Marine Construction & Welding

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Module No. # 01

Lecture No. # 08

Structural Assemblies Double Bottom Construction

We will start with the double bottom construction, with the structural assemblies. If we look back, what we started with the plates and profiles, then we had the sub-assemblies units. So, decks, side shells, bottom shells, they were under the so called assemblies. Gradually the things are growing, from the plates we had small subassemblies, the brackets, floors and then we came to decks, bottom shells, bilge plate.

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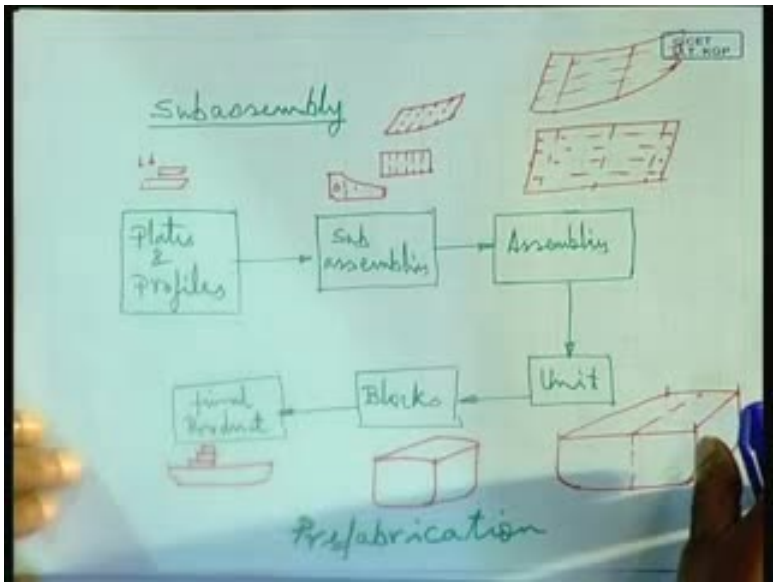

Putting these together, we are getting the units, so another unit will talk about the double bottom construction, wing tanks and these items.

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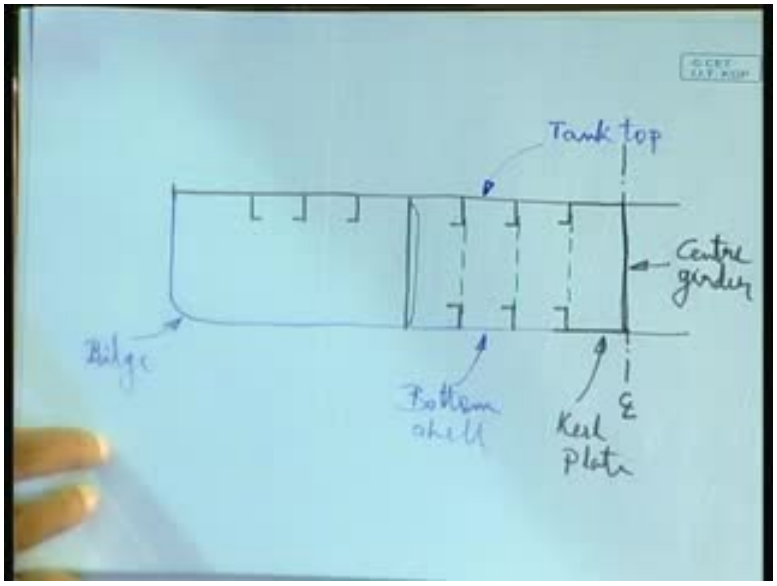

As per as double bottom construction is concerned, as you can see that it comprises of the inner bottom plating, also referred to as tank top. We have already talked about it, but just taking relook; this part is the bilge plate, obviously this is bottom shell. Here, this is the entire double bottom; we have drawn only one half of it. This is my ship centerline, so here, part of the plating of the bottom shell that is referred to as keel plate of the total bottom shell. The plate at the centerline is referred to as keel plate, why different name? Because, it has some additional function, the strength of the thickness of this plate is generally more than the adjacent bottom shell plating.

One can say, as if its forming so called backbone of the entire ship, the keel plate will be extended like this, as well as the tank top plating is also extended. So, along with this vertical member here, which is refer to as center girder or also termed as center keel (( )).

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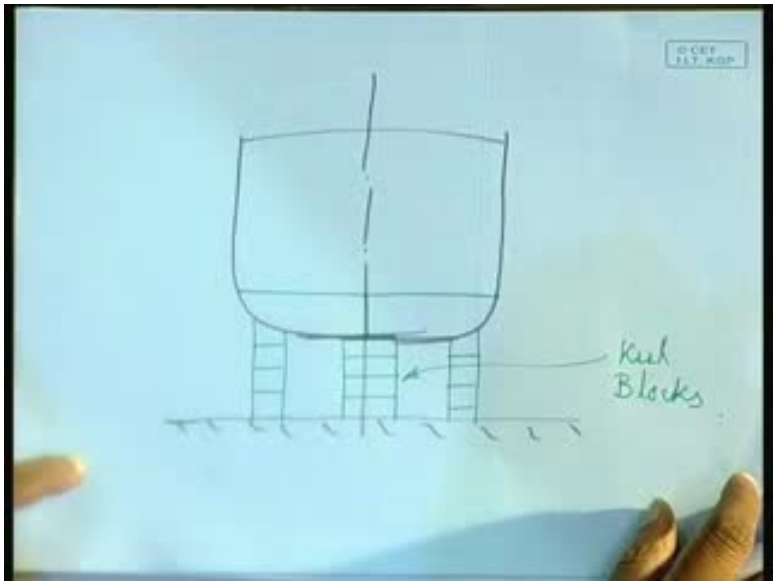

When a ship actually is put on what you call on the keel blocks, when the ship is under construction. You cannot really put it on the floor, is not it. Then, it will be difficult to work. So, it should have a proper base over which it can be put. So, if this is my floor line that means the ground line, the ship sits on such blocks. These are blocks, generally you have three rows of blocks to support, over it sits and they are referred to as keel blocks.

Here, you can see the keel plate rests over the keel block, so thereby here you have the double bottom, you have the center girder, so there by the weight is supported. Because, when the ship floats, then situation is different, the entire hall is supported by a distributed force. Here, it is supported at certain concentrated locations, because keel blocks are not everywhere, at certain spacing it is there. So that needs the bottom most plating of the double bottom unit, is referred to as keel block.

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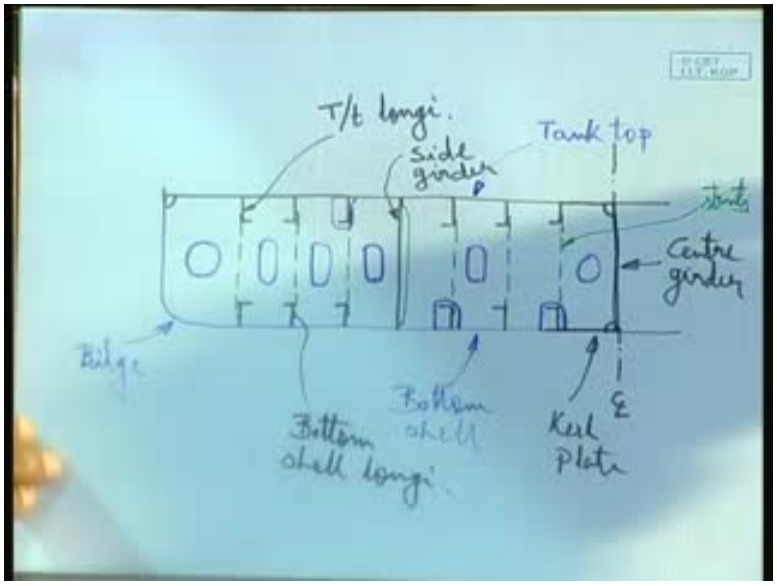

Then, you have the bottom shell bilge plating and so on. The construction inside the double bottom unit is it looks something like this. As we are drawing it, these are the bottom longitudinals, we are putting it. These are my bottom longitudinals, these are inner bottom longitudinals or tank top longitudinal, these are bottom shell longitudinal or bottom longitudinal. What tank top inner bottom plating or tank top plating- I am writing tank top, well that is shorter than that word inner bottom any way.

Then, you see these green lines, what are these? Struts - they are referred to as struts. What is the function of these? They are essentially stiffening the floor plate that is a floor plate here. The plate is in this plane, in the plane of the paper. In the floor plate, what happens? You have such openings, only some of the openings I am drawing, not all of them. But, in all the longitudinal, you will have such openings, through which the longitudinal pass. Also, the floor plating has so called lightening holes, right. In between the struts, you have these openings cut, we have talked about it.

Why these openings it looks like this? Then, what about the member here - in between this black line? This is center girder, by this one continuous line it refers; that means, there is some vertical member continuously going, so this is referred to as side girder. This is in the centerline; this is on the side, so you have a side girder. This is a port side girder; on the other end, there will be starboard side girder. There can be more than one side girders, here we have shown one side girder that does not mean that there is only

one. Depending on the breadth of the vessel, the number of side girders will depend. If the breadth is more, you will have more than one side girder. More than one side girder means, more than one side girder in each side. Port side one means, automatically starboard side one, so there are two side girders. We are saying - that means, total side girders could be 2 or 4 or 6 whatever.

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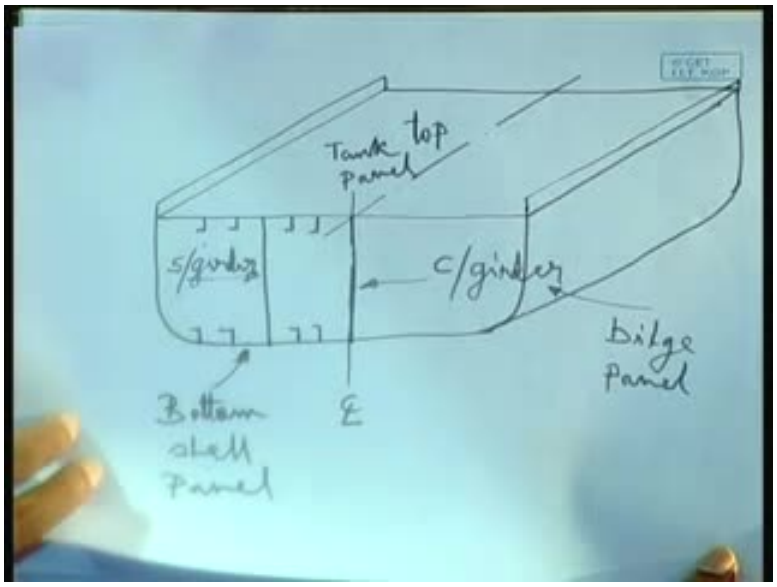

These are the side girders; obviously, you will have in the floor such cuts, which are referred to as what you call the scallops, so this whole thing would look something like this, a double bottom unit. So, this double bottom unit is manufactured from or fabricated from this plating, this stiffened panel. The stiffened panel is the tank top panel, then you have the bottom shell panel, this is my - we have talked about - even you can have the bilge panel.

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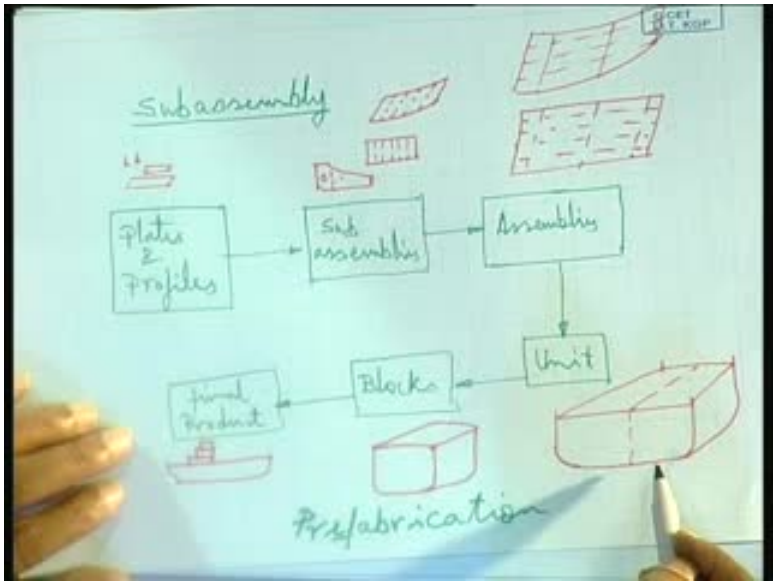

Then, you have the separate side girders and the center girders. This is the center girder, this is the side girder. So what we mean to say is, first that means, as we are moving from subassemblies - assemblies, then to units, once this assemblies means, the tank top panel, the bilge panel, like that they are separately fabricated. That is what is referred to as prefabrication; they are prefabricated, then they are put in place.

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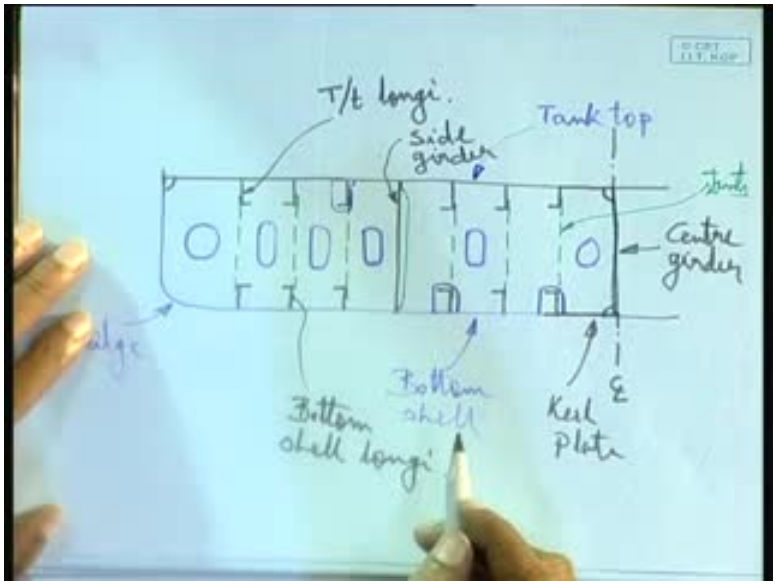

The bottom shell is put in the place, place means where that is what is called skid. Skid means, because here, what we are doing is, drawing or showing you is, the bottom shell is absolutely flat; not necessarily it will be always flat, isn't it.

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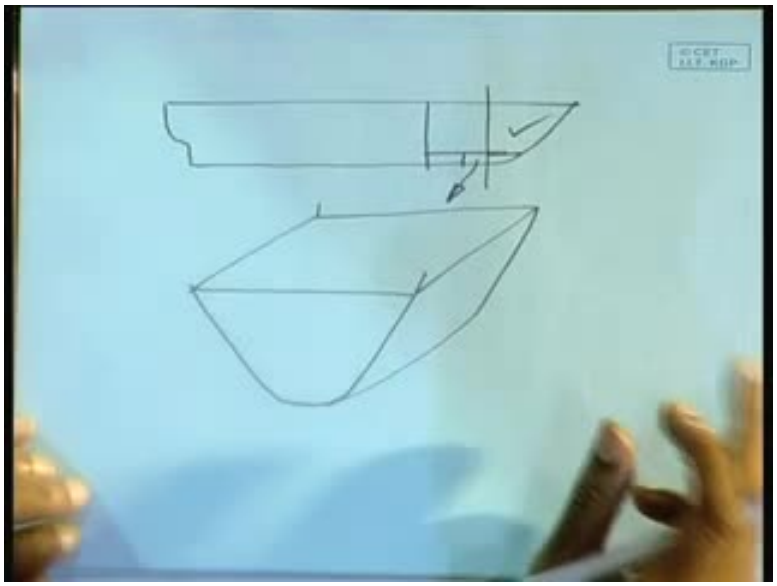

If we look in to the entire ship, say the ship structure, suppose you are fabricating this part, let us assume you also a have a small bottom - double bottom unit here. So, in this section, the double bottom unit may look like this.

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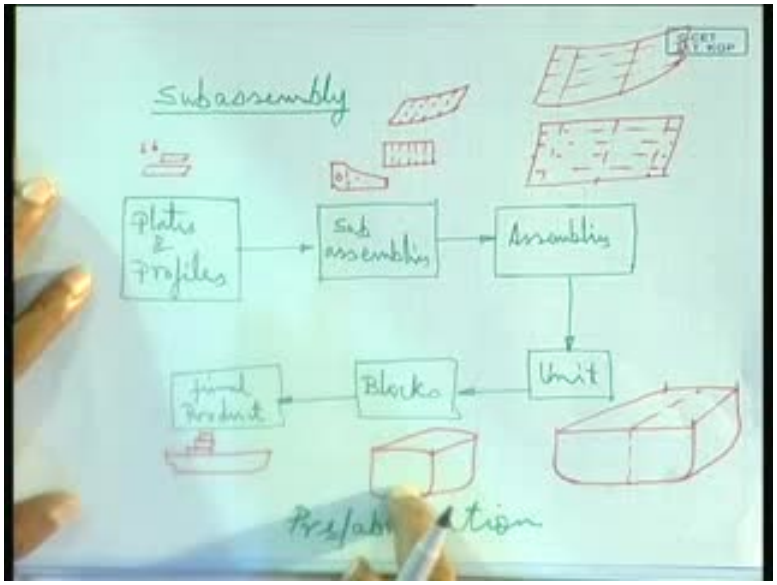

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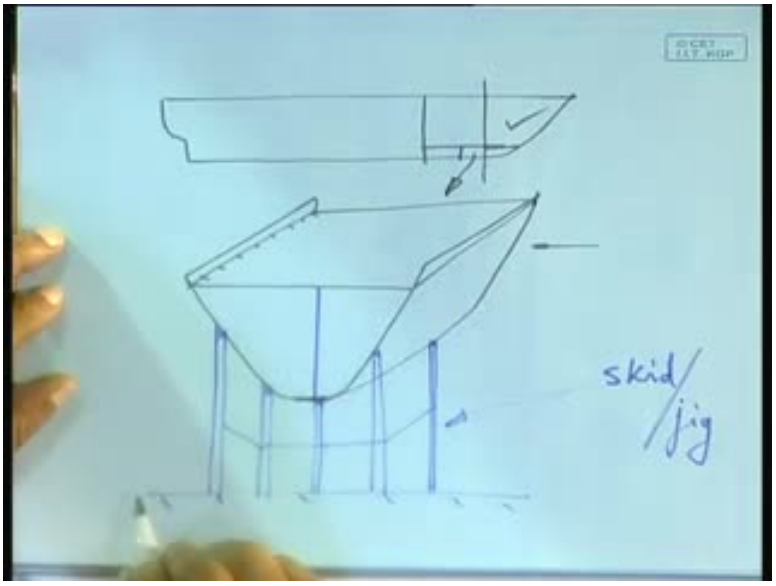

Here, you have your - some part of the double bottom unit can be this way. The part of the double bottom here would look like this. So, what happens is, as I said there, we talked about keel blocks, the ship wind the blocks, are erected that means once this blocks are erected, these blocks are transferred over the keel blocks and align individual block, put them together. You have the whole ship, but when these units are fabricated, those units are put over some - one can say the working bench here.

Working bench should be - this is your say the ground level, so working bench should be something like this. That means, some supports over which this plate is - the structure is erected. So, these supports, they are properly connected with each other, so that they have the necessary strength. This is referred to as skid, also termed as jig, they not only serve the purpose of supporting the structure, but the top surface of this skid or the jig, if I Put a sort of joint lines and develop the surface over the skid, it will actually confirm to the ship surface.

How the fabrication process goes? Here, the this assemblies that means the curve panels -here you have the curve panels, the plates are bent in the plate bending machine, they are checked for the bend shape, whether they have been correctly bend. Then, you bring and put on the skid, it should match perfectly on the skid surface.

Then, it is a double check, not only it support seat on that but also you can see that well it is matching. That means, this skid pillars they are not arbitrarily erected, they are erected

at predetermine locations. That means, so that I have this coordinates, where ever it is touching the surface, this coordinates are known.

So, it is such that it will match perfectly not – so, it serves the purpose of supporting the structure, but also checks whether the surface is correctly done or not. The curve shells are put and then weld. The curve shells coming with the stiffeners, then your further erection of the central girder. If there the center girder is erected, welded then this inner bottom plating is put over it. Also, the necessary welding is done that means there is proper sequence is followed. So, these buildings - all the buildings at the end, you have to entire unit prefabricated.

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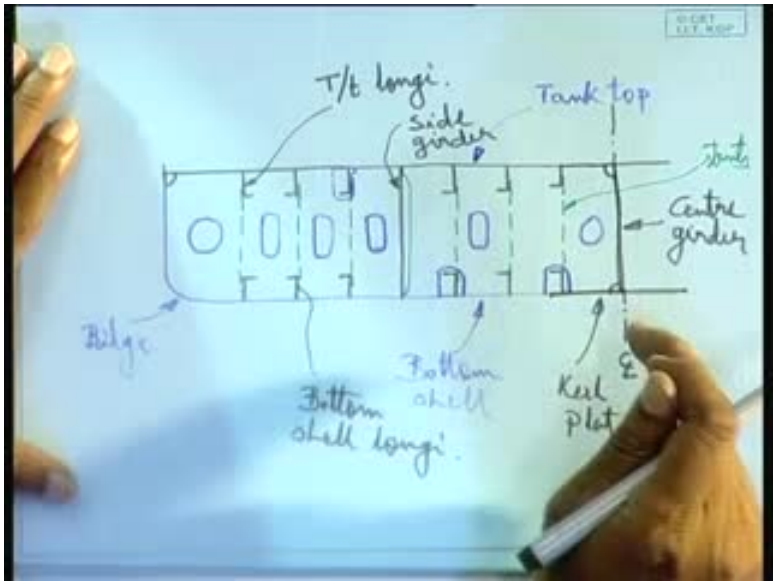

It is part of the bottom plating, can be the part of that keel, whether the keel is narrowing down even. Keel means, it is nothing but no other special thing, only this part of the plating at the center, is referred as keel plate. Generally, it is a little of higher thickness compared to the additional, compared to the adjacent plate. The reason of this been higher is there is a wire in; I mean it sits about the keel block. So that is why it is given little extra strength, because concentrated load will come on this that is how.

I mean, it is not a must that you will have to have a keel plate of higher thickness, not necessary. If you provide a higher thickness, well the separate name is given for this streak of the plate - keel plate.

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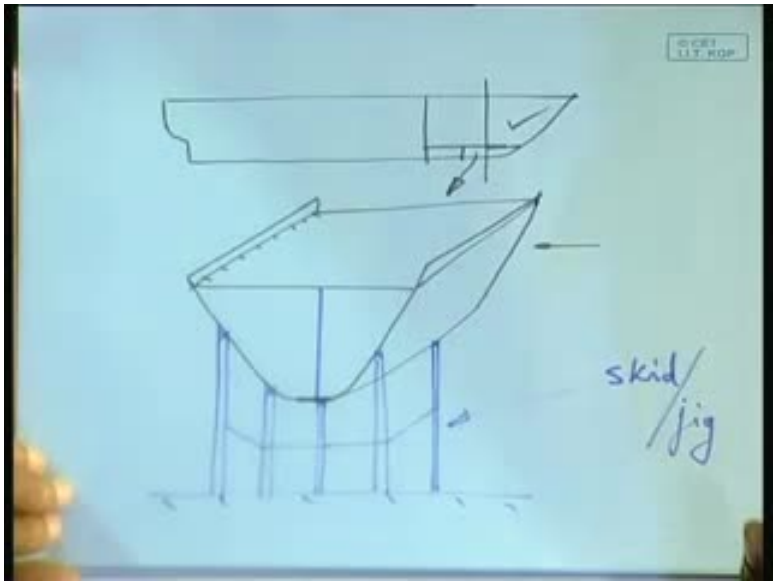

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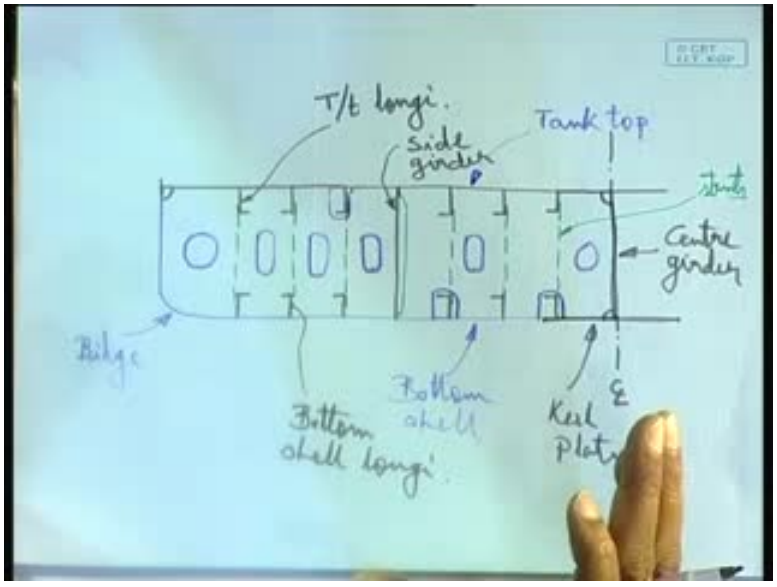

That is what your double bottom construction is. The double bottom construction thereby comprises of what? Essentially, the bottom shell - inner bottom shell and the relevant stiffening members, what are the relevant stiffening members? Stiffening members of the individual panels - inner bottom longitudinal and bottom longitudinal; this is a case in case of longitudinal framing system, we are not going to discuss the transfers framing system, because for all practical purpose, it is preferable to go for longitudinal framing system. Why because, in longitudinal framing system, we have better buckling strength, may be this; we can once again look back to that the framing systems, say a plate.

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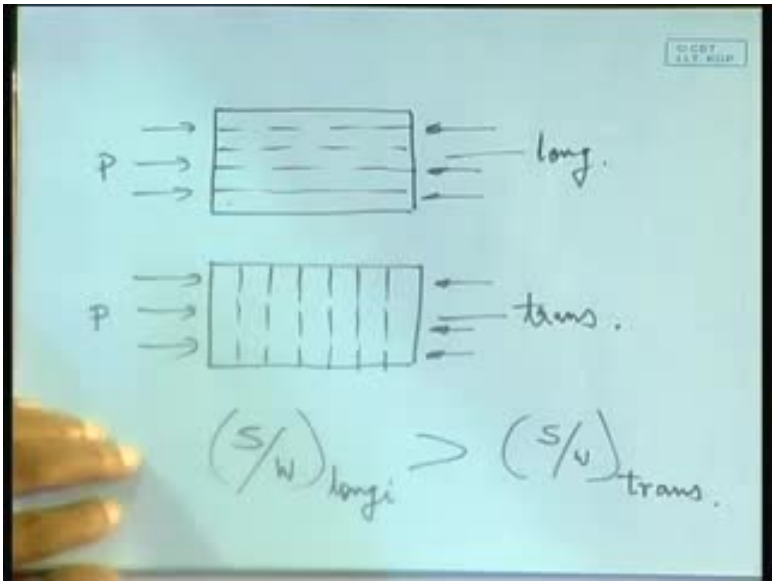

If it is stiffened in this direction, identical plate is stiffened in this direction, so that the top one longitudinally framed and bottom line is transversely framed, isn't it. This has been done by longitudinal framing system, as if this is transverse framing system, both of them are under compressive load in this direction.

Obviously, the one with longitudinal framing system will have a higher critical buckling stress, isn't it? For the every arrangement, this will have a higher critical bucking stress; that means, we will be able to sustain higher amount of load. In other words, for the same loading, this is P, this is also P for the same loading and I can have a structure in this case of lesser scantling.

That means, with longitudinal framing system, I will have strength to weight ratio in longitudinal framing system, will be higher compared to the weight ratio of the structures with transverse framing system, isn't it. For the same weight, strength will be greater; I will have a greater strength, so my structure will be more economical. So that is how we will have to see while arranging or making a structural arrangement, so that we can maximize the use of longitudinal framing system.

But, in some places, there can be cases, where for some other functional requirement we will have to deviate from longitudinal framing system and take the course to transverse framing system. Anyway, so that is what - so that is how the double bottom is, since double bottom space only usage is either it remains empty or you use it for carriage of

some liquid, not cargo, but say fresh water or fuel oil or lubricating oil or ballistic purpose. So, if I am carrying liquid, then whether it is longitudinal framing system or transverse framing system, it does not matter, isn't.

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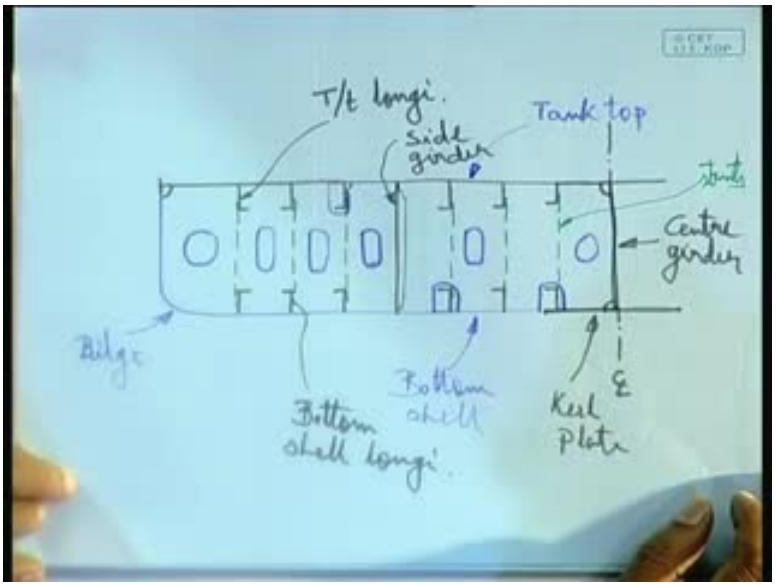

It only is said that - where longitudinal is difficult, where it becomes difficult? Where you have interference with the cargo, mainly which is the main cause of concern at times, when I have to shift from this to transverse framing system. Otherwise, all longitudinal - that is why in oil tanker, the entire framing arrangement is longitudinal framing arrangement. So, double bottom also is similarly will go for totally.

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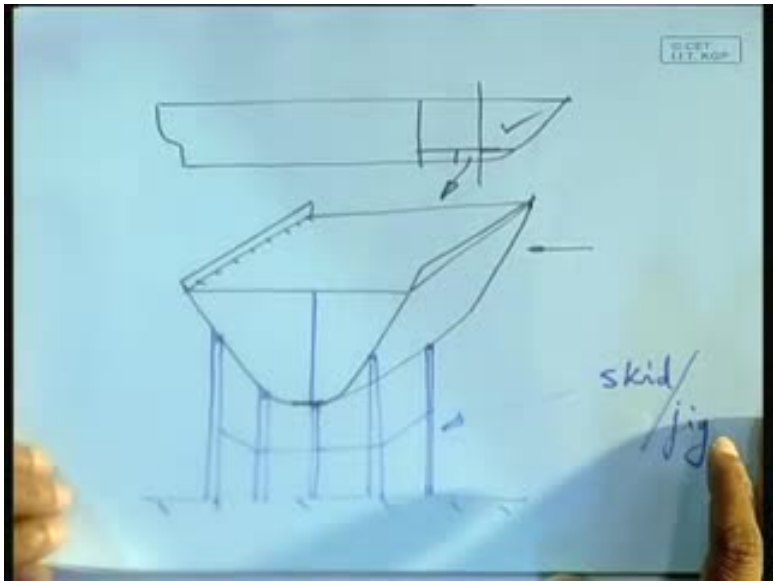

A framing system based on the longitudinal framing system; so that is what I mean - whole this so called concept of the double bottom construction, these are the 3 d units fabricated from the stiffened panels.

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Now, we have other 3 d units or wing tanks - the wing tanks, before you go to wing tanks, we can have a little look in the double bottom one aspect.

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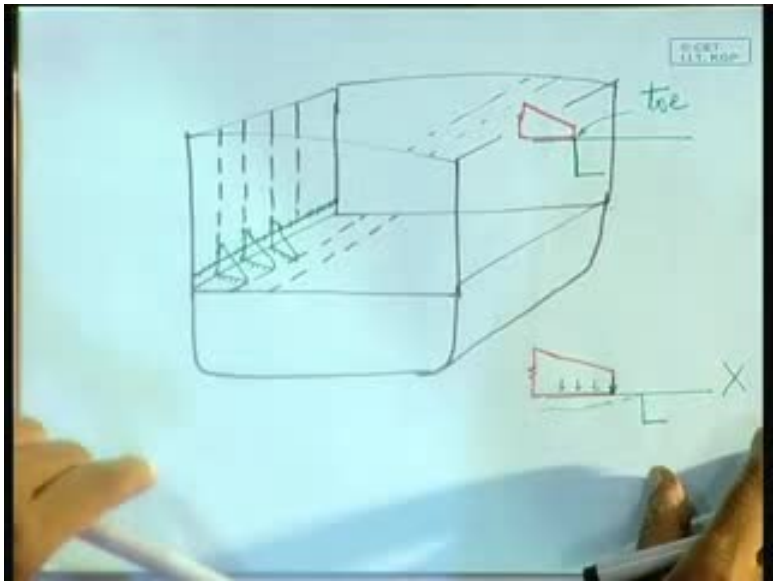

Just to show how the things that they take ship? Say, this double bottom has been fabricated and then what happens? The other stiffened panels or the side shell panels we have talked about - so side shell panels, once they are fabricated, they are erected here that means you have the double bottom.

So, the side shell panel is erected, side shell panel erected means what? Physically placed in that position; when you are placing it, well you will have to have all kinds of support to hold it there. This panel is either transversely framed or longitudinally framed; let us assume it is transversely framed. That means, you have transverse frames, side shell frames like this. The double bottom was longitudinally framed; that means, this is my tank top plating, this tank top plating has longitudinally stiffness below, so they can be shown by this dotted line - this dotted line indicates that they are the longitudinal running below this. So, once they are put, then you provide the so called it is connected with a bracket, brackets are coming like this; among this, this is welded.

As well as, because just the entire side shell panel, if you just weld along the line, it does not get enough strength. So, you provide those brackets, we have talked about brackets, they increase the load bearing area. They enable better load path, so you can see this brackets are welded over the tank top. These brackets are welded here, to the side shell and to the tank top. Where we are welding? See the drawing, where we are welding the bracket? Where you have those longitudinal? That means, it is taking the support of the

longitudinals from there, then it is going on the tank top. Where I am ending the bracket toe on the longitudinal, we are ending the bracket toe on the longitudinal. That means, you have this bottom shell plate - inner bottom plating. Let us assume this is my longitudinal below and I am providing the bracket, it is coming and it is terminating on the top, on the longitudinal; it is the part of the bracket, is showing.

This is called bracket toe, this is a vulnerable point, because imagine, this bracket toe terminating here. Means, suppose instead of that you have a connection like this, you have the bottom longitudinal here. Let us assume that I have the bracket coming and terminating like this, this is not a good design. Why because, this bracket was the function of the bracket, it is transmitting the load. So, all these forces are acting, here at this point, it is acting, so the load is not effectively transferred. This may lead to a sort of a deflection of the bottom plate like this.

Whereas, in this case, it is taken up by the bottom longitudinal that is much stronger load supporting member. So, always in construction, we have to keep in mind that whenever these connections are done, you will to have the proper support to the end points. So, the toe of bracket should land over some stiffener below.

That is how the side shell is erected; similarly, on the other side also the side shell will be erected. Then, you have the – then, bring the deck panel and erected over it. Deck also will have the necessaries in the same fashion of longitudinal stiffeners.

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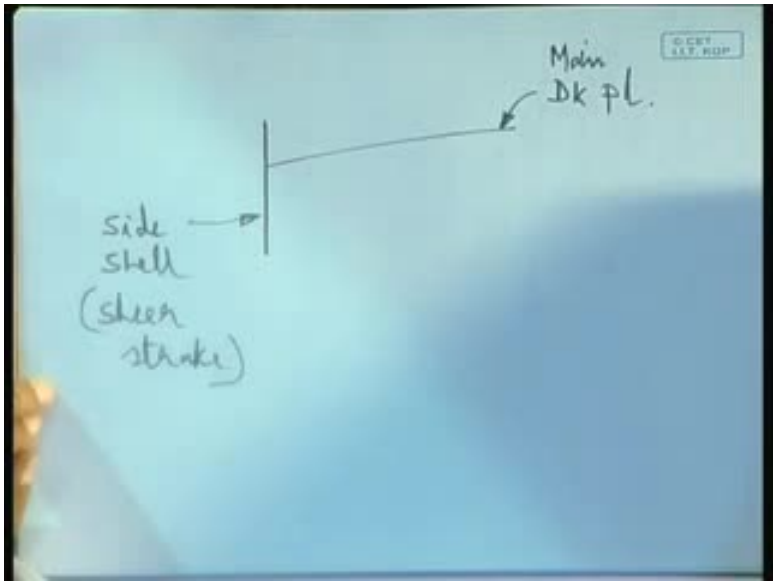

The longitudinal stiffeners will be there, then the connection of this is my part of my side shell; this is the part of the deck plating, this is side shell. We are talking about - if we are talking about main deck plating, then this part of the side shell has a different name that is referred to as sheer strake.

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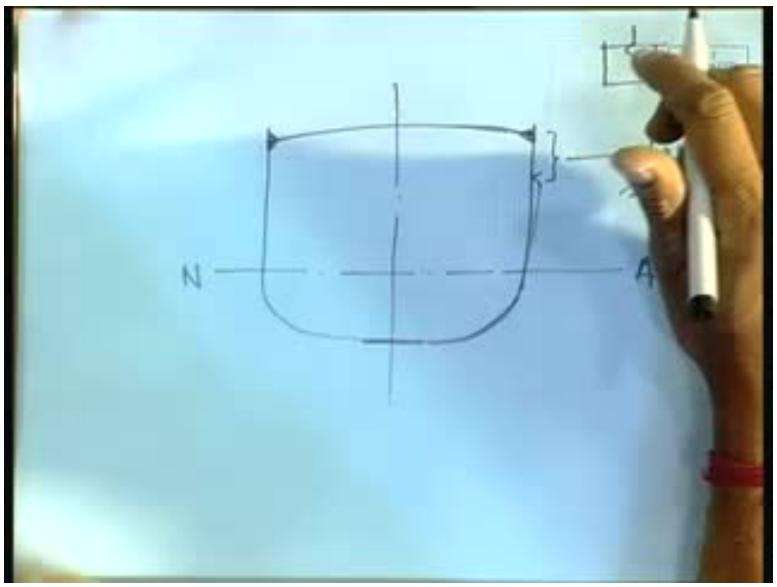

Sheer strake means, here essentially this is my - if you see the a section of a vessel, the top most part of the side shell plate, we have named the plate - keel plate, bottom shell plate, bilge plate, side shell plate. This is also part of the side shell, but the top most part of the side shell has a special name sheer strake. Why because, a special care is given to that so just to identify that particular strake name - sheer strake. Why, what so special about this plate? What do you think what is so special about this? The primary thing is, it is the strake, which is one can say furthest away from the neutral axis.

Because of the longitudinal bending, the maximum stresses, as well as the side shell plates are concerned, the sheer strake will undergo the maximum stress that is number 1. Number 2, the sheer strake is connected to the deck plating, it is welded. Number 3 is, well it is more prone to some damage - possible damage, why? You imagine a situation, you are loading the cargo.

Some cargo is coming, it is hanging, so it may hit. Some accidental hitting could be there while loading the cargo, unloading cargo. Any failure or flaw taking place in the main deck, it may get propagated and goes to the sheer strake. If sheer strake cannot withstand

the sheer strake, it will fail the fracture or crack propagates, the whole ship will break in to two. So that is how sheer strake needs a special consideration. What are the special considerations? Well, the thickness is more a higher grade steam is used.

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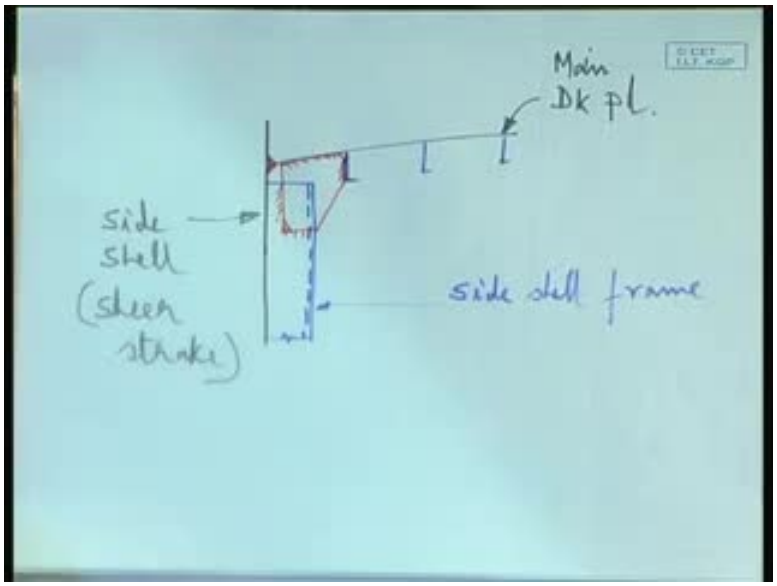

This particular welding, these are the welding's - this particular welding is thoroughly checked, so that there is no flaw there that is how anyway, so this joint is also vulnerable, but the side shell - the sheer strake is welded to the deck. Why this joint is important? Because, through this joint, the load of deck is getting transmitted, so it should have a proper path. Now, what are the structural configurations here? Our main deck is longitudinally stiffened. Suppose, it is going like this, let us assume the side shell is transversely stiffened, in case of a general cargo ship - general cargo carrier will see that the side shell, it is preferable to have transverse stiffening - transverse stiffening means a stiffener will go like this.

Also, let us assume, the side shell stiffener is angle section, it is referred - named as side shell frame. So, there should be, if I just weld it, it is not enough, isn't it. For all load to get transmitted, it will be better if I have a connection between the stiffeners. So that is, stiffener is given - that connection is given to a proper bracketing arrangement and the brackets are like this.

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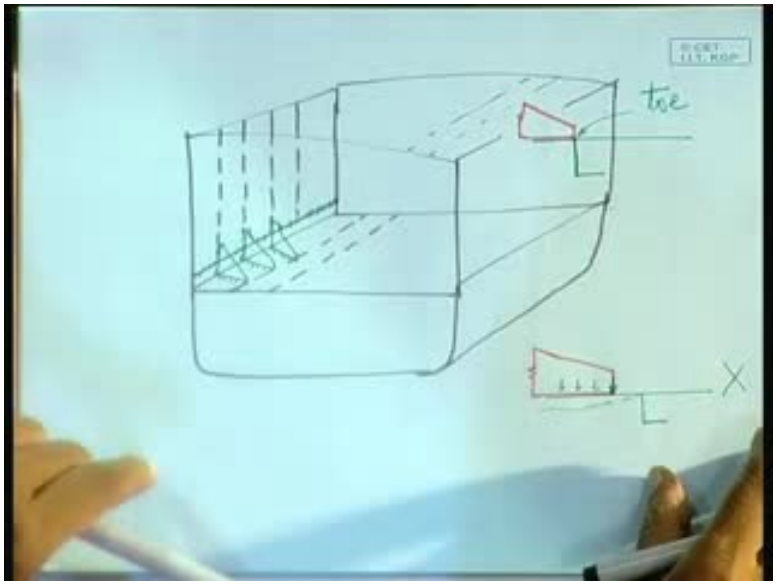

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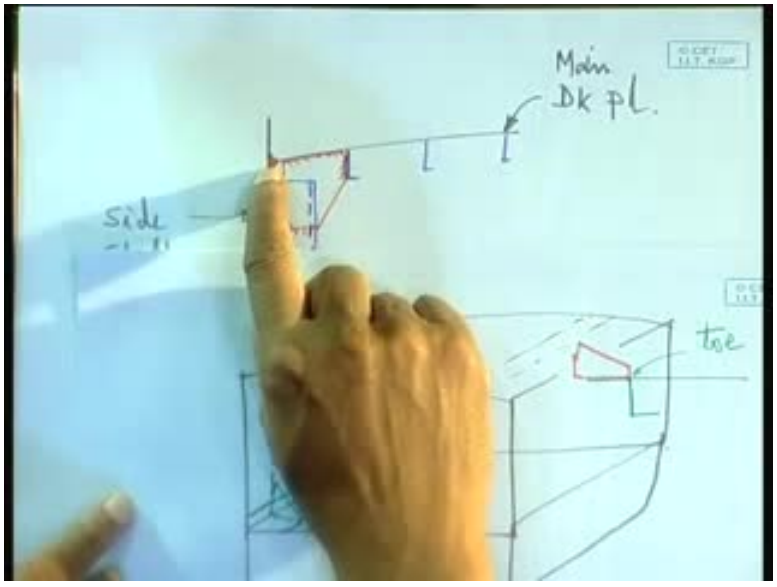

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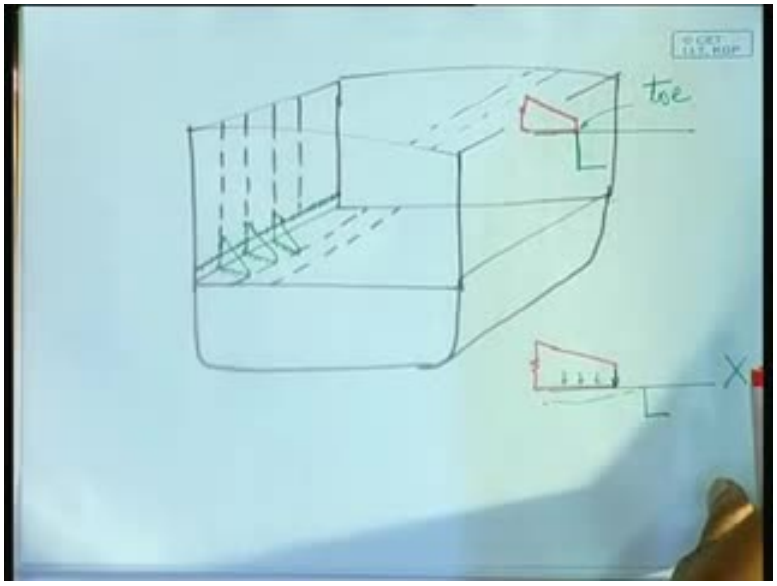

Well, it is preferable to have it sight here. These are welded, this we have already shown, so that is how you get the proper load path. When the deck is erected, after erection means what? We put in place, align it and then go on joining this. This welding is done; all this brackets are welded, so you get the full block, so that is how you end up in the full block. In this process, we have not done the wing tank; this is a section of the general cargo ship we have shown, so wing tank now we are coming to that.

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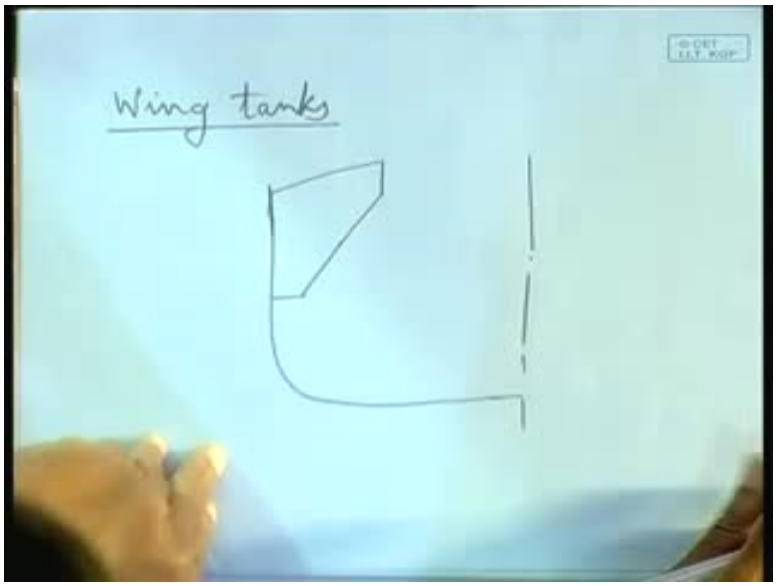

Wing tank, as you can see, the name, it is kind of a tank. As if right this wing tank and that the tank is in the wing that is how the name of the wing tank. In bulk carrier, we will see, we have already when talking about the different type's vessel, we have seen there is a kind of vessel, which is referred to as bulk carrier.

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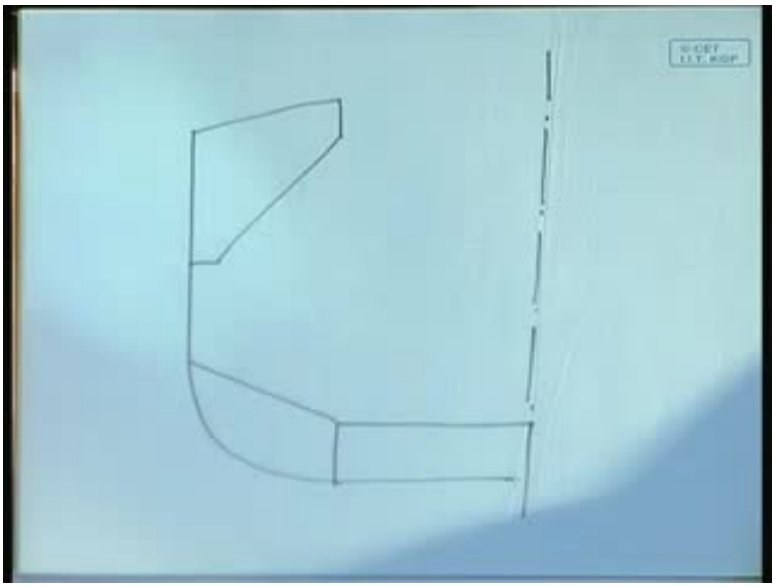

There is a kind of vessel, which is referring to as bulk carrier. It carries cargo in bulk, well let us take a look at the sectional view of a bulk carrier, wherein we have the concept of wing tank; this is what the wing tank is.

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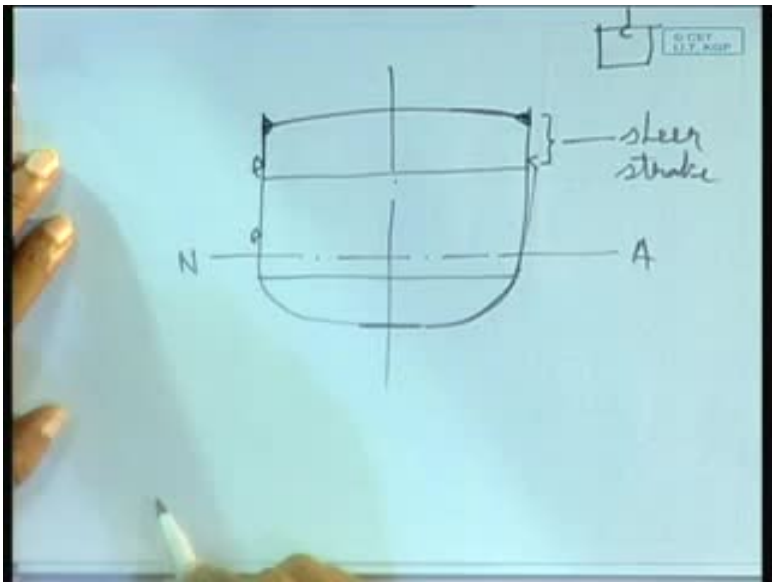

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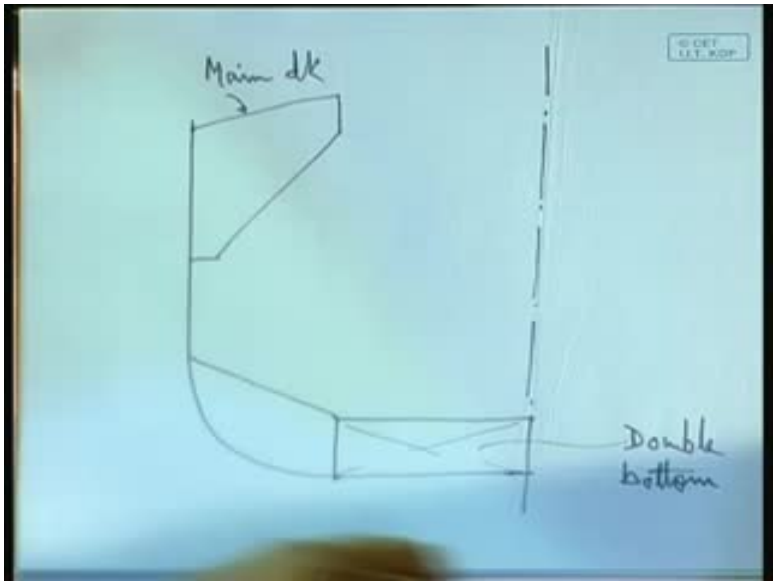

So, you can see the difference. Till such time we had been drawing mixed sections, something like this. You had inside a double bottom, depending on it was general cargo shape. You had a lower deck, now this is a different kind of section, where in this is my hatch opening, so this is the part of the main deck. This section is drawn in line of hatch opening - in line of hatch opening where the hatch opening is that there it has been drawn.

We can see there is nothing there. As if in this part, the double bottom is only this part, is the double bottom. This is my double bottom, its constructional features and details are identical to what we have talked about. In that case, the double bottom extended further to the bilge plate, it has stopped here. It has stopped in one of the side girders that are the only difference. There we have seen the side girder.

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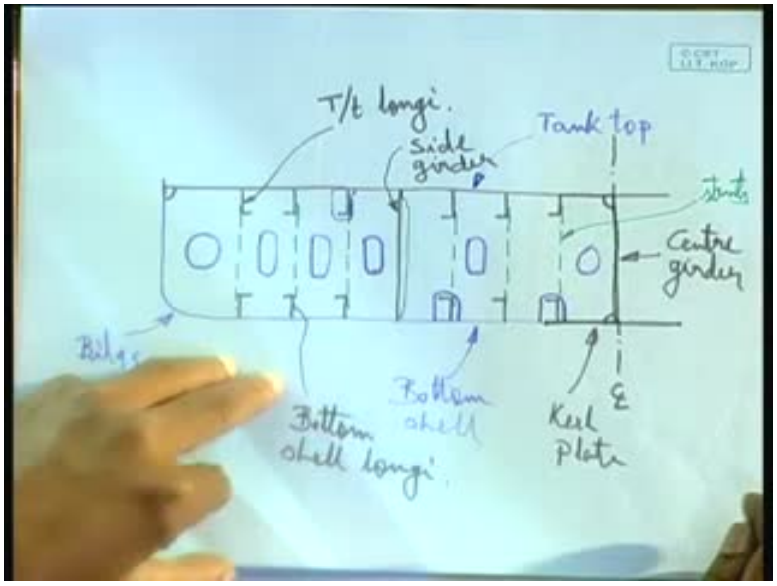

Well, there is one more word about these girders. The center girder is generally a water type girder, totally water type plate. Means, this center girder divides the entire double bottom, in port and start boat independent tanks.

That means this port side tank. That is the port side tank they are independent, it is divided by the central girder that runs water tight. Side girder may be water tight, may not be water tight, depending on your requirement. Generally, they are not water tight, means they will have the floor, you have these openings. Then, the side girder you will have openings - side girder is a longitudinal member contributing towards longitudinal strength. Floor is a transverse member contributing towards transverse strength.

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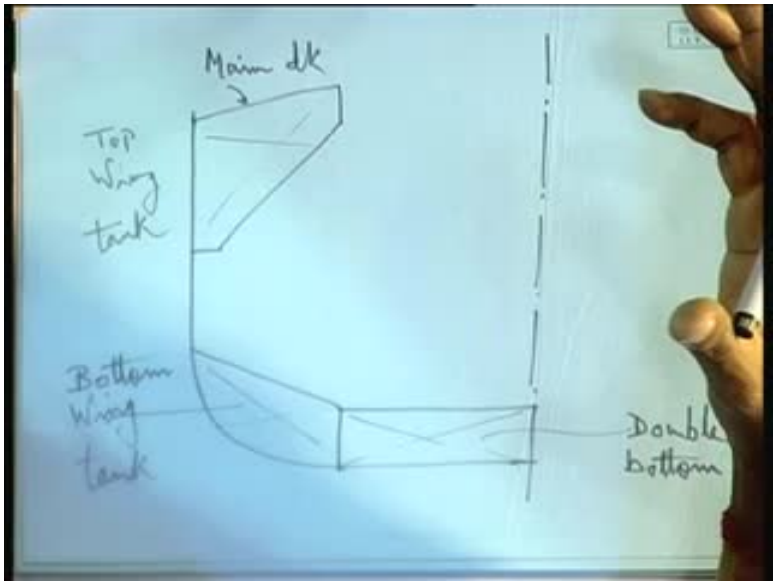

This side girder you assume in this case, as if the double bottom as ended in the side girder. This side girder is also water tight, such that this is a separate tank in that case. Similarly, here also I can see some tank like space, so this is referred to as bottom wing tank and this is top wing tank. This is a typical feature of bulk carriers only, in bulk carries, you have such wing tanks, why this wing tanks are coming?

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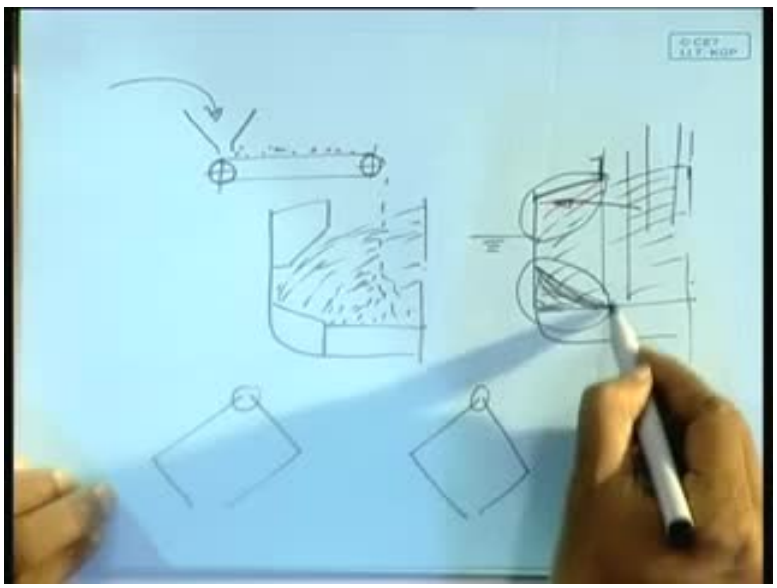

Then, well in this context, probably, possibly in better to talk about the bulk carriers, a bit, what is the function of a bulk carrier? To carry cargo in bulk, what does that mean?

That means, you put the lose cargo in the hold. How do I put the lose cargo in the hold? How the loading process through a hopper? Through the hatch definitely - through the hatch head, but it will come through a hopper; naturally, it will be preferable to have automated loading arrangement. That means, you can think of such an arrangement, say you have a Conveyor sort of a thing or even without any hopper just you have conveyor here, whatever thing is coming and it is falling.

Suppose, you are loading wheat, so you have arrangement here, this is a conveyor system. Here, you are putting the wheat say from the trucks or trailers or whatever or from silo, if you have seen silo means, basically sure containers of this wheat, sugar, bulk kind of things. So from that you put it or load it on the conveyor, through the conveyors to the ship hold. You know, when such thing is dropped, it always forms a heap, isn't it. It will form a heap like this, so if the hold. If I keep the ship hold, in this fashion, I go on loading with this in this way, what will happen ultimately? I will have a heap like this, isn't it?

This will be my cargo in the process, what is happening? Some space - this particular space is remained under, I mean not utilized - empty that is number 1; number 2, you think the reverse process of it, unloading it, how do you unload these cargo? They are unloaded either by a hose - pump it out or by grabs. You know, there are some grab, some such arrangement - not properly drawn, some such arrangement. This opens up; you dip it, closed it and lift it through the grabs. Either pumping it out or through grabs, in both the cases, once the cargo is unloaded, then what will happen? A part of the cargo will remain here in this corner.

How much corner it will remain? If you lower the hose up to this, this will remain. So again the problem of unloading-full unloading, you would not be able to do and that will be quite substantial amount. It is not only the substantial amount; it is going to contaminate the next consignment of cargo that can be something else. It is sugar, next consignment salt, may be so loading and unloading, both creates problem. In loading what is the problem? If it remains empty, because as it is I cannot load, it further load this much, it has already hit the so called planes of line. That means, the loaded draft, it is designed for carriage of so much. You have loaded it, it was already in this and this space remains empty, so no problem. If it remains empty, because as it is I cannot shove, let manually pack more material, because it is already there.

But, what problem is, it can give, if it remains like that. So, it is not only the question of the space is remaining unutilized, but it is some other is remaining, vacant – empty. So what problem could be there? Stability means not releases, stability in these terms, not what stability? Yes, so there will be the direction of stability problem, not the statically stability that much, but direction of stability. That means, suppose it hits a little bit of rough weather and starts rolling. That means, executing oscillating - oscillatory movement, so this cargo may shift.

In one rolling motion, the cargo may shift to the port site; in the next phase, when it is going in the starboard site, not necessary the whole cargo will shift back, this is not water. So, it may so happen there will be a dis balance in the weight distribution and the whole ship may remain healed condition - in an inclined condition. If it remains in an inclined condition, then it will have problem of maintaining directional stability.

What does that mean? That means, suppose your ship is supposed to heads straight, means your radar also will be of 0 angle. Now, what will happen? Since, it is healing, so it will have a tendency to take a turn, deviate from the straight course. So, you will have to give a radar angle to bring it back to the desired course. Giving a radar angle means you are wasting power, so there will be drop in your speed. To boost this speed you will have to power, means your fuel consumption will increase, operating cost will increase and so forth. So that is how - this is the problem; that means, this space has to be looked into, as well as unloading time, this has to be looked into.

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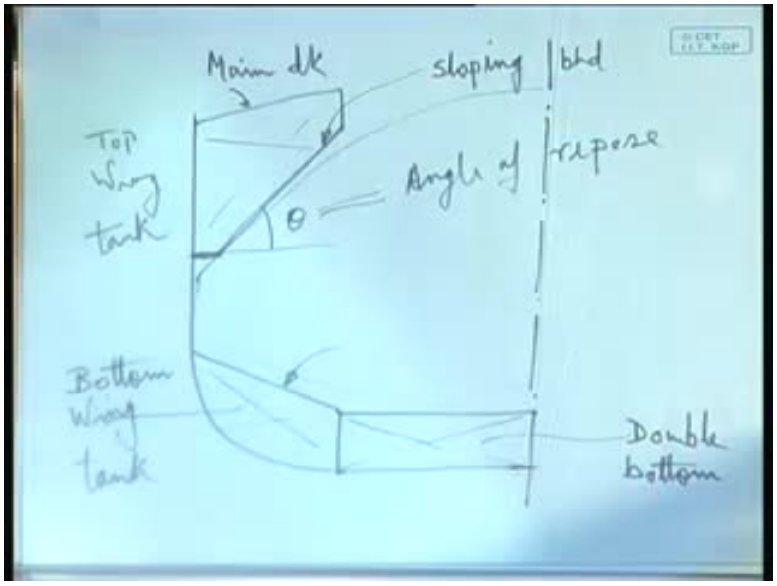

The solution would be that cut of that space, provided a plate cut of this space and also provide a plate. That means now when I load cargo, the cargo comes like this. When I unload also the whole things gets unloaded, because this slope of course, I am drawing it very shallow. We will have a definite slope - required slope such that the cargo will come down automatically to the central part, from where it is pumped out or through grab, it is taken out.

What should be the angle of this? So that angle is generally defined from the angle of repose. This is a particular term use angle of repose, means when you pore say sand or wheat or sugar, it forms a particular heap with a certain angle, so that is what is referred to as angle of repose. Based on that the kind of cargo it is supposed to carry - now the angle of repose of all those cargoes, some average angle is selected and accordingly this configuration is even. So, in this process, what happens? That means, this is a fixed plate, this is also a fixed plate.

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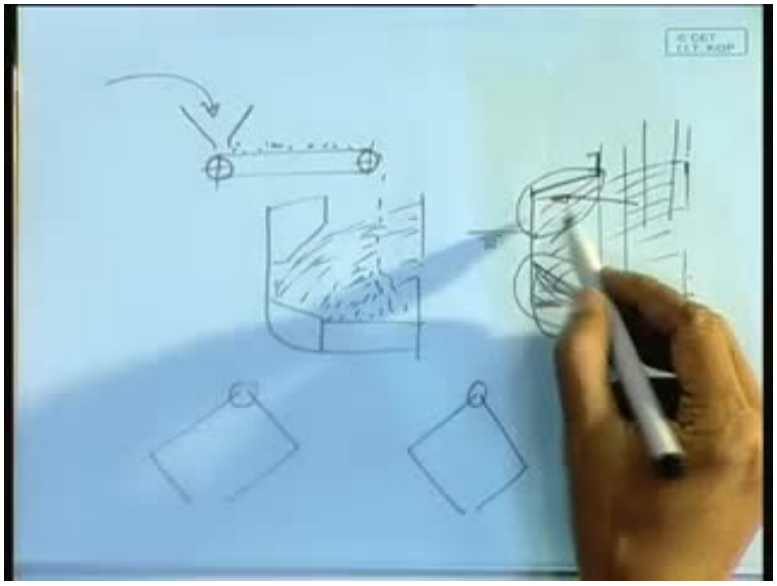

These plates are referred to as sloping bulkheads, sloping bulkhead of top wing tank, sloping bulkhead of bottom wing tank, so I get a tanked space. So, these are my wing tanks, what is the purpose of this tank? Tanked these spaces, same as that of your double bottom space; that means, otherwise, what was happening is, as it is we could not use this phase, so by making a tank, it does not mean that I will carry extra cargo there.

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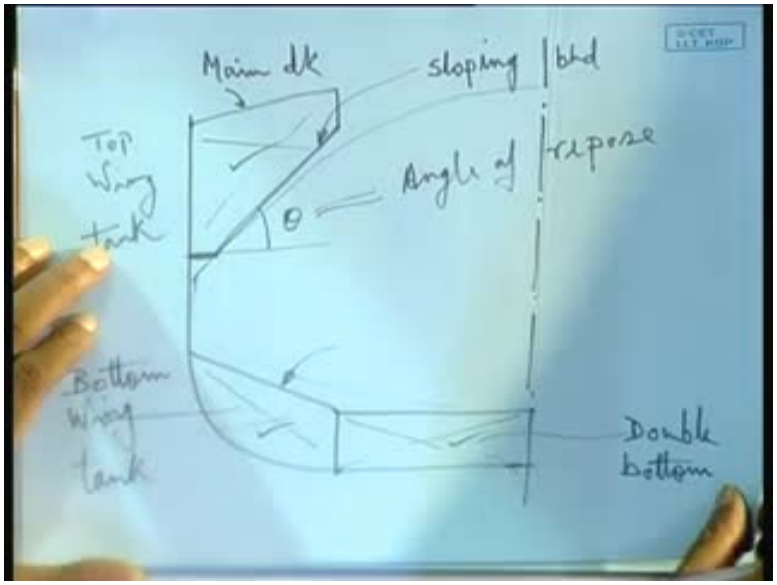

It may remain as well empty, absolutely empty or in necessity, I can put some well fresh water, if necessary ballast water, whatever, but it is not exactly that way that means it has

to be decided, pre-designed. That means, in the design stage itself the spaces has to be year mark, whether it will be is going to remain empty or whether it is going carry fresh water or whether to carry ballast water, whatever.

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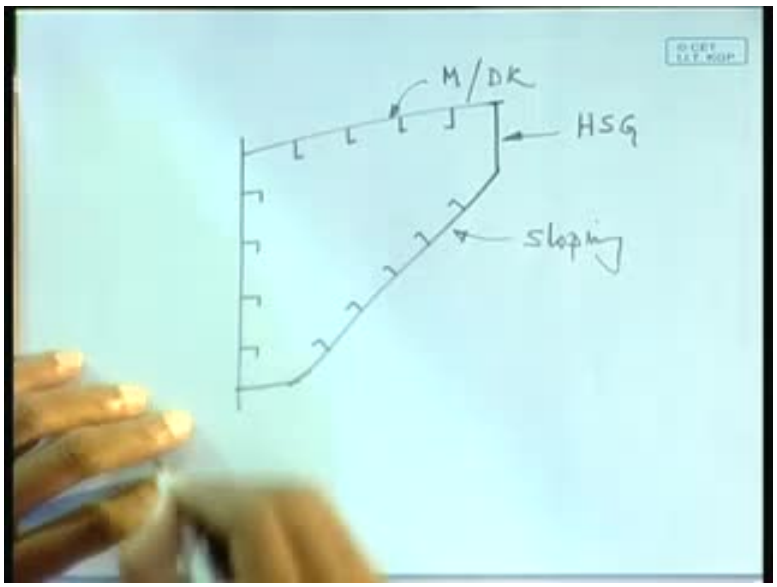

That means, I have additional space in addition to the double bottom, I have bottom wing tank, I have top wing tank, they can be utilized. Now, if I just look into the top wing tank or the wing tanks, the construction point of view, it is like this. This is the main deck, this is my sloping bulkhead and then this can be the hatch side girder. So, deck is longitudinally stiffened, once again we are using longitudinal stiffening of the deck.

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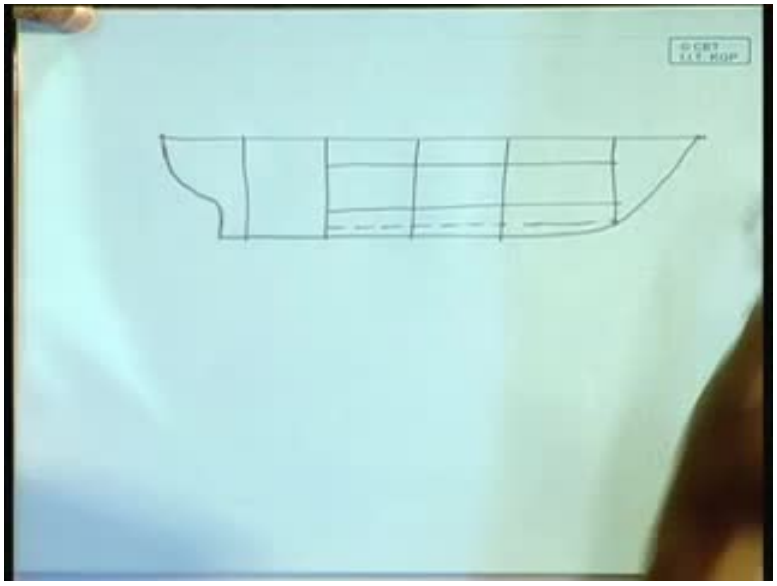

Similarly, you see here, this part of the side shell; I can as well go for longitudinal stiffening, is not because this space is going to be used for some liquid if at all. So, I maximize my longitudinal stiffening arrangement, this is also longitudinally stiffened. There by this entire thing - this particular wing tank, it becomes a quite strong structure. In the profile, say this is my engine room and these are my holds - cargo holds. So, the top wing tank will run all along the length of the holds, the bottom wing tank is also running all along the length of the hold. Here, you have the double bottom.

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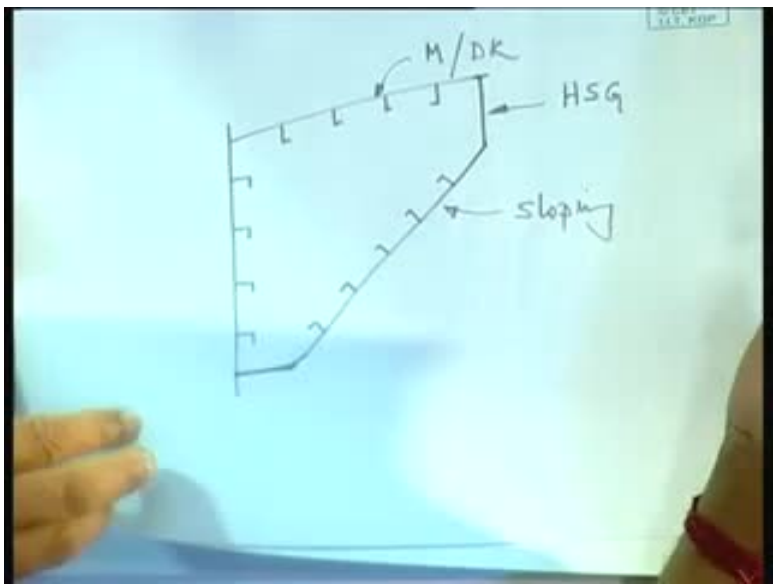

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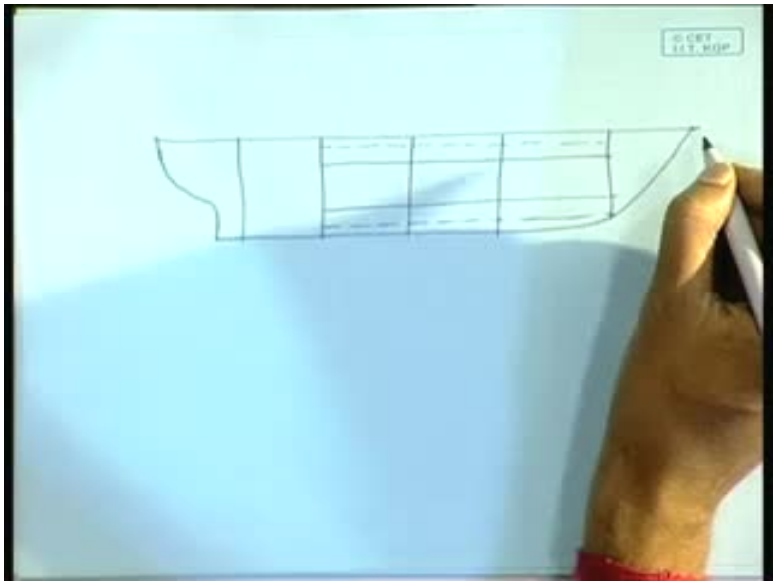

Like that it provides these both - the wing tanks, it covers quite a substantial length of the ship, so it provides additional strength also. Additional strength that means all these wing tanks it is totally longitudinally stiffened, you have the sloping bulkhead, the hatch side girder and the bottom plate of the top wing tank. All together provides a sufficient longitudinal strength, what about the transverse strength? Then again the same question is coming that these are longitudinally stiffened means, your longitudinal members are running like this. Say, any longitudinal - this particular green line represents one of the longitudinal, which is one of this longitudinal.

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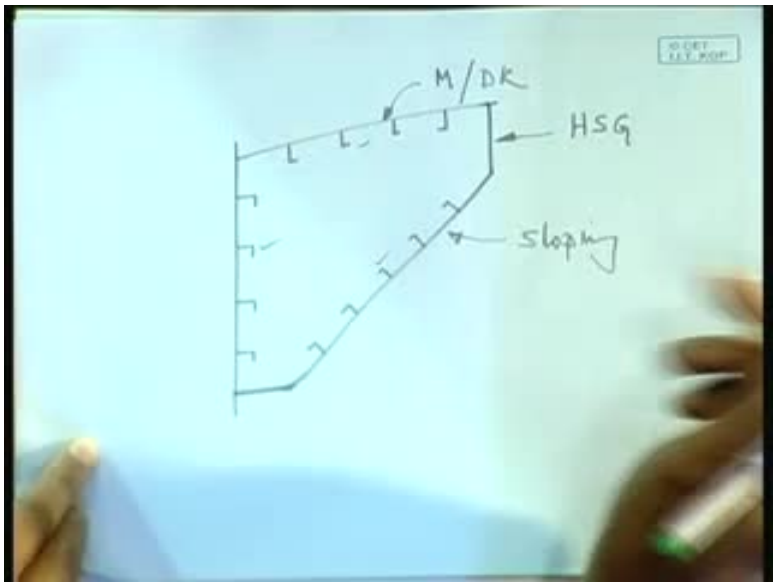

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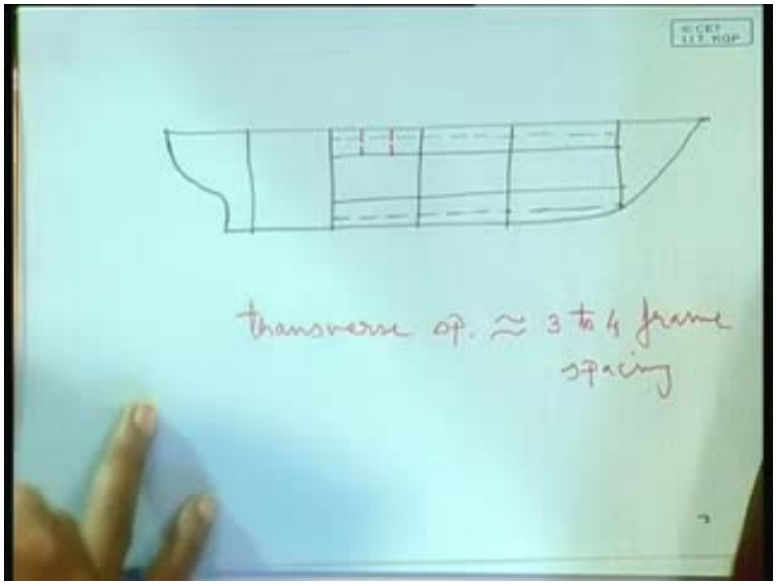

It could be one of these, it could be these and the longitudinals will run like this, isn't it. So, again you need to provide necessary support such that the span does not become too much, because otherwise your supports are at the bulkheads.

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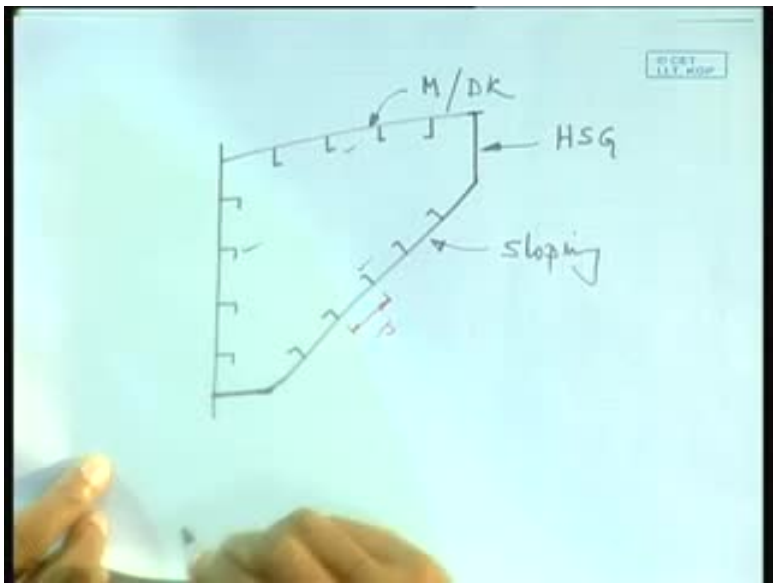

The questions of transverses come that means transverse, so the spacing of transverse spacing is generally how much? It is generally 3 to 4 times the frame spacing or in another words, the span of the longitudinal remains 3 to 4 times its spacing. Frame spacing - frame spacing is spacing of the longitudinal, this is my frame spacing.

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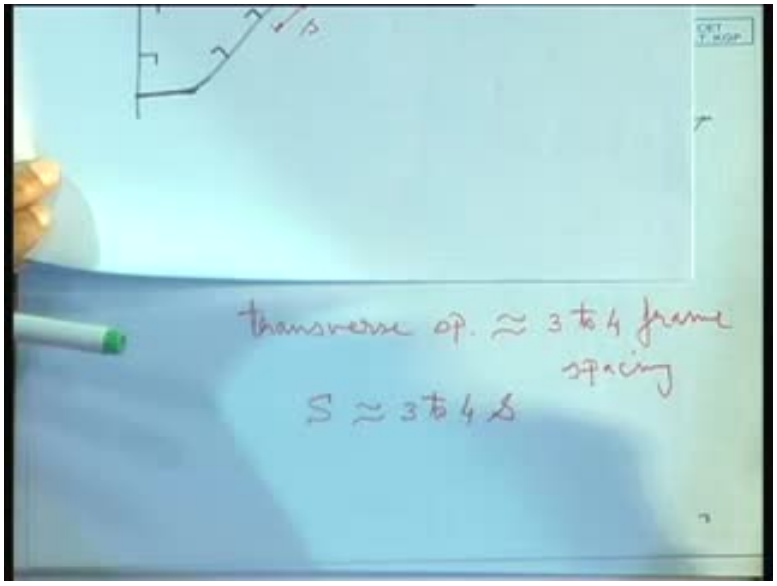

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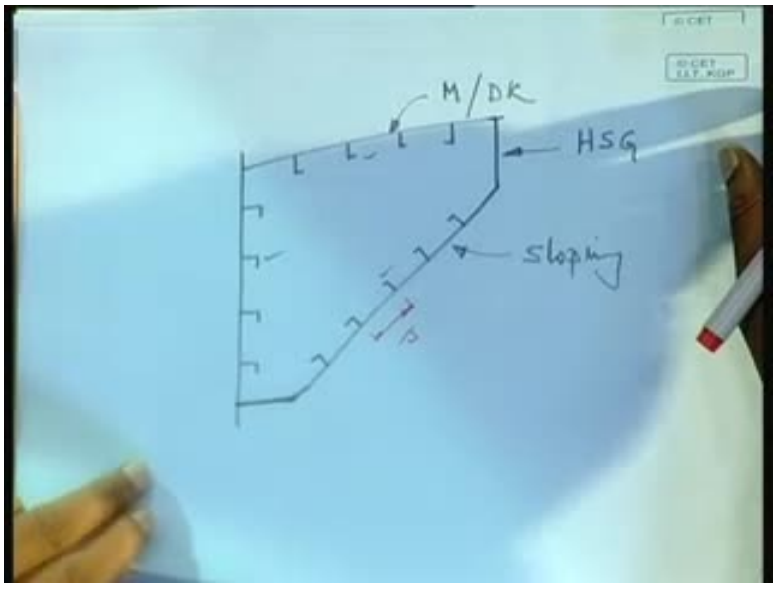

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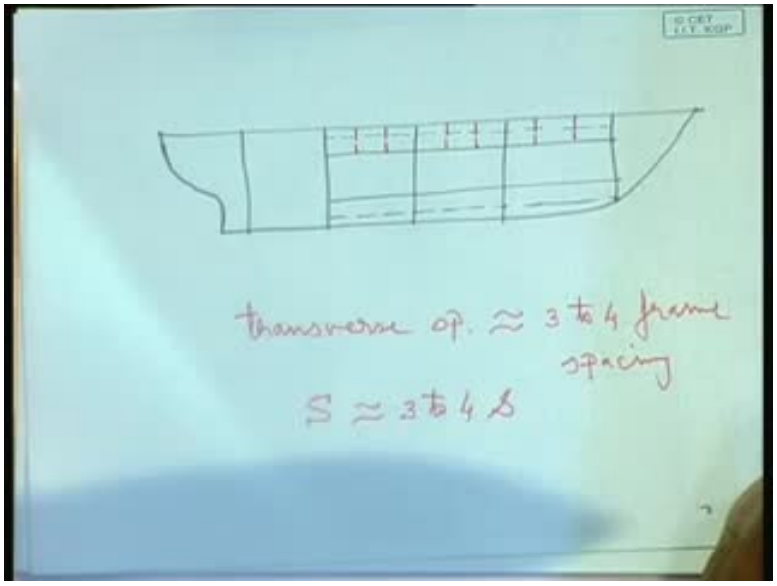

If transverse spacing is represented by capital S, it is 3 to 4 times the small s. Here, you will have the transverses, how? That means at intervals like this, you will have the transverses - wing tank transverses; they will be refer to as wing tank transverses.

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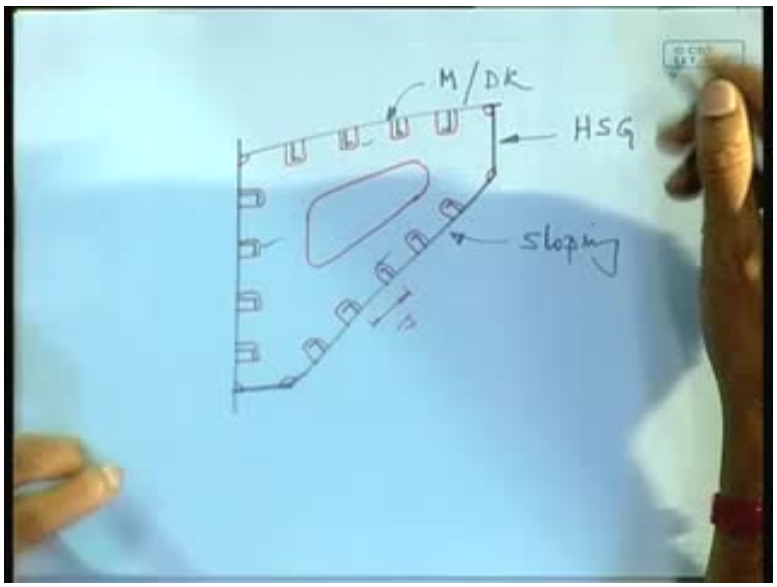

How they look like? This red line is the - basically is the transverse member, this are the cuts in the transverse plate.

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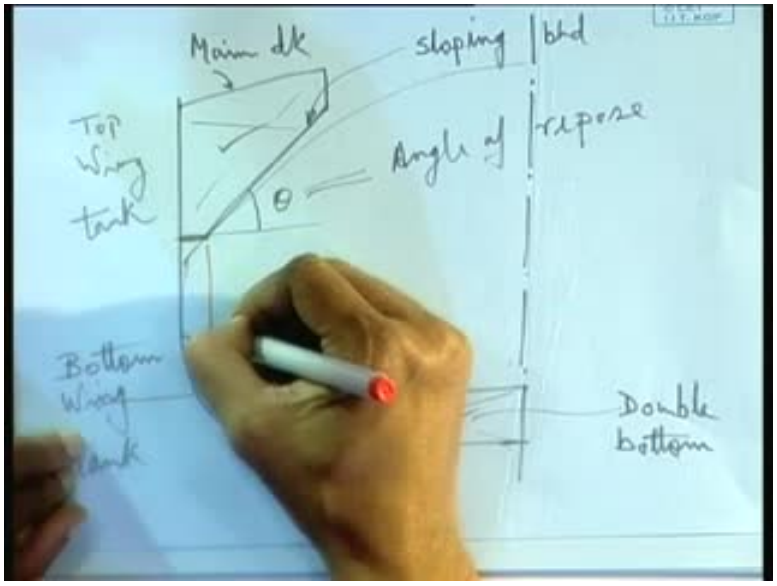

In the similar lines, as we have seen in the floor plate, these intersections of the longitudinal and the transverse plating is same as that of bottom longitudinal and the floor plating, the same logic is followed. Now, this is a plate in this plane, so where ever you have a plate floor in the bottom shell, in the double bottom space - a plate floor, you will have a bottom wing tank transverse, you will have a top wing tank transverse and also you will have a web frame here, a side shell frame of higher scantling. So, it forms like a ring.

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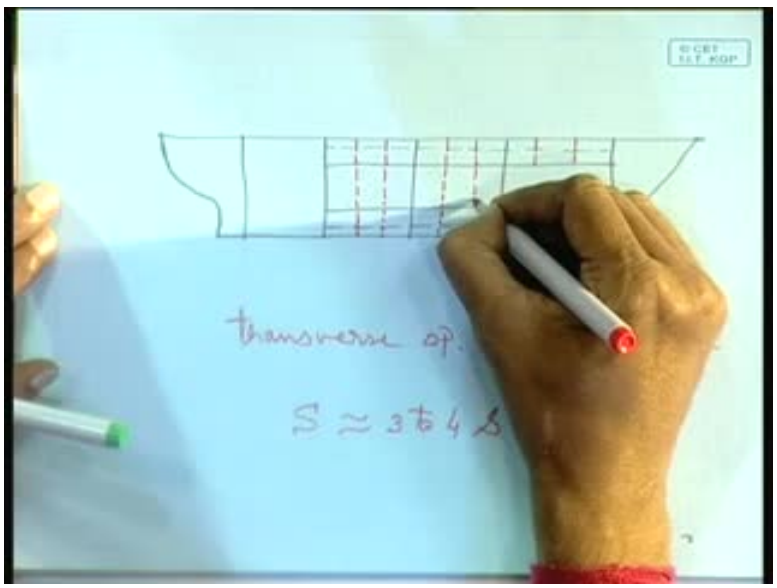

When you see this, when you talk about this transverses, right at intervals, so in the same interval, you will have a web front in the side shell, a bottom wing tank transverse or a plate floor, top wing tank transverse web frame, bottom wing tank transverse plate floor. So, such will be the deployment of the transverses or the transverse stiffening members.

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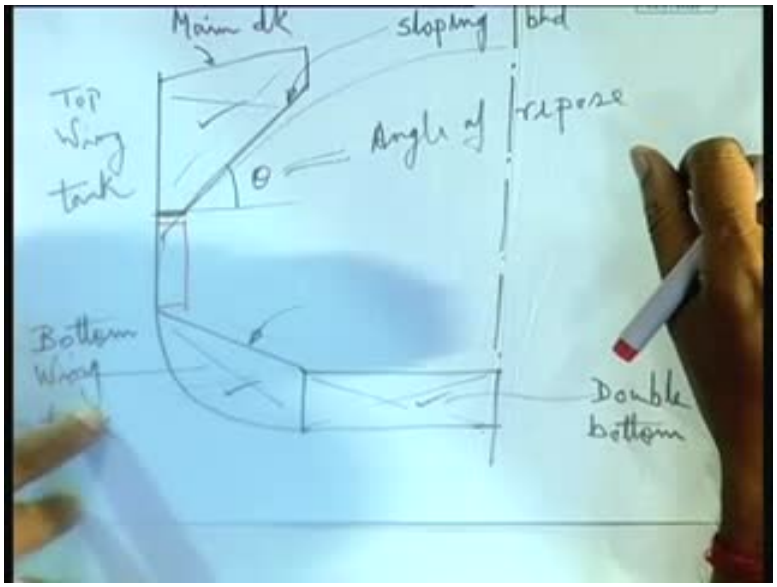

These are taken all together, it forms a - as if a ring structure like the reeves, at intervals you have the reeves, so they are forming the reeves. Those reeves are as if supporting the longitudinal members, so this is what.

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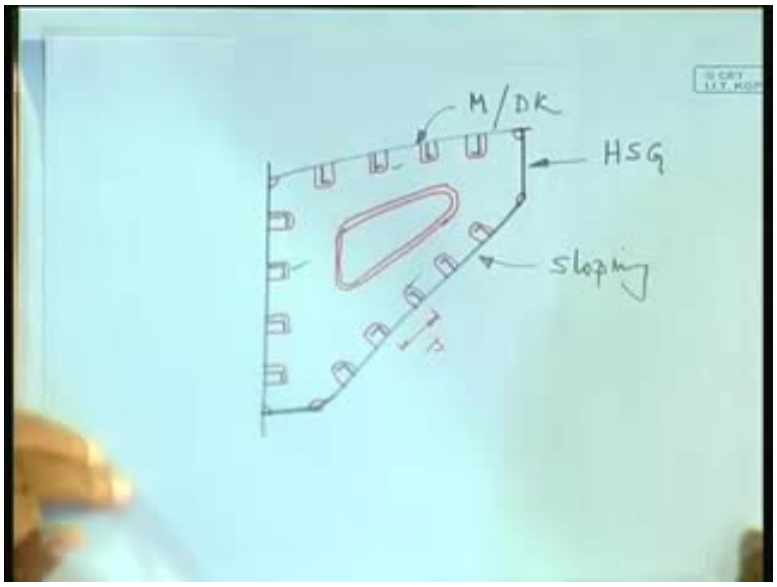

Then now for local strengthening, because of this particular plate, these dimensions can be substantial. So, they may get buckled in between, because of others loads coming on that.

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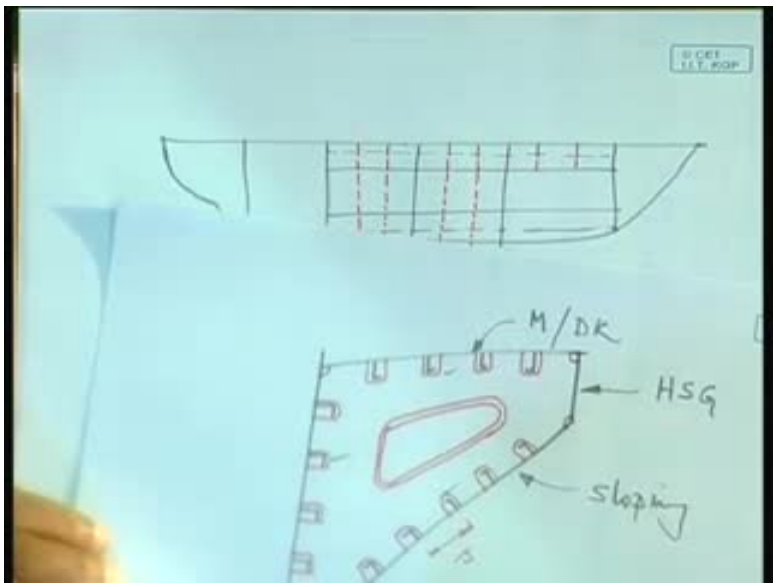

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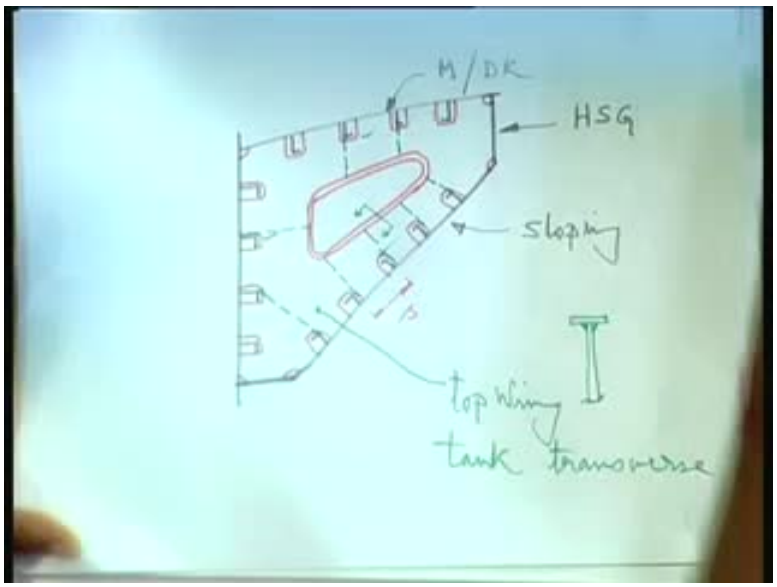

So, what we have is a Face plate welded to this cut, this is the opening. Again, the opening is for lightning thing, we have said that this place can be used as a tank head space. So, if I carry some liquid, the flow of liquid, so the openings are needed. So, there are opening, if you cut an opening, you stiffen it with a flat plate. Stiffen it with a flat

plate. That means if I look a cross section here, it is nothing but you have the transverse member plate, there a flat plate is welded. That means, a flange is welded all around, a flat bar is welded all around.

From here, like in floor, you had struts. These are my struts, those green lines - those are a strut that means they are stiffing it that means, this transverse member, this particular plate is top wing tank transverse. This is a plate in the transverse plane, it is providing support to the wing tank longitudinal and all these longitudinals taken together, I can refer to as wing tank longitudinals. They are providing support; these details are the same as those details, we have shown in the floor longitudinals, so that is how.

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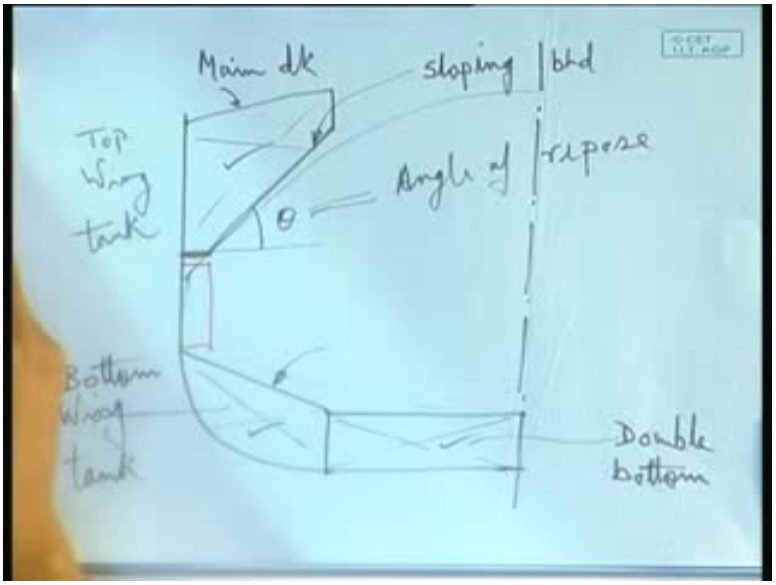

Now to provide strength to the transverse, you have this struts welded, we have this flange welded here, so that is what the top wing tank is. The similar configuration will be in the bottom wing tank - identical configuration, all the shapes are different. So, we stop here today.