept of containerization came as I think. So, we have already talked about it is essentially to implement or to have minimum port time. What does that means, very efficient loading as well as unloading of cargo because a ship owner will not only like to have a very efficient vessel I mean high dynamically designed so that it consumes minimum power such that your fuel bill is minimum. At the same time, you would like to have systems or facilities such that he can load the required amount of cargo as well as unload it at the minimum possible time. Because this process of loading and unloading they are actually not a revenue earning time for the ship owner. It is actually a expenditure kind of thing for him because he is in the port; longer he stays in the port, more fees he pays to the port.

And not only is that he just kind of idling. Had he been moving means he is taking the cargo to some destination; he earns revenue that if he earns. So obviously, one would like to have it a loaded unloaded as fast. Now you have seen the general cargo ship all cargo are individual a piece of cargo has all kinds of shape size and weight.

So, loading unloading will be very tedious. Instead, if you can think of a system where in we pack the cargo in a box of standard size, then the loading and unloading become very easy.

So, that is how the concept of this containerization came. In fact, in container ships, essentially carrying a general cargo in the container. Instead of piece by piece in loading and unloading, I will just handle one container whatever items are there inside, they may have different shape, size, and weight.

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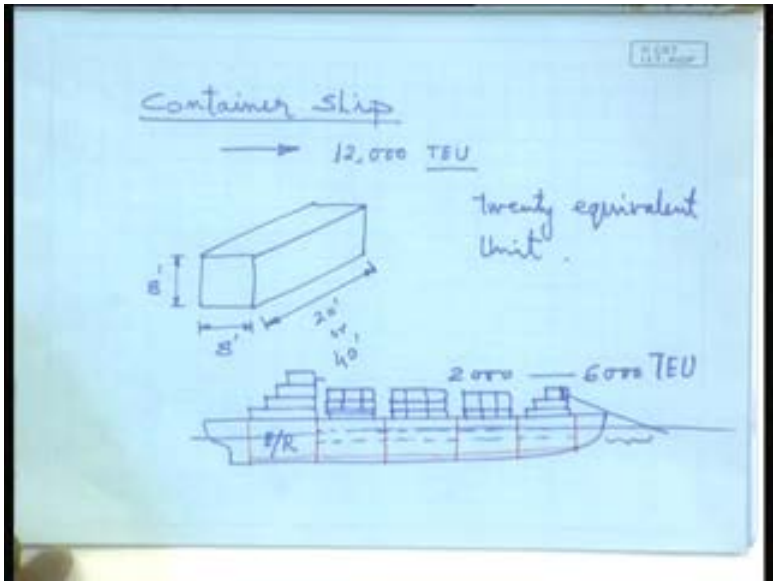

So, that is what the basis of container ship is. So, in the process what happens, we have seen general cargo carrier, bulk carrier, we have talked about carrying capacity in terms of tons, dead weight; how much dead weight. How much cargo it can carry in terms of tons 12000 tons, 60000 ton like that. Whereas in container, we talk in terms of T E U 20 equivalent unit.

That means, in container ship that carrying capacity is referred to as in the form of T E U. I have written here 12000 T E U what does that mean? That means, a vessel can carry twelve thousand such containers. Twelve thousand 20 feet long containers or could be six thousand 40 feet long container or mixture of that.

So, this is what is the kind of unit T E U, which gives you the idea of how many containers it can carry. So, here while doing the container ship design, we will have to keep in mind, if the owner want to say 6000 T E U container ship means you will have to make provision, you have to design the vessel in such a fashion that 6000 such containers can be loaded in the ship and obviously, this containers are not only kept in the hold, also they are kept above the hatch covers.

Also they are kept above hatch cover that of course, depend on design how many tiers of container will keep above hatch cover means open in the air. It is in any guess. So, that is what is container ship. So, what we see, the very typical feature of container ship what it would be; it would be as we go on increasing the capacity of container this 12000 ton T

E U is not a very common container ship. Commonly we have well in the range of I would say I mean so called ocean going container ship could be in the range of 2000 to well may be 6000.

This 12000 and all that is a very ambitious kind of container ship possibly one or two have been built. They are huge they are really huge. By huge what do you mean. We mean the length could be very big. So, as the length is becoming bigger, what is happening? It is becoming more slender, your bending movement is increasing terribly and also slender.

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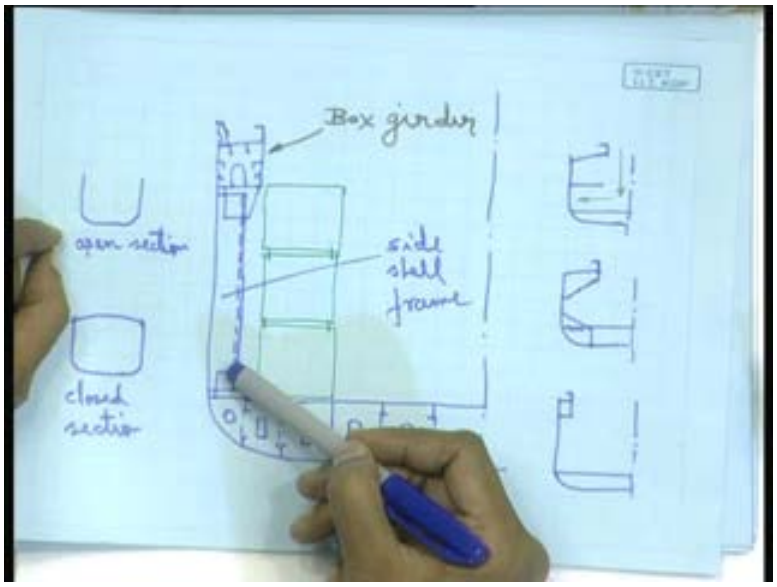

And for we have talked about we have containerized the cargo because of easy loading and unloading. So, if you have to do that we will have to have a mid-ship section something like a open section means fully open. Till now all the vessels we have seen, if I just make a comparison here, we can say the all the other vessels had a hatch opening like this; be it a general cargo carrier or a bulk carrier.

So, something like this. So, what do you see here is that almost half of the deck approximately not necessarily, you have the deck plating and then you have an opening. But in comparison to that if I see a container ship, these are irrespective of capacity. If the general cargo carrier a say a small general cargo carrier say 3000 ton of general cargo carrier, or 10000 ton of general cargo carrier, you will have sufficient amount of deck plating and then a hatch opening.

Similarly, with bulk carrier, but a container ship whether it is a small container ship or a big container ship, its hatch opening would be in comparison like this.

If this entire three are of the somewhat same so called external dimensions, same load carrying capacity, here you can see the hatch opening is much bigger. For the simple reason, that unless you do that we cannot have my loading and unloading or so smoothly operated.

Because the containers will be like this, it will be vertically loaded and vertically unloaded. One after another it will go. So, I will have to have the hatch opening as big as possible such that I do not waste any space in the side. Because if I have a small opening like this in case of bulk carrier or general cargo ship, then I have to lower the container and shift it laterally, lower the container and then shift that laterally which is definitely not a worthwhile proposition. So, it is done this way and this continual handling is done fully automated in properly automated ports where you have facilities of handling container ships. They are automatically done means without any fully automated system, the containers are lifted and kept on the dock and from there it is I mean well send to the destination.

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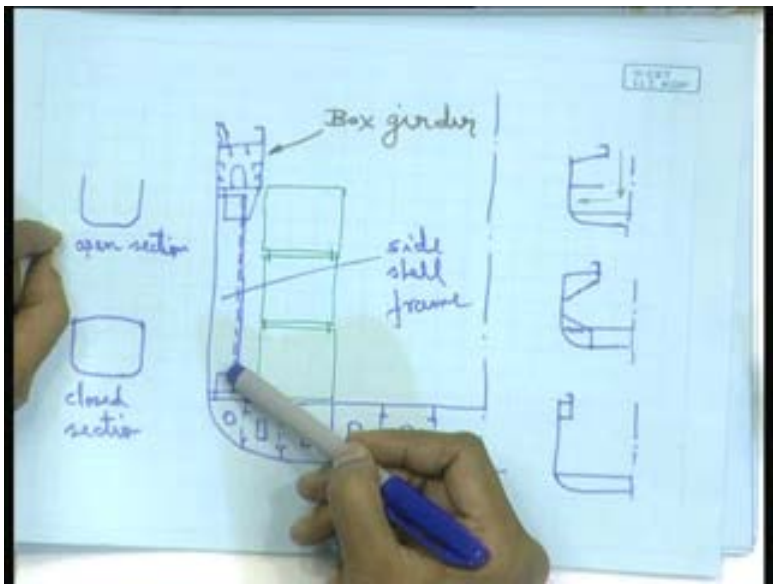

So, as the size of the container vessel increases, we have the length increasing thereby giving raise to increase bending movement and where whether it is a small one or a big one, you have a huge hatch opening; means with increasing length, it is not only

becoming more slender and your bending movement is increasing. Your torsional strength is decreasing drastically because it is becoming a case of open section. This is what an open section is and somewhat equivalent to an open section in case of open section just the opposite of it is what? Obviously, close section and oil tanker. This is a close section and that is what the oil tanker is.

So, we can see when those huge super tankers were built; of course for some other reason this days those super tankers are no more build the super tankers means of their carrying capacity of around half million tons of crude, half million ton is 500 1000 tons of crude the vessels could carry, vessel length of the order of 400 meter huge.

But today even making a 12000 T E U container ship is much smaller than that, but still we say it is a very challenging business; a challenging job to build a vessel having 12000 T E U capacity a container ship.

For the simple reason it is open section. Torsional strength becomes a big problem here well. So, that is the basic of it. Now how this torsional strength is taken care; that is the major thing here. Till now we have seen we have designed well again the same thing from the functional requirement, we will have to have a huge hatch opening. From functional requirement we had wing tanks in bulk carrier from functional requirement, we had lower deck in general cargo ship.

Why lower deck because for segregation of cargo in general cargo ship. It is called a go anywhere type of ship. So, it can carry any cargo to anywhere, any place. It has its own handling facility. It does not need any port facilities. It should have enough draft so that it can park itself. It has its own cranes derricks to load unload cargo and so for segregation of cargo, you provide a lower deck certain things we will have to unload from there, certain from below. Any way functional requirement wing tanks functional requirement here functional requirement is a big hatch opening.

A big hatch opening and that is leading to the other things there we did not have any structural problem. Here you have a strength problem, torsional strength that takes precedence I mean that becomes more important than longitudinal strength.

So, one we will have to look into the aspect of torsional strength. How that has to be taken care of. So, here you can see the kind of the deck well these are all same or so called Bul work and you hatch what you call, hatch coming.

So, the deck is very small how small well; obviously, it has to be enough such that it gives a good working/walking space because you will have to probably work/walk from the fore end to the aft end all that and plus well it can be just the single skin of the hull. So, there will be stiffeners inside. So, that much space. So, it could be as less as 1.5 to 2 meters even.

Anyway. So, what is done is this particular arrangement as you can see, at the top it is called, this is primarily this full thing taken together this is referred to as box girder.

It is something like you have observed the I mean for domestic use the tumblers I was talking about. What you see in tumbler. Just to give it the necessary torsional strength, they are generally of this shape.

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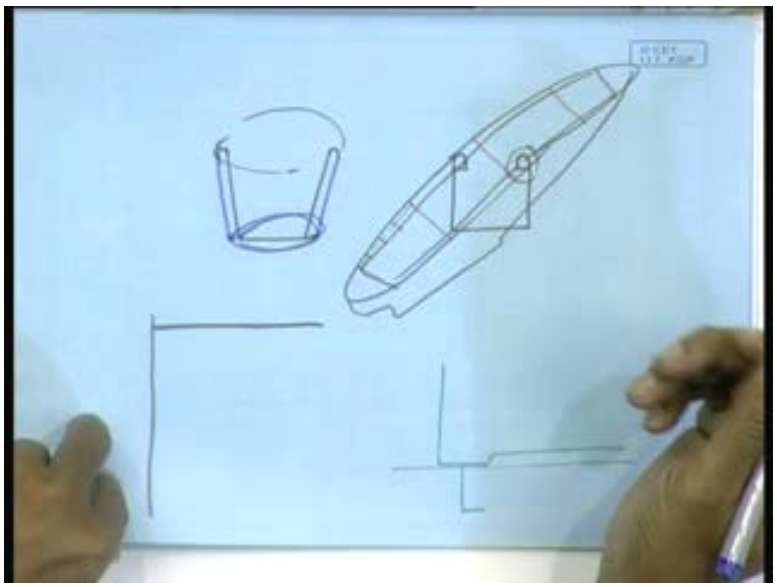

If I keep the edges without any stiffening, it does not have any torsional stiffness. Just to provide stiffening this is bent like this. Those plastic tumblers, domestic tumblers that gives you the strength. So, here imagine the case, instead of I mean we are just simplifying it trying to draw equivalence. This and instead of turning out side say I turn inside I also have the same stiffness.

And obviously, here in case of a tumbler, it is a quite a small thing, but in this case it is a long, much longer object. So, this rigidity is required all around.

So, what is happening? This box girder I mean this stuff is extending all through or in other words like here in that case of the tumbler, just by turning the edge I could achieve the required stiffness. Now here obviously, stiffness is going to be much higher. So, I am not only turning the edge I making this heavily constructed.

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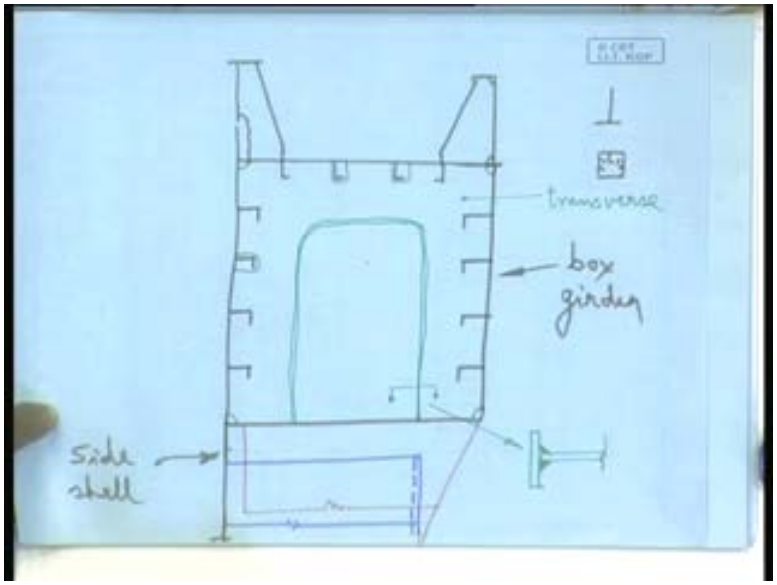

How heavily what basically is done? If I just enlarge that part of the box girder, it is nothing but such enlarge section of the box girder. This is your box girder. This is the side shell plate. Here you have as usual the Bul work and or railing whatever. You have this hatch opening here; this is the hatch coming. So, only this much is my deck then rest is full open. So, what is done is this is your side shell. We will just take a look how it is done in other vessels.

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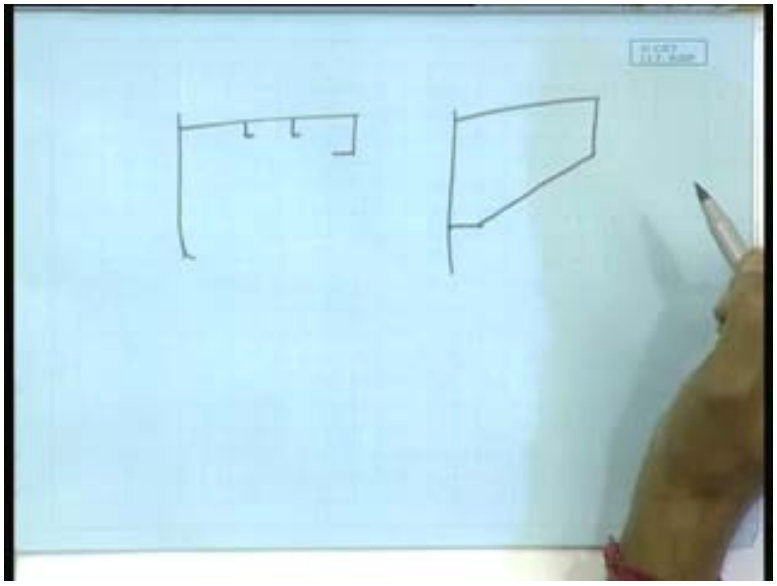

Say general cargo ship once again, you have the deck opening. So, stiffening of this was done by means of a hatch side girder and then stiffening of the deck you had those deck longitudinals etcetera.

In case of a bulk carrier what we did, stiffening was done by also a vertical plate; I am no more calling it as a girder, but the function is same. Here I had this girder, here I am having the vertical plate which is slopping bulkhead. So, this is providing the necessary stiffness.

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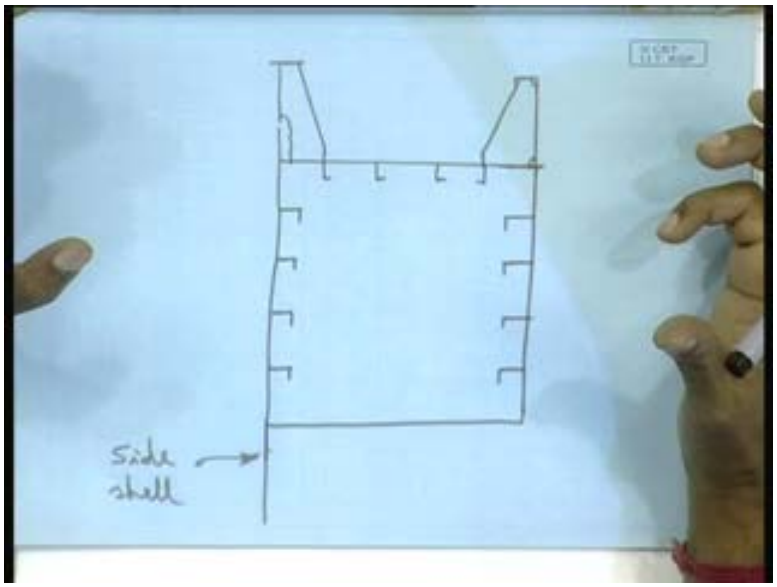

Now, here what is happening? Bringing a same plate vertical plate or a girder and in addition having a fully horizontal plate thereby completing a box like thing. And this is now stiffened. These are my so called deck longitudinal. This part of the side shell is also longitudinally stiffened. Again for the simple reason that a longitudinally stiffened system gives me best buckling strength. It provides me I mean it is not only good in case of I mean it is good in case of structures which is subjected to longitudinal bending and when a structure is subjected to longitudinal bending, in the event of compression it suffers buckling.

So, what is important is buckling strength. Now if longitudinal framing system is adopted, then it will give you a better buckling strength. A better buckling strength means your critical buckling stress will be higher. So, due to longitudinal bending it would not buckle that is what is important.

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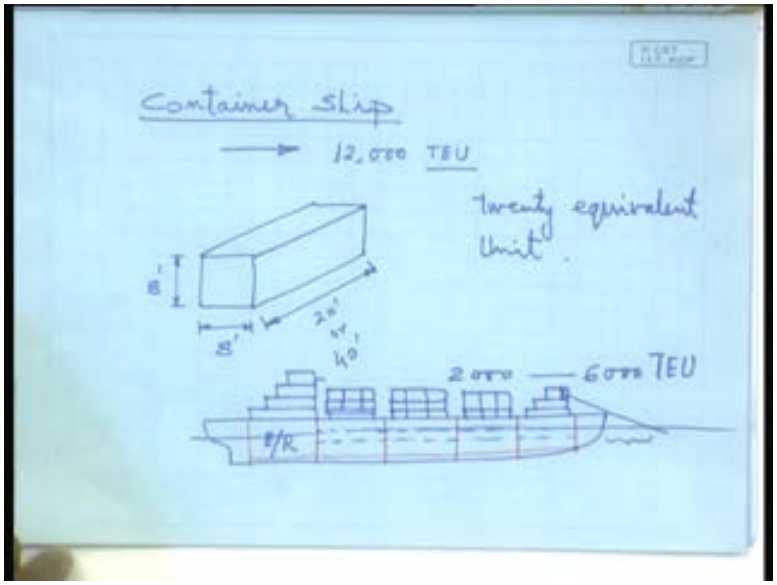

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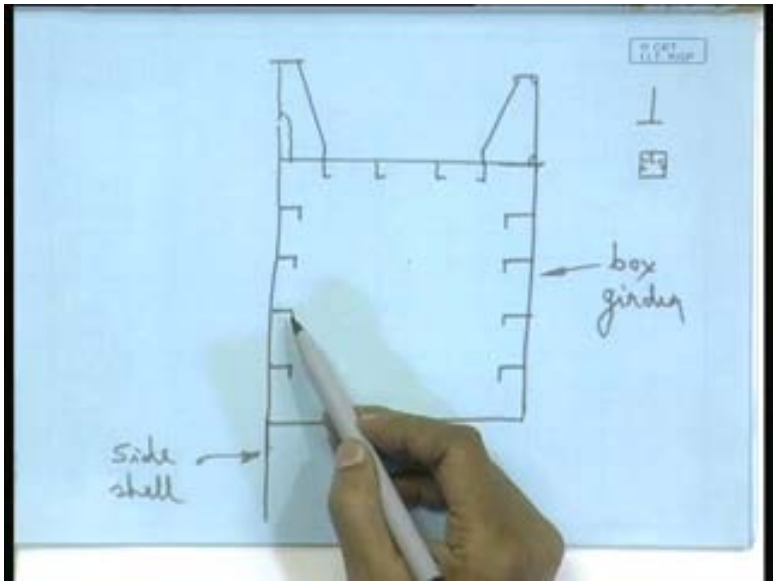

So, here again the same thing. We are providing longitudinal framing system because of the reasons I just talked about thereby this will behave perfectly as far as the longitudinal strength is concerned and also we have said that if we go on increasing the number of a container the length is increasing, bending movement will increase. So, you need more longitudinal strength. So, this is how. So, this box they are the total box it is referred to as box girder. The word girder means essentially a heavy stiffening member.

That girder can be a just a t section or girder can be a box like a thing. In this case it is not only a box, it is a stiffened box. It has all kinds of stiffness inside like we can see again within this box you can see that it is the weight has been done it has a sufficient strength longitudinally, but again the same issue.

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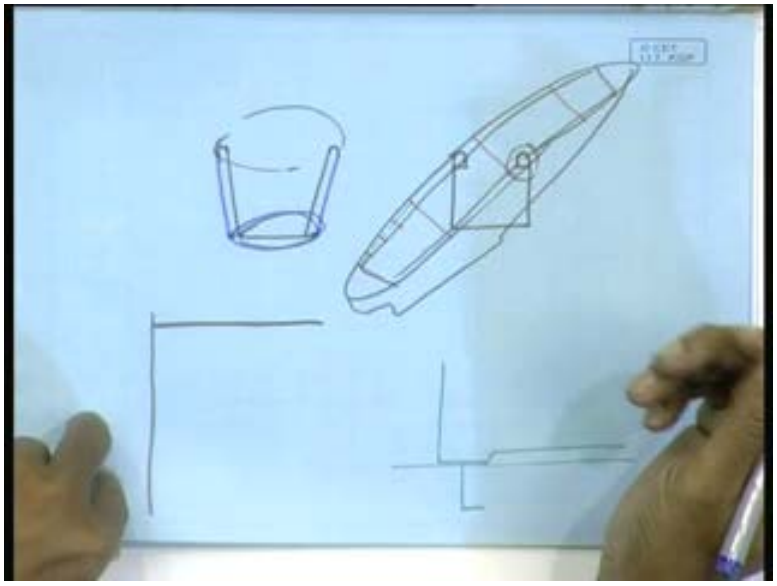

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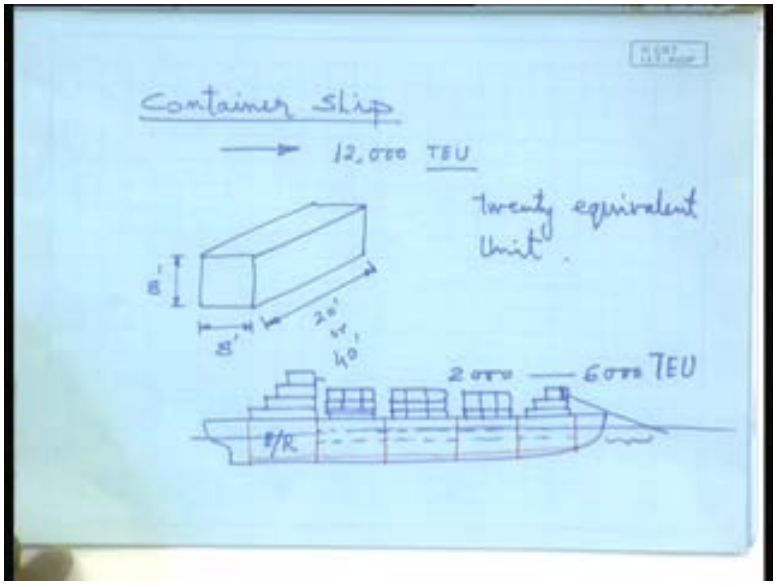

This longitudinals are running all along the length. So, you will have to have support in between, in between transverses are needed because well you have the bulkheads. When you have this, whatever that concept of bulkhead that remains because one thing you can see, this transverse sub division bulkheads they are a must; whatever be the ship type they are must. Why must? Because that gives us the so called required safety aspect from the safety point of view that in the event of any accident or damage, this will provide me quite a substantial level of safety before the vessel really sinks.

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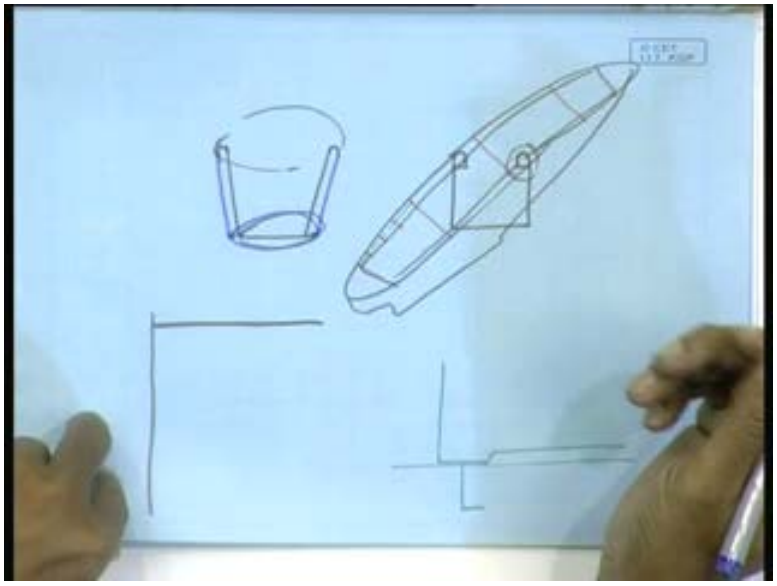

So, bulkheads are there. So, in the process what happens, if the bulkheads are there like here I have drawn in red. So, this longitudinals in the box girder in that case will be running from one bulkhead to another bulkhead. So, this again becomes a quite a huge span. So, again from the same logic, we will have transverses in between like we had the deck transverses in the general cargo carrier or bulk carrier.

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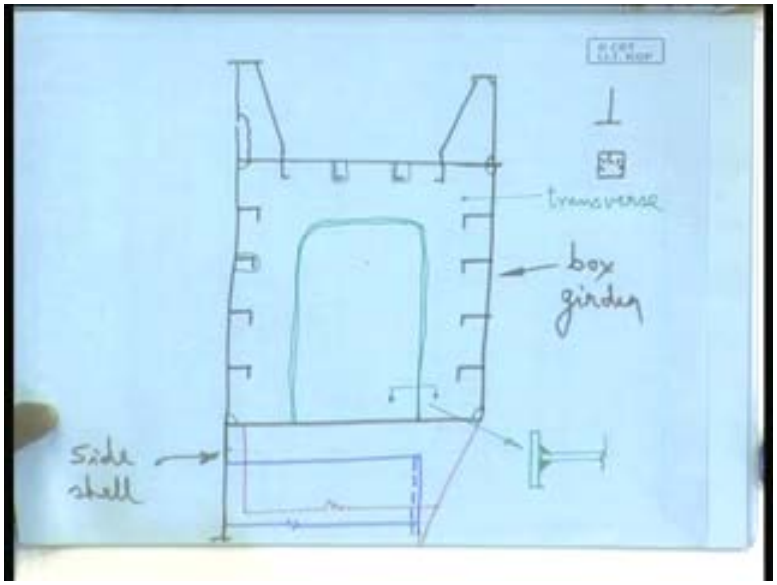

So, same logic is there. So, here the transverse means what; means essentially a plate here, a plate there. So, together it can be one plate which can have a like in bulk carrier

we had the transverse in the top wing tank. Same thing; this is a transverse having a flanged. This is joining a double line means I am showing that the edge, there is a flat bar welded to the edge which provides which functions like a phase plate. This cross section is nothing but we have the plate and there is a flange welded a flat bar welded. So, this is a transverse and now once this is a transverse means well those same things those scallops, those cut outs will be there.

So, thereby we see that this transverse. So, this is a transverse. Again the same thing; this transverse will be spaced every three to four frame space. So, as you can see that entire structural arrangement whatever be the ship, the method of arranging them, the deployment of stiffening members; all follow the same principle because at the end of that their purpose is such that there is no part of the structure attains a stress level beyond permissible limit. That is a final purpose; in all service conditions no part of the structure should attain a stress level beyond permissible limit.

Now, only variation of the structural type etcetera is coming because of functional requirement. You need here the torsion becomes more important. They are the well the bending becomes more important and so and so forth.

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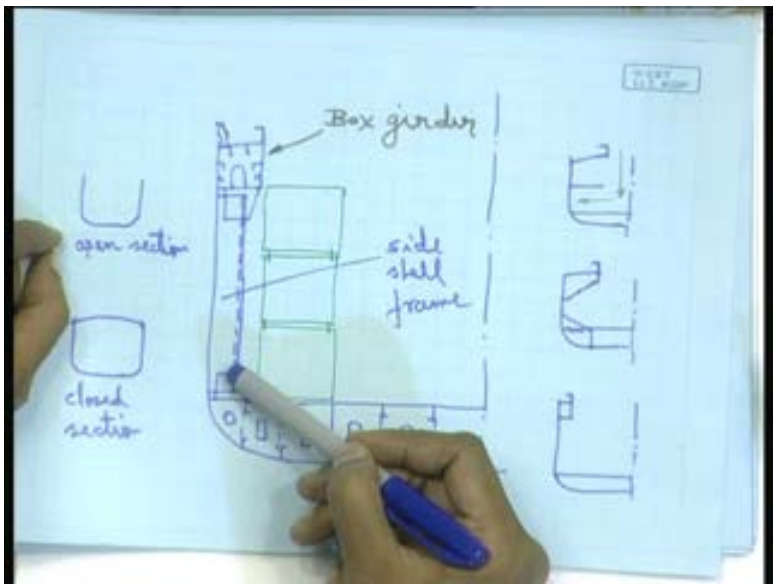

So, that is how this is what is the box girder construction. So, this provides we can see a quite a heavily stiffened structure right at the top of the I mean at one end of the entire hull structure.

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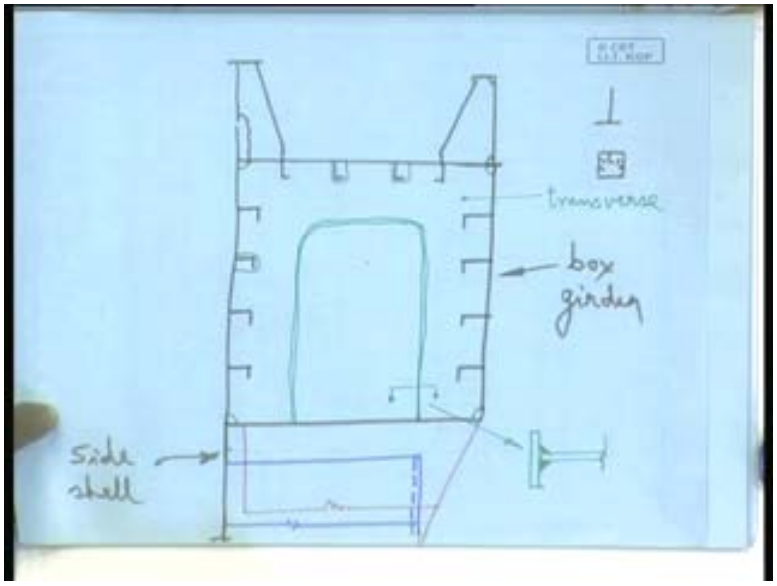

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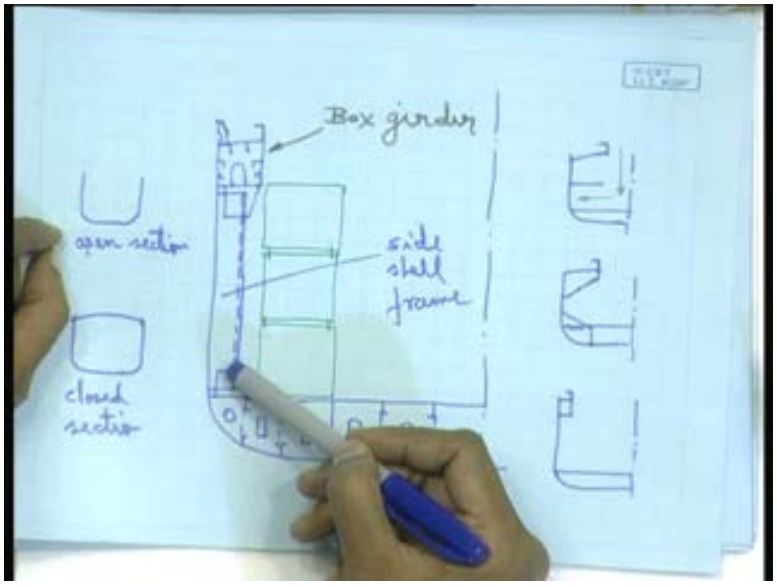

So, this provides you a sufficient strength towards torsion as well as longitudinal; obviously, as well as longitudinal, but this alone is a I mean much less stiffening would have been required if we would have calculated only on the basis of longitudinal bending; bending longitudinal strength, but this is provided to provide called additional torsional strength as well as your side shell stiffening.

So, we can see the side shell here again is transversely stiffened. You have heavy transverse framing on the side shell.

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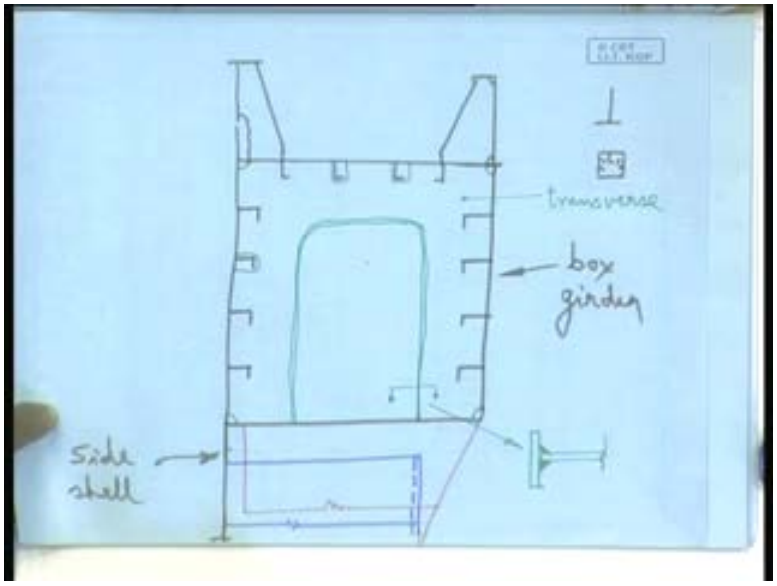

So, that it is may be this is side shell going and this is a part of the transverse frame which is now which will be suitably bracketed; that red line is the part of the bracket is being shown, the blue line part of the side shell frame is being shown as you can see here.

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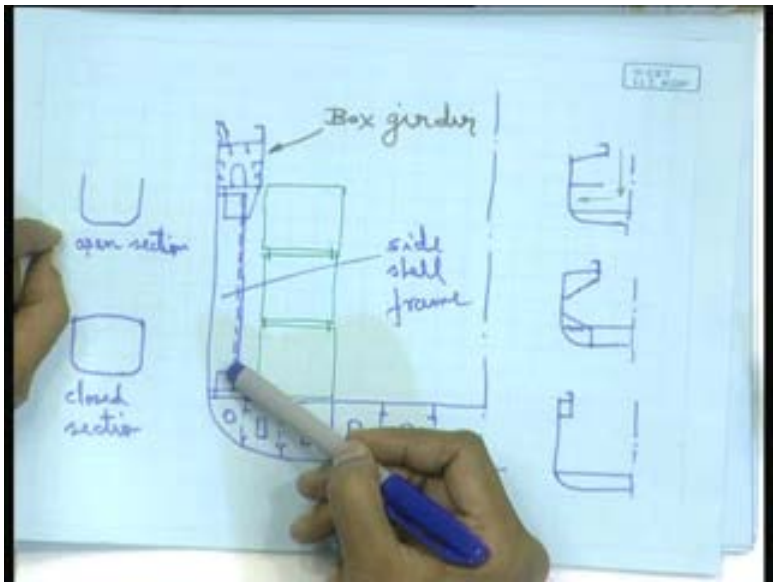

(( )) Yes bottom side we have not provided because you see the construction. In the bottom side at every frame space this frames are coming and they are bracketed to the bottom plate. So, bottom plate is stiffened by these brackets.

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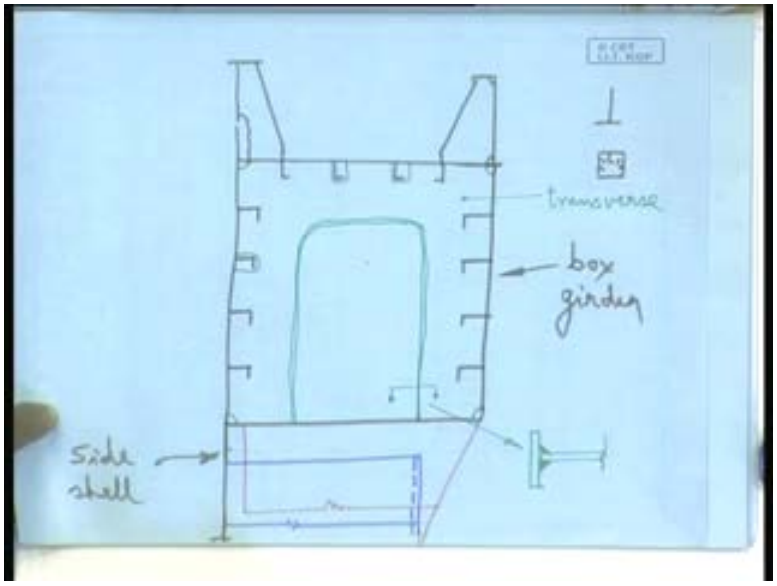

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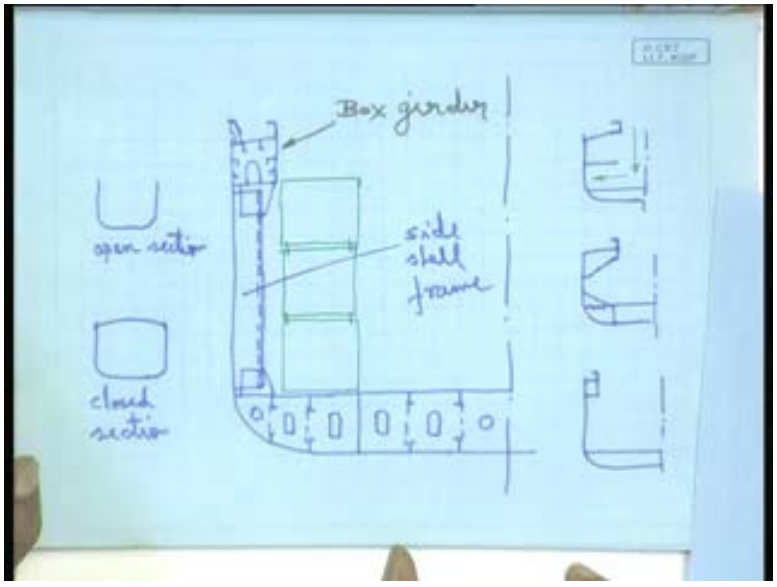

Rightly pointed out that this side plate or the deck plate as well as this side shell plate are stiffened by stiffeners; longitudinal stiffeners longitudinals whereas this bottom plate is not stiffened as such, I mean we are not seeing any stiffener here. What is happening; this is getting stiffened from below by this bracket because a huge bracket is being welded at every frame position.

So, this bottom plate is stiffened by this bracket itself. Like these plates are stiffened by this longitudinals, here these are stiffened by these brackets. Because this side shell

frame; this is a side shell frame; this side shell frame will be there at every frame position. This is a side shell frame. So, what you see that the side shell is transversely stiffened.

So, transverse stiffening or transverse framing arrangement is taken in the side shell. Why? Had it been longitudinal framing system then again the case of those two big transverses would have had come. Some it could have at enclosed in the cargo space, boxes would have I have to shift more, some space more space would have got wasted. Not only that, in addition to that for torsional strength requirement for transverse strength requirement this transverse framing is weighted because here I need because to provide for torsional strength I need transverse strength also.

Because torsional strength is it gets twisted. Transverse strength if you do not have it gets deflected in the transverse plane. So, if I provide for transverse strength, it automatically provides for torsional strength.

So, side shell is transversely stiffened and double bottom you can see, same as in any other vessel. It will be same as in any other vessel. Only thing here what has to be see is the frame spacing etcetera should be taken in such a fashion that this continuous this seat truly on some longitudinal; like in this it is not very carefully drawn, as you can see this corner of I mean this edge of the stack of containers it is not sitting on a longitudinal.

This is not correct. So, depending on the box size and box sizes are fixed 8 feet by 8 feet. So, their spacing of the I mean they have self-locking arrangement when you put one box over the other box one container other container they set properly.

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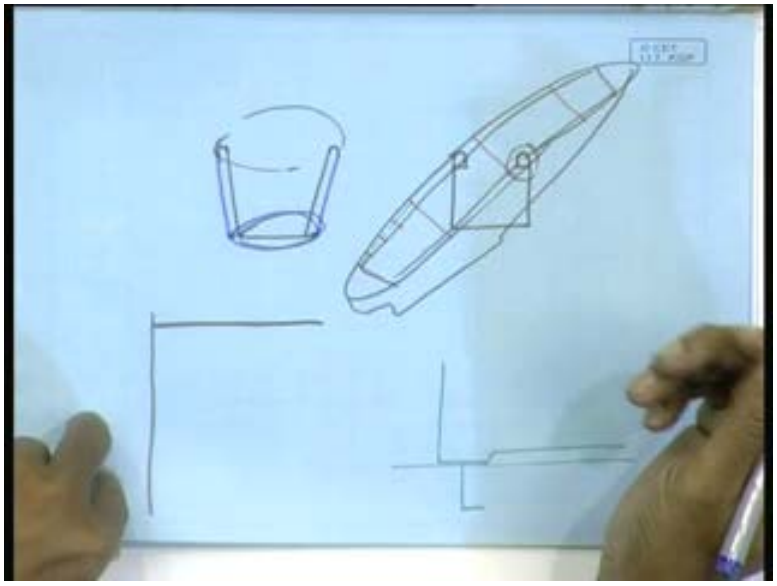

That means, the container edges there is a small actually the container edge is something like this. So, it should sit suppose on the deck and there should be a stiffener there.

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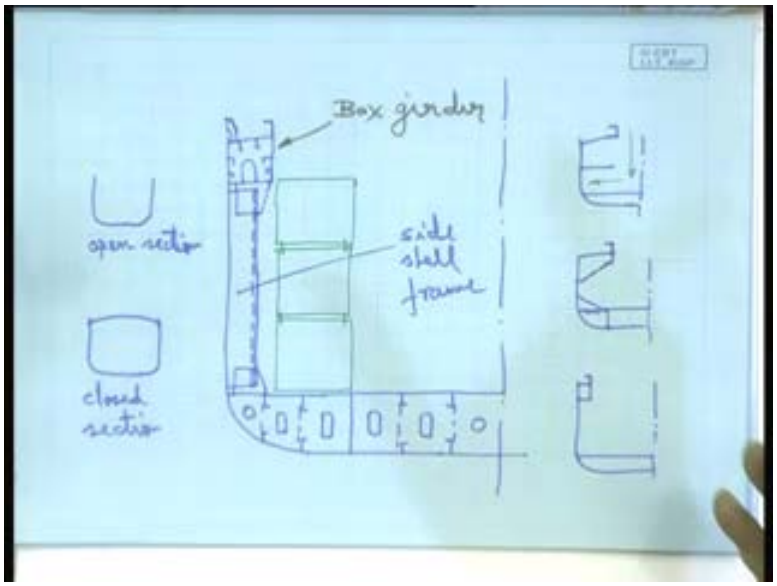

So, the arrangement should be done in keeping that in mind that it should the load path should be there proper load path; that means, it should sit on some stiffener below.

Anyway. So, here we can see that because of this, you have the because of the loading I mean the functional requirement, you need a big opening. For big opening, there is a

problem of torsional strength that is solved by this providing a heavy box girder arrangement at the top deck level.

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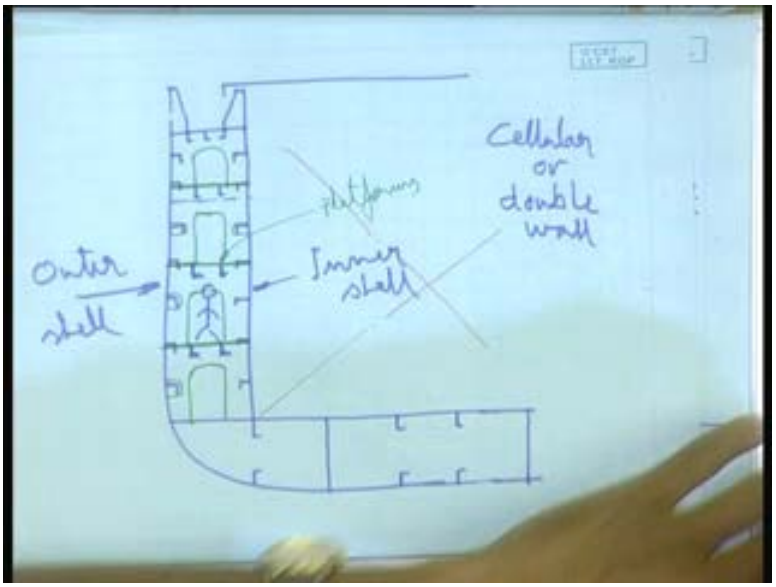

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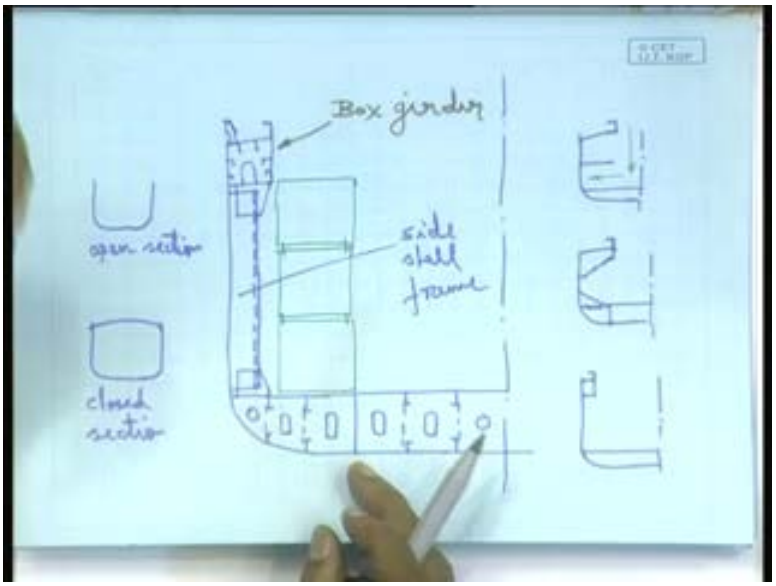

Side shell is transversely stiffened with heavy bracketing at both the ends and bottom part well a double bottom like in any other vessel. So, with this one can go up to a certain size. Then it was found that when we are talking about 9000 T E U, 10000 T E U bigger and still bigger vessels, then it was suggested to go in for a construction which will provide you the required torsional strength.

That means, this kind of box girder arrangement was becoming inadequate because here your heavy construction is there only at the top. At the middle part or just below that you have well transverses are there, but still it was becoming inadequate.

So, the idea became that instead of keeping the box only sort of located at the top that is it continued till the bottom, let it be continued to the bottom, then automatically your strength becomes much more or in other words, you come for a condition which can be referred to as cellular construction or a double wall construction means, double wall.

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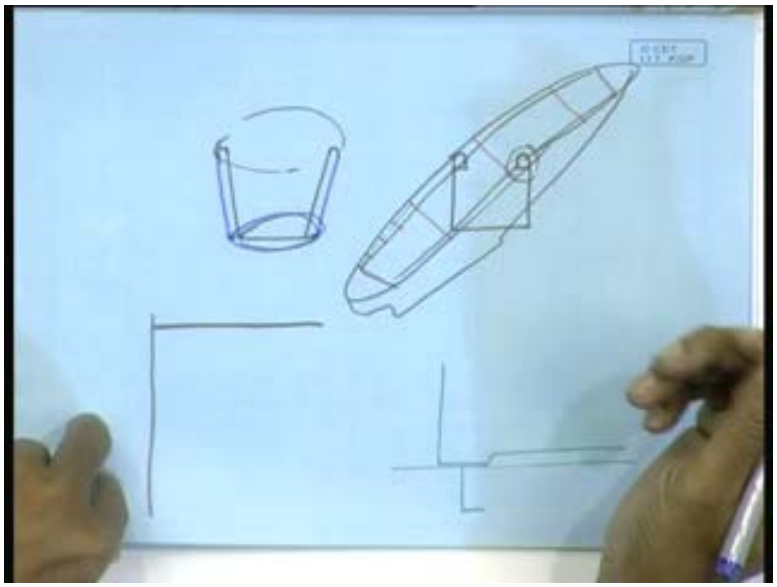

This is referred to as cellular construction or double wall construction, not double hull, double wall. So, this is my inner shell, this is my outer shell obviously, then it becomes much stronger because now what is happening? If we go back to that bucket example, instead of this I made the whole thing double if this way I could have made the bucket wall then it will become well rigid. Same thing is happening here. The box girder is not there as if the box girder that box thing was only this much, as if it has extended till double bottom the full thing I have extended. So, in the process what I have come for we have come for a cellular construction, a concept of cellular construction or a double wall construction; that means, instead of one side shell I have two side shells. This will not only increase weight, it will increase cost everything it will increase, but it is needed to provide further required strength.

Because I have to see I have to provide for the… when you are designing a vessel the purpose is that it should deliver the requirement of the owner. What is the owner's requirement? To transfer cargo from one point to another point that is all safely. That is important I am transporting half way gets lost or half the time it gets lose you cannot do that. You will have to ensure that that it will be safely in a safe and sound manner it will be transported then only people will come and load his cargo in your ship.

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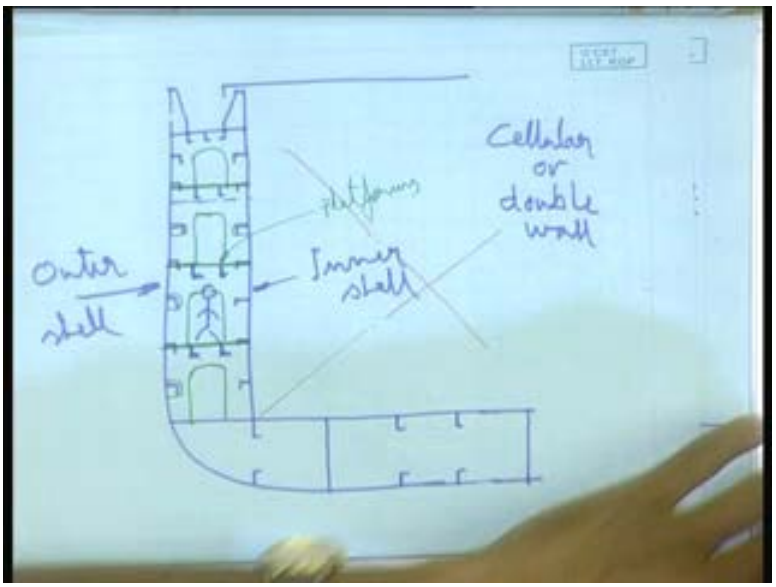

So, that is what. So, that calls for as I mean double wall construction obviously, as you are saying that well it is not only will act to the weight it will act to cost.

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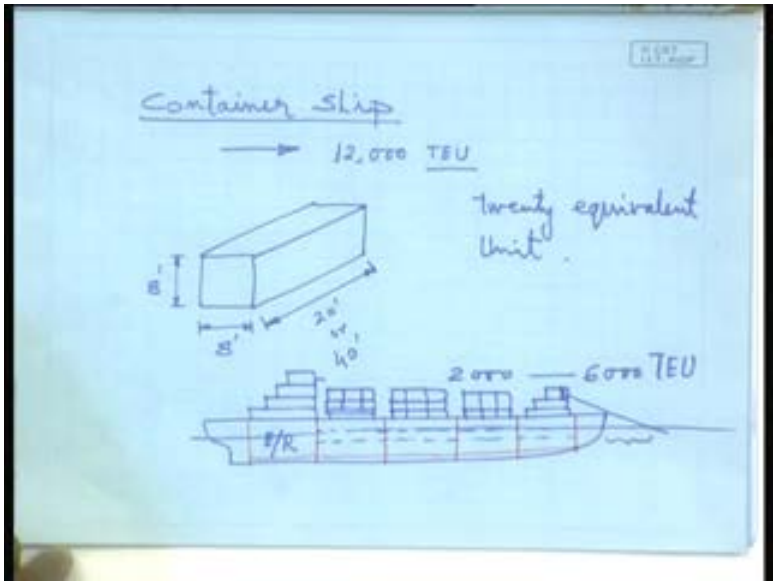

You say additional work, additional material; you will have to cost, but this is become necessity as we are growing in size. Probably if you design a 6000 T E U container ship, it do not go for double wall it will not be a wise decision.

Its that way, but your building a vessel of 11000 T E U, probably you will have no other option other than to go for a double wall.

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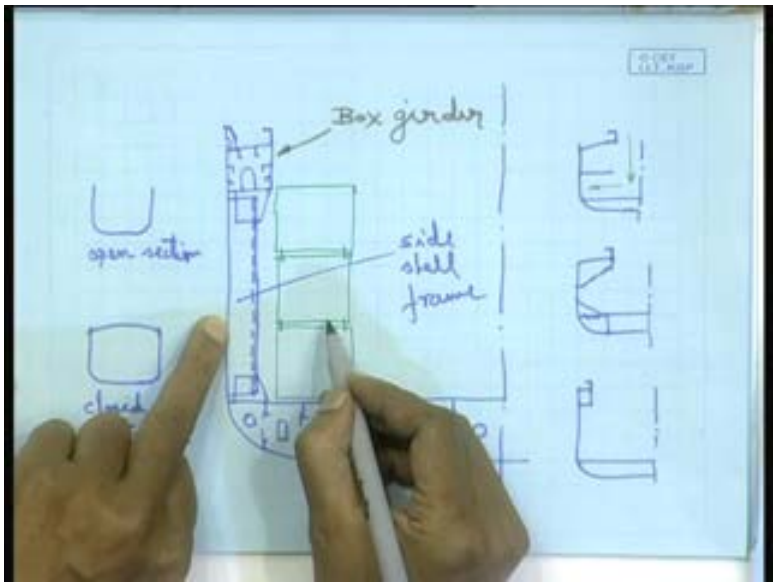

One can try through this box and all that, but probably we will find that if I have to do in this, the sizes of the side transverses may become so big.

Eventually the weight of this and cost of this will become more than if it have gone for a double bottom.

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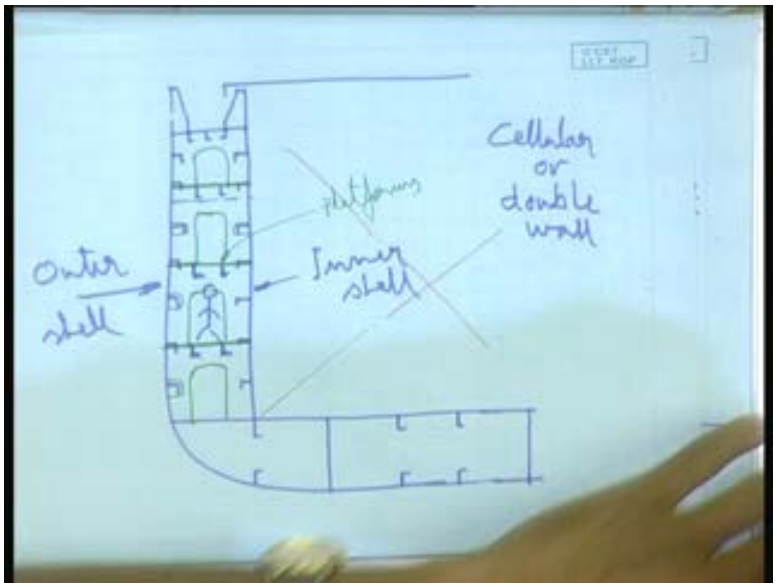

So, these are the aspects one we will have to see. In any guess in double wall what is happening? The moment I go for double wall construction obviously, it is entirely the longitudinally stiffened.

Because then that problem of your firstly interfering with the cargo space or interfering with I mean cargo any other functional interference is not there. The moment there is no functional interference, obviously, I would go for a longitudinal framing system because that is most effective.

So, the entire both the both the shells the inner shell and the outer shell or both the walls or longitudinally stiffened as well as obviously, the deck is also longitudinally stiffened. The whole thing is longitudinally stiffened.

And then, as in this case, you had the transverses. You need transverses here also for the same reason because otherwise again the same logic the longitudinals will have very big span. Now what is done here is instead of putting all longitudinals all around, I am cutting of some layers of longitudinals by these green lines. Well let us take this. So, this horizontal green lines what I have drawn are nothing but platforms. Instead of a longitudinal, I extend the full deck as if one can even imagine as if these are my lower

decks in the form of deck, but I am not calling them deck because it may give you a concept of deck means well usable space. It is not a usable space, this space will not be use for anything it will remain empty. So, this better I call them platforms.

But they are also this platforms are also strengthening member, like the deck is a member which contributes towards longitudinal strength because deck the deck plating is continues all along the length. Similarly these platforms are also continuous.

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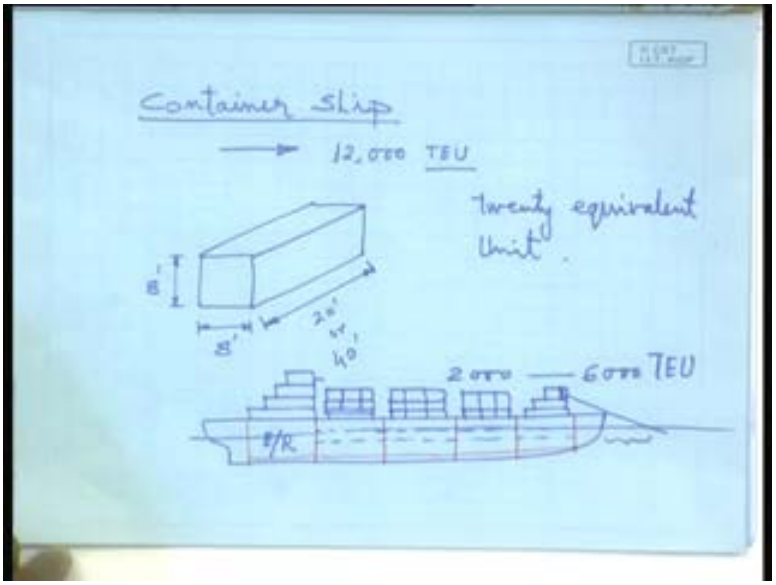

But in the engine room, the entire hall region from the entire length wherever it is there it is there suppose; that means, say this is a double walled vessel, then this platforms will continue like this. And in between, you have the longitudinals; this is my engine room. So, they are also strength providing members.

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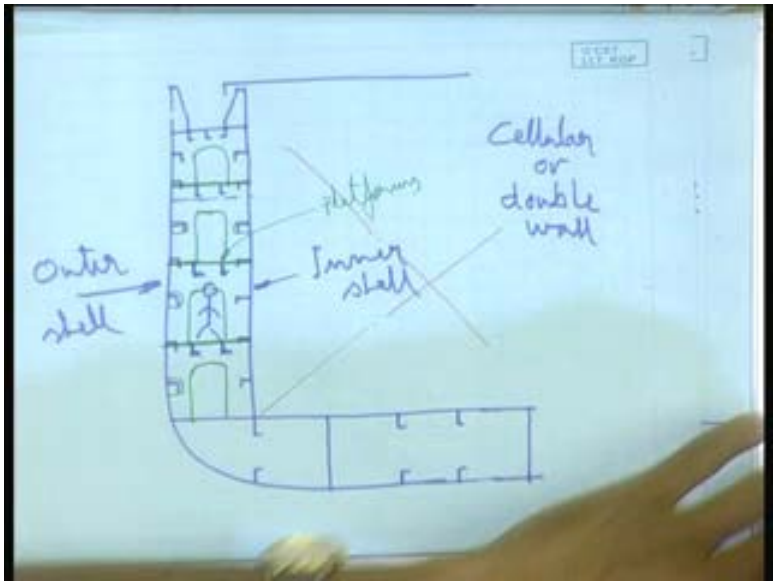

These horizontal platforms also will provide for longitudinal strength and if they are going to provide me for longitudinal strength means, they will take part in longitudinal bending. So, they are themselves having to be stiffened by stiffeners. So, they are equivalent to that of lower decks nothing else, but lower decks right .What is the purpose of giving this? This I could have as well avoided and provided this oil for maintenance, it is simply for maintenance nothing else because if this is provided, then a person can walk through all along and do the inspection maintenance of this because probably it would be something like this. The spacing between these platforms would be such that a person can a average height person can comfortably walk through.

If we can do that, then you can do the other jobs also. Otherwise imagine how you are going to do the maintenance. For that reason, these things are provided. So that means, it is a design when you are doing not only you are taking care of your torsional strength, transverse strength etcetera, but also taking care of future maintenance work. So, this is what a double wall construction is. Now we see that it is perfectly done as far as longitudinal strength is concerned and to provide for necessary required transverse strength and also provide for providing for supports to the longitudinals you have now similar type of transverses. I can have transverse members like this.

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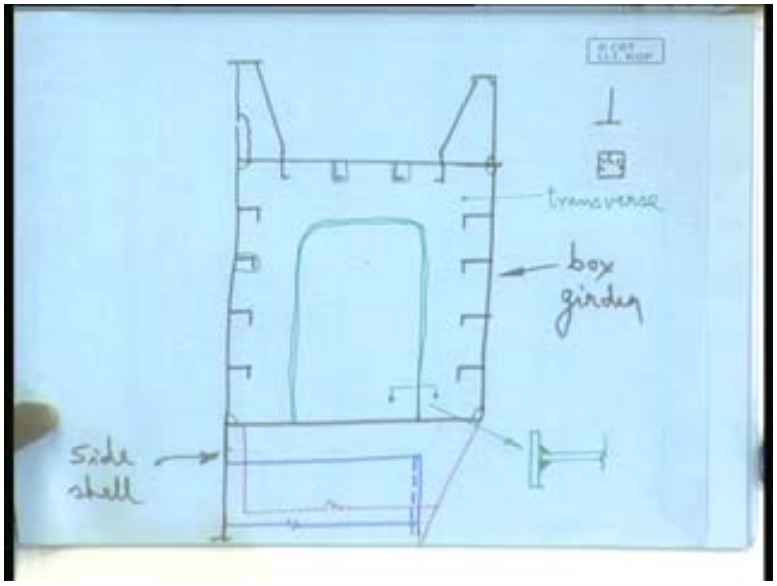

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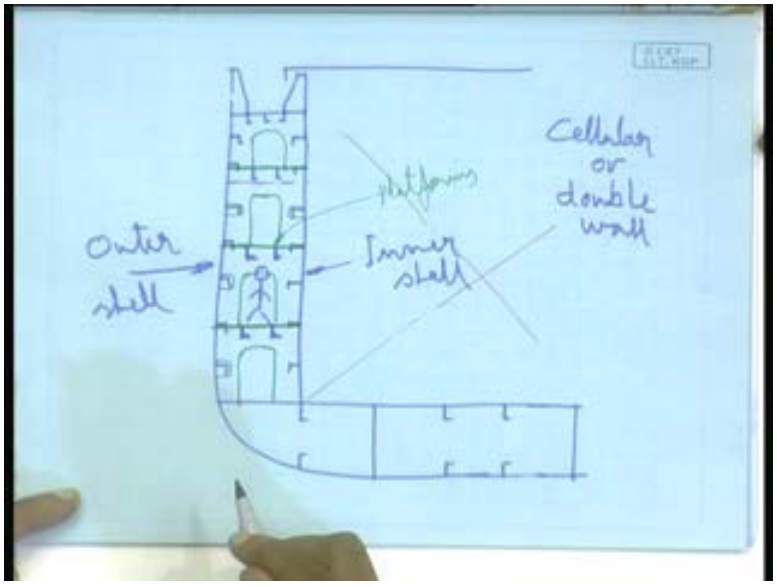

Like the one here. It is as if that this plating was there. So, a number of boxes I have added, this double wall you can see the way I have drawn it as I said that boxing I have extended. So, I can do it in this fashion. So, it is not necessarily that this the only way of designing it, but very concept I mean the idea is that you design, you do the structure layout, there can be different solutions different way of doing it.

But you will have to keep in mind well the strength part of it, fabrication part of it, maintenance part of it. So, that the arrangement it is friendly from the production point of

view. Arrangement it gives you the requisite strength, arrangement gives you, it becomes maintenance friendly also. This is one of the very simple ways of doing it and so it provides for all necessary I mean this satisfies all those necessary conditions of strength, production friendliness, maintenance friendliness. So, this is what is the double wall construction and now below this, again same thing means the double bottom there is no difference in the double bottom.

Well only thing could be that one can decide upon a center girder or one can decide upon a duct keel. That is up to the I mean both are same, but well you have some functional advantage in a duct keel. So, you can have a duct keel arrangement or a center girder arrangement; that depends on the designer.

So, this is what is a cellular or double wall construction which provides for necessary required torsional strength and here another advantage you can see, you have the cargo space, the so called the container loading space is absolutely clear of any obstruction. You have a horizontal flat clean bottom you have a vertical flat clean wall

So, there is absolutely perfect rectangular space or cubic spaces available where in you I can mean these containers can be properly loaded. So, that is what is what is called container ship and well. So, the mid ship section for a double wall will look like this and well this is your hatch covers. So, on the hatch coming you have the hatch covers and over.

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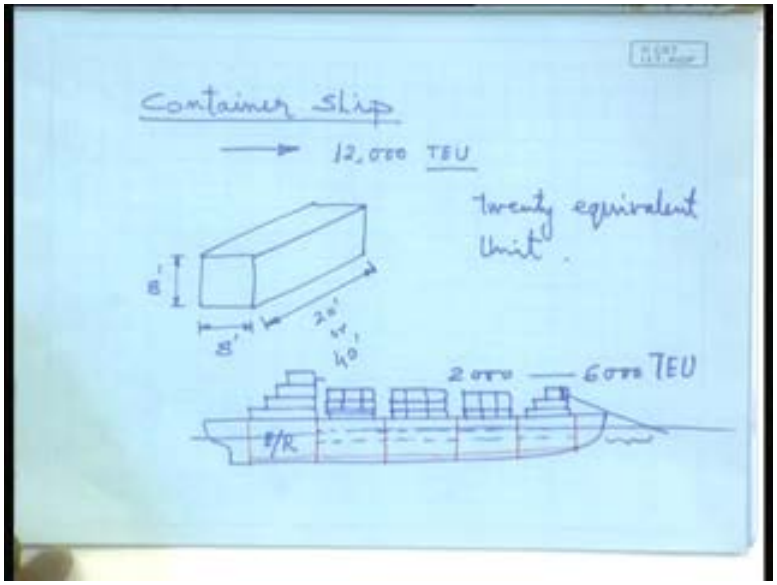

What is done is, you have those big hatch covers. So, over the hatch cover also containers are stacked.

So, in this process what happens that a very typical feature of container ship is that you may have an additional super structure in the forward. These are my containers stacked on the hatch covers outside the hold. You have required number in the hold and you have provision for keeping as I have drawn three more types of containers above the hatch cover. Accordingly the hatch cover has to be designed obviously; that means, this should be able to take that load.

Well and generally you have your so called super structure of the deck house just above the engine room. Why it is located above engine room? What could be the reason? Simple. Access to the engine room because in that deck house of super structure, who will stay. It is basically the engineers and the deck people, deck officers.

Well deck officers may not have any business in the engine room. So, they could have been elsewhere also. But you generally in a ship you have only one super structure, one deck house where engineers and officers all are housed.

Primarily it is built there. Why because from there right directly you have access to the engine room instead of coming out you just straight way go down. So, that is good. Now in case of container ships generally you have two sets of super structures like I have drawn that one in the ford, one in the aft.

Can you tell me why I mean just from common sense generally you will find two sets of super structure. Because you have here this container stacked. So, what happens yes no problem in that thing is from the (( )) house deck, your line of sight; your visibility should be there perfect. So, here that gets affected.

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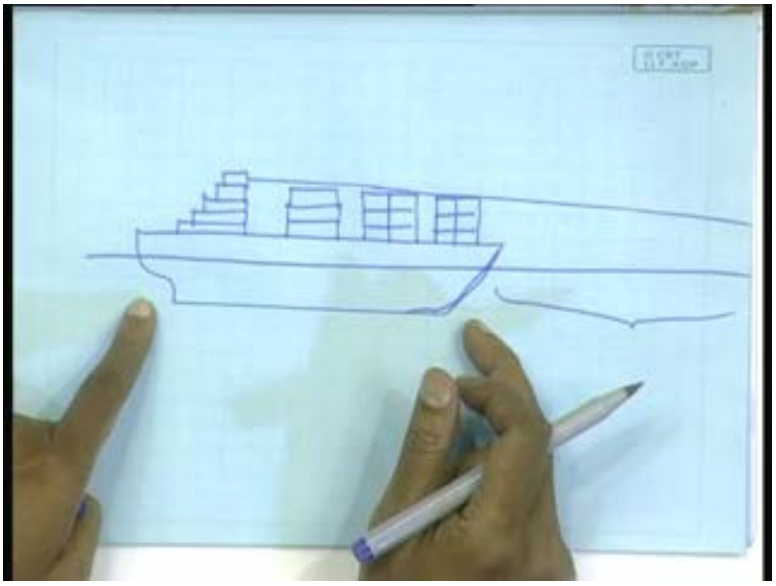

If there are containers like any way let us draw a small one, suppose say for example, this is my (( )) house and you have containers stacked like this. So, then what is happening, your visibility; your line of sight is becoming like this. Your water level is somewhere here. So, you can see it is going much beyond.

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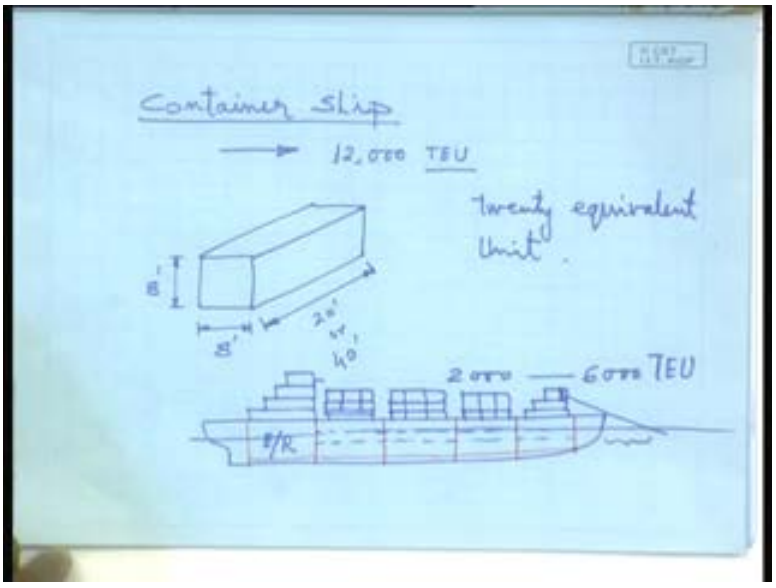

So, this place is becoming the blind zone. There is a rule that blind zone cannot be more than some length of the ship. I think one and half length of the ship or some such rule is there. It cannot be more. In such an arrangement, your blind zone will become several

times the length of the ship. So, anything coming in front of a ship you do not see that zone becomes too long. So, that is solved by providing a forward super structure. So, that you have a very easy I mean very small so called blind zone only this much.

And well very nicely you can house all the deck officers in the ford super structure and the engineers in the aft super structures. So no problem. So, that is a typical feature of a container ship. It may have two deck houses for this reason. Otherwise this particular deck house will have to be made several tires higher and too high which is not very feasible.

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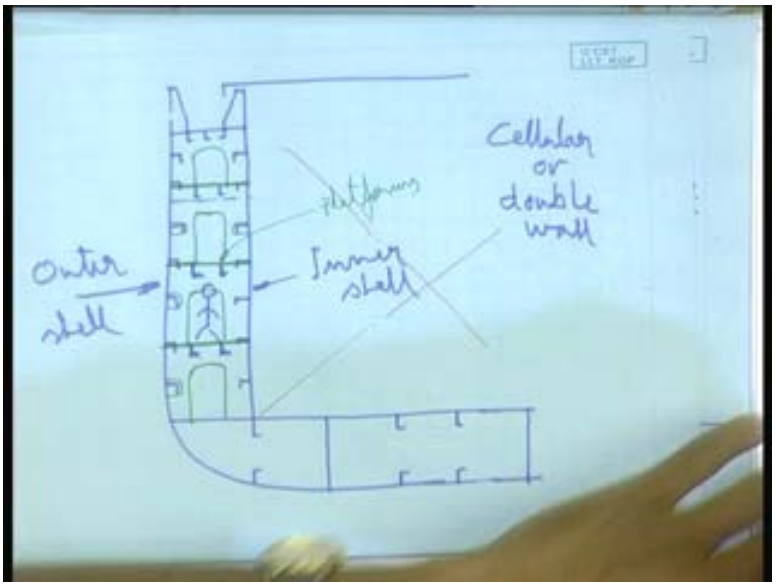

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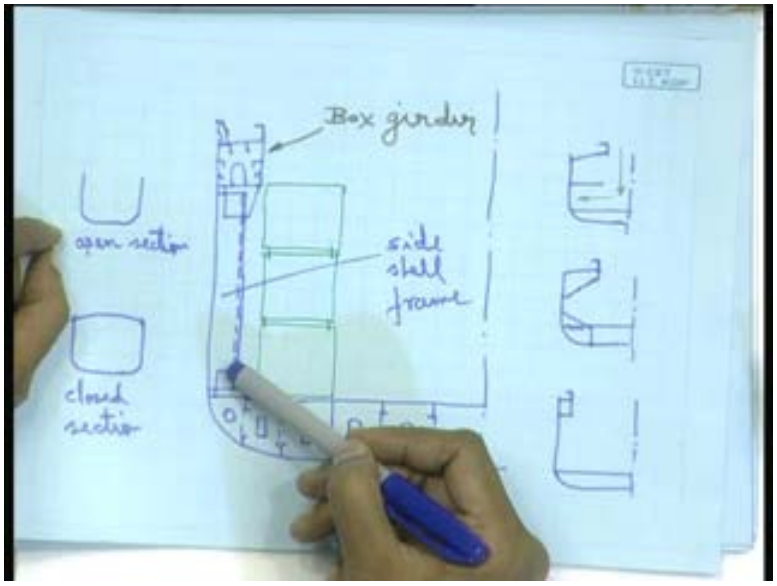

Well. So, that is what is about the container ship. So, we can see that here if it is a box girder kind of arrangement, then we take a combination of longitudinal framing system and transverse framing system. If it is a double wall construction, then all along longitudinal framing system. There is no transverse framing system taken. So, we stop here today.