Marine Construction & Welding

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Lecture No. # 12

Bulk Carrier

Today,we will take up thisbulk carrier,there is another term also used - OBO that is Ore andBulk Oil.Essentially, bulk carrieras you can see the name isin which it carry cargo in bulk.Now, we look into the structural arrangements precisely thatwe have in the midship section region.We have seen thatprimary purpose or primarily structural arrangementis decided based on thestrength requirement such that it can sustain the service loads, but at the same time we have seen that from the functional requirement that arrangement changes.

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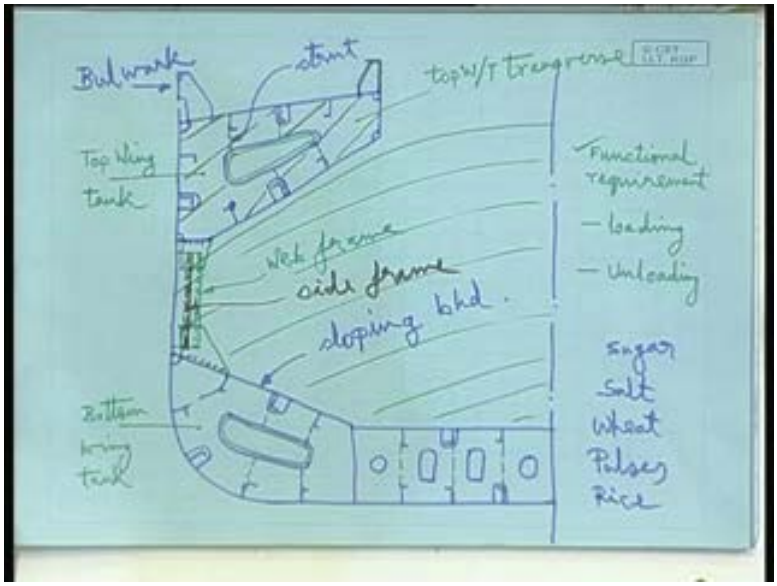

What happens in case of a bulk carrier?Bulk carrier, as the name you see that it carries cargo in bulks. It has a loading pattern as well as I will have to think of how unloading will be done. Loading and unloading are two important aspects in cargobecause, if we have a mechanism by which I can load the cargo faster as well as, unload the cargo faster

it is better, why?Because I need minimum dock time - minimum port time - because, I would not have to keep the vessellong waiting in the port because that costs money.

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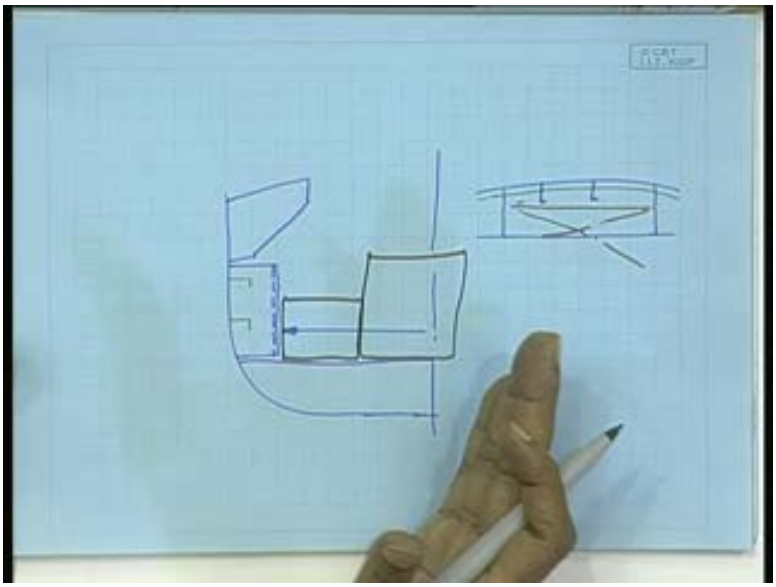

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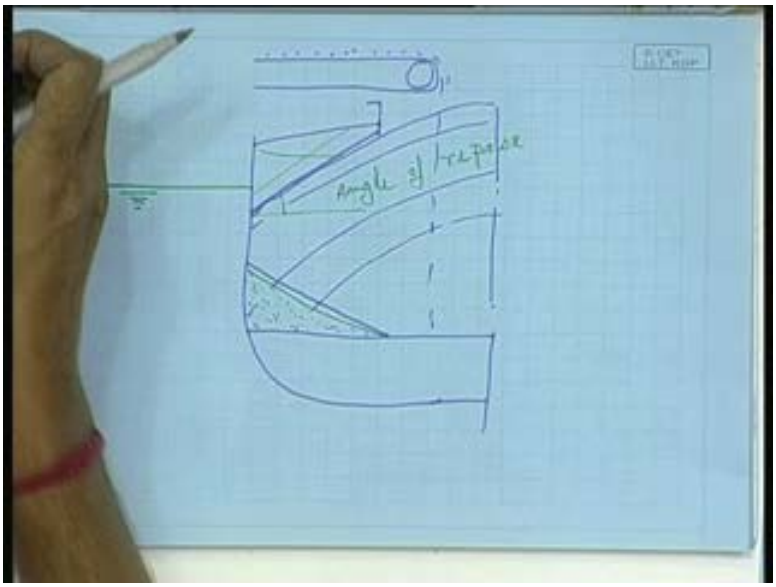

In bulk carrier the cargo is in bulk means, the cargo would be just poured in bulk within the hold that means schematically, it may look something like this (Refer Slide Time: 02:20).You have the vessel,let us assume the vesselcross section or the midship section is conventional like we have seen in thegeneral carrier in that case will not see

this.Rathersay, just the outer hall is there and as I have said we need a double bottom to have a flat surface and then the deck and then we have the hatch opening.

Now, if cargo in bulk that is for example,salt has to be carried,how it is carried?Generally what happens isthat it is transferred through a conveyer belt. Here, salt is there, it rotates and it will be directly being loaded in the hold. In the process what will happen?As itgrows the salt heap will form something like this.In the process we see that this particular space remains unused.

Same thing while unloading how unloading is done?It is done either by sucking through holes or by means of grabs. Again, same thing will findthat part of the cargo will remain in the corner like this, because it will not slight down, that is a property of that particular at what angle it will remain or what angle this heap will form, all those things depend on - I mean cargo to cargo to be different.This particular angle is referred to as angle ofrepose.

If the vessel isdesigned to carries a sugar or salt or wheat, depending on what each ofthose material has certain angle of repose. If it is a multipurpose thing that means, in onevoyage it takes sugar, the return voyageit brings wheat. One can decide uponthe average angle of repose such thataverage angle of repose can be decided.

Now, what is to be done? Here,we see that this space remains empty, what is the problem if it remains empty? Because that is not a loss of space that by loading it up to this point,it is already attaining my, what you called the loaded draft.That means, in any case this space has to go empty, but if I just keep that empty will there be any problem?Well, what happens is - I mean - if that remains empty as such it does not have any problem.

The cargo shifting may take place that means, while it issailing in the sea and if the weather is fine there is no unto wards motion ofthe vessel then no problem but,suppose facesa little rough weather and the vessel start rolling,there can be cargo shifting to one side. If cargo shifts to one side means, it will remain in a permanent healed condition which is called it will have a permanent list.If it has a permanent list then, it will have problem in directional stability, it will not go in the straight direction,will have to give a radar angle that means there will be a wastage of power.

Similarly, when unloading the thing, if this much amount of cargo remains, what is the problem?Definitely, this is a direct problem you can see, because in the next voyage if I carrying something else that gets contaminatedand if you want to really unload it manually then the all-purpose is lost that means, your unloading time increases drastically,so thisis the problem. If that is happening the best solution would be, if I can cut it off that means, put a plate like thisand put another plate here like this, cut it off simply.

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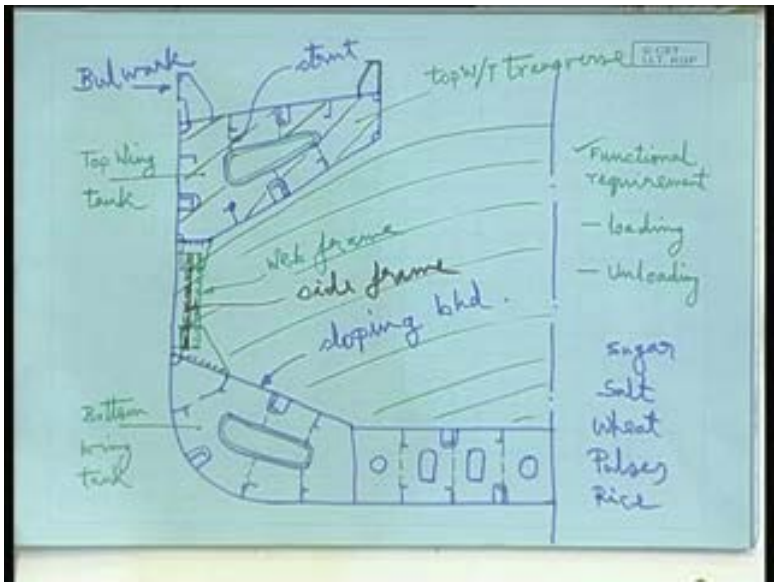

Thereby,we come to the section shape like this. What happens in that case is here we have the cargo loaded like this, the entire cargo is there.So, while loading automatically this corner is taken care of and while unloading again this corner is taken care of, it has been given a right amount of slope such that you will slightdownand thereby the form comes.

We have got in the process one space here which is referred to as top wing tank, because it forms a tank like structure, so that is referred to as top wing tank.Similarly,here this is bottom wing tank,it is at the sides, so they are referred to as wing tanks and the double bottom remains as it is.As we have seen in other cases the double bottom construction is same, the only thing is the length of the double bottom has become less it has gone up to the one of the side girders.Here, this side girder is a water tight girder?Means, same as that of a centre girder,if I have a centre water tight girder, this side girder is also water

tight, why?Because,it is forming a part of the boundary bulkhead for that bottom wing tank or boundary bulkhead for the double bottom. So, I have individual three seats of tanks, the double bottom tank, bottom wing tank and top wing tank.

Here, you have the cargo hole, since these are all tank head spaces, so I have all of them longitudinally stiffened, you can seeall are longitudinally stiffened. Double bottom is longitudinally stiffened, bottom wing tank longitudinally stiffened means,longitudinal framing system has been applied in all these, because they are all tank head spaces.They may go empty that isan immaterialbut, if it is decided that this particular tank and this particular tank will be used forballasting or fuel oil or fresh water, some purposethey can be used. Obviously, these spaces are not use for cargo carriage only for ballasting or fresh water or any other such purpose like fuel oil.

What you see is the construction of this wing tanks they are similar to that of the double bottom, only thing there is we have the plate floors as transverse member, here we have a transverse member like this.The top one will be referred to as top wing tank transverse it means,it is a transverse plate.In this what you can see, here you will have these scallops cut at the corners, there is scallop for the longitudinal, these are the deck longitudinal, these are the sloping bulkhead longitudinal.This will not be T section it is only anglesection itself, this is part of the side shell within the wing tank which is longitudinally stiffened,all these will have those scallops. The transverse plane a plate which is referred to as top wing tank transverse that plate is giving support that is a transverse member supporting the longitudinal.

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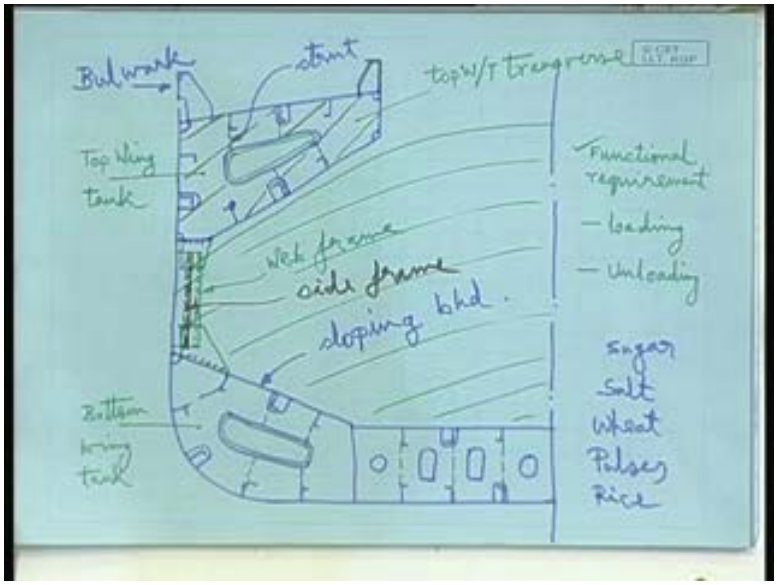

For its own stiffness these are my struts, like you have in the floor here struts, same thing similarly these are also the struts. This green line here I have drawn will refers to that means, opening has been cut which is reinforced by a fled bar welded all around, because the opening if I keep unstiffened then, there will be lack of rigidity.Like you may have observed those tumblers - plastic tumblers - which we use in bath rooms,the top the edge is not cut, the edge is just folded why that means given a flange, so the edge become stiff, you just cut it offthen it will not have the stiffness.Same logic applies here that you have this,it is stiffens similarly same something at the bottom wing tank.

What we see is that the structural arrangement is essentially will have stiffening arrangement means, first will decide on the stiffening arrangement whether longitudinal or transverse.If I find that providing longitudinal arrangement is not anyway obstructing to any of the functional requirements then you gostraight away for that, because that is giving me a bettercritical strength, buckling strength, betterstrength to weight ratio. So that is how it is done.

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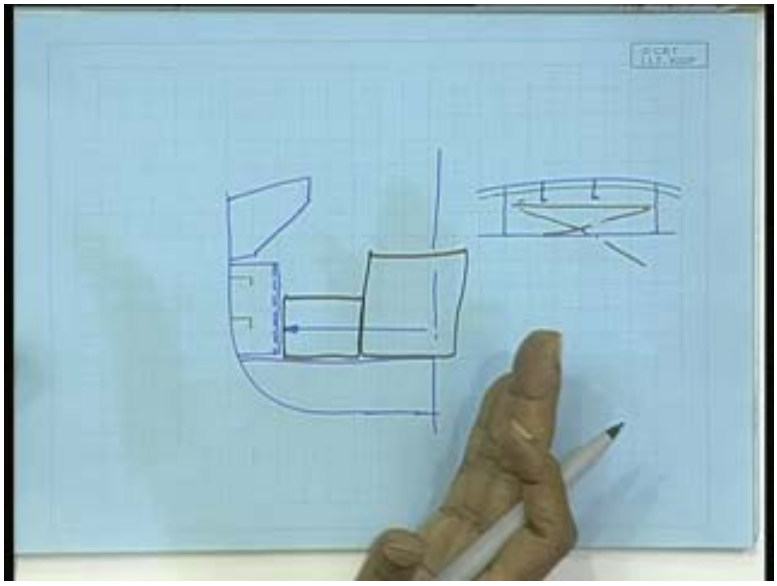

Now, we can see a part of the side shell is remaining yet to be stiffened. What do you think the stiffening arrangement should be, logical, why not longitudinal?Because,in the general cargo ship we have talked about that we have provided transverse framing.The logic we get that if I provide a longitudinal framing - the side shell longitudinal framing - that means if I have the longitudinals like thisthen, what happens? I will have to provide fora transverse frames almost double to that of the depth of the longitudinals like this.That is needed because this longitudinals are runningfrom one bulkhead to the other bulkheads so you need support, you will have to cut down the span - sort of not physically cutting down the longitudinal- but bringing down that L components smaller otherwise, your bending movement will be high, your scantling will be huge etcetera.

If that happens then we saidthat in general cargo ship we are getting only this much ofcargo storage space, because what happens if you see in a plan view say, this is my- I mean - let us assume betweentwo bulkheads, the side shell if it is longitudinally stiffened then what will happen? The longitudinal will go like this,isn't. The longitudinal and thistransverses will be at every 4th frame space will be projecting like this. Thereby, we can seemycargo straights space becomes virtuallythis much, this space gets wasted.

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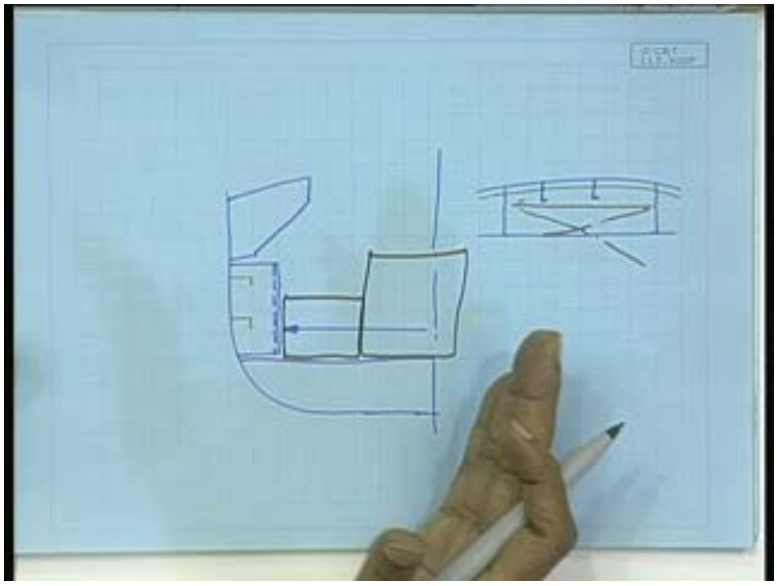

As far as a bulk carrier is concerned what is the problem?Because here,I do not have -in case of general cargo ship the cargo pattern are generally like this,it will be boxes or rows of different size and shape. If I have thisframes protruding from the side shell definitely, I am going to lose the space I cannot utilize, because the boxes such a size that between to those who are reference I cannot put green. If I really have to maneuver my cargo within the cargo hold then your loading time further increasesbut,as far as bulk cargo is concerned - this is a bulk cargo is something like that of a liquid cargoit can go in any nook and corner. So, I can havelongitudinal framing but,do we have longitudinal framing?Is there any other problemdifficulty?We actually have transverse kindwhy?Can you tell me,what would be the problem if I put longitudinal.

Problem is simple if I put longitudinal framing they will form as shelf - it will act like a so called shelf. So, cargo will remain herethe longitudinals will be running all along the side shell like here I have drawn, so all along this cargo will remain stuck on this, because they will form like a shelf whatever be the dimension of this stiffenersay,300millimeter it can be 400millimeter depending on how big your vessel is, so it is remains.Suppose, you are carrying sugar, much of sugar remains,it is not important that much of is getting lost because again unloading you cannot do manually you cannot afford to do that.

Two problems one is some amount of cargo will be lost will remain there, second next voyager carrying salt.So, it is a contamination of this and third, continuously some cargo is remaining, so corrosionwill be very heavy, becausethat place will remain continuously wet, so there is a corrosion problem. Because of these problemsside shell is transversely stiffened.

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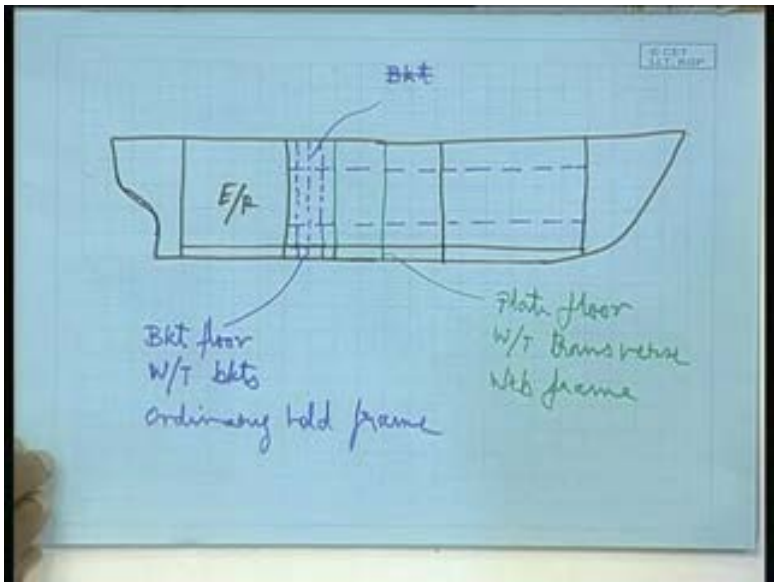

Bulk carrier side shell is also transversely stiffened and the bracketing arrangementgoes something like this, the side shell. So, that is how we have the arrangement midship section arrangement for them.This is the transverses here, this top wing tank transverse this what I have drawn is a plate - this is a transverse.

Yes, always - I mean -what happens is,if see in the profile view; say, this is myprofile of the bulk carrierlet us assume, we have aft engine row.This line refers to the double bottom let us assume only two holes are there as if.Here,this line will refer to thebottom plating of the top wing tank.This line refers to the edge of the sloping bulkhead of the bottom wing tank.This line refers to this and this dotted line refers to this particular point;the sloping bulkhead of the bottom wing tank, so this is how the tanks are going.

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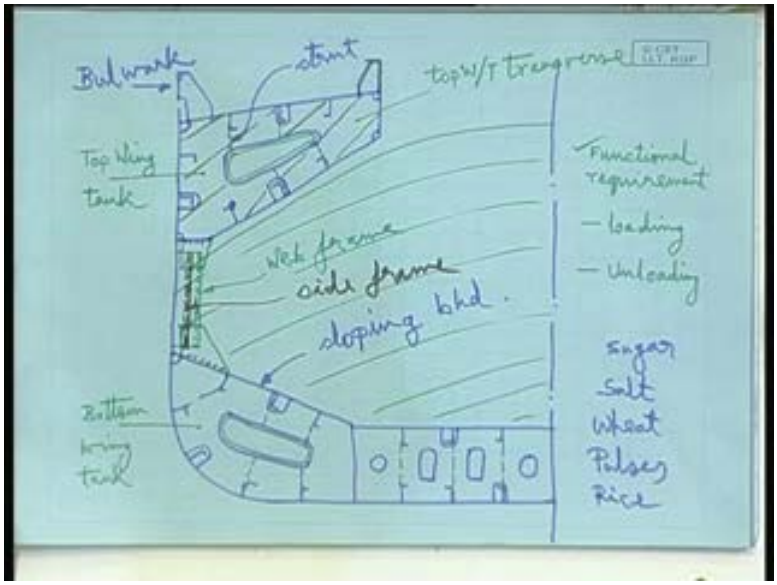

We will havethese transverses they are in one plane, the top wing tank transverse.In the same plane you have a side frame, in the same plane the bottom wing tank transverse, same plane plate floor.

The very next frame because every frame space some stiffening is there very next frame what it will be,there will not be any transverse,there will be a smaller side frame.This black one what I am drawing is the normal side frame.The green one is the web frame that is called web frame.Green one is the web frame means, scantling is little higher whereas,the black one is at the frame space, where it can be referred to as the side frameor side shell frame or hold frame.

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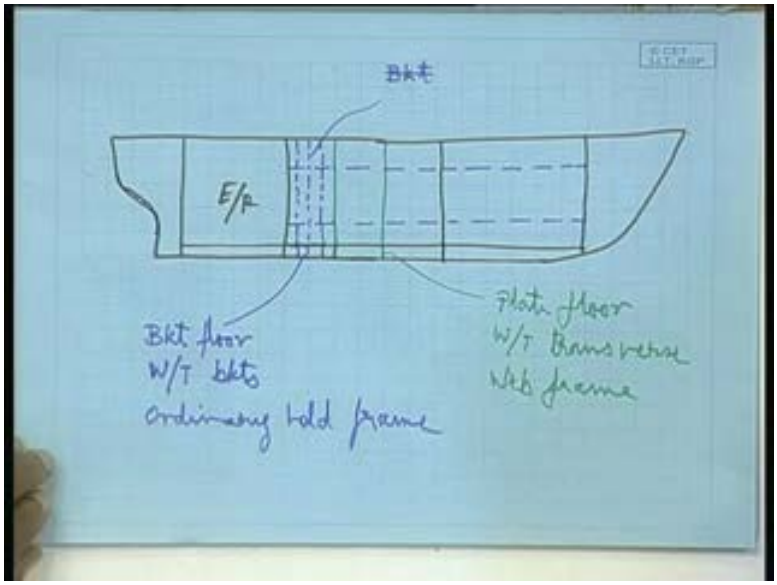

What I am saying is like this.Here, I have a floor all these transverse members, in green I am drawing, this is my plate floor.In the same plane you have the bottom wing tank transverse, in the same plane we have the web frame top wing tank transverse.

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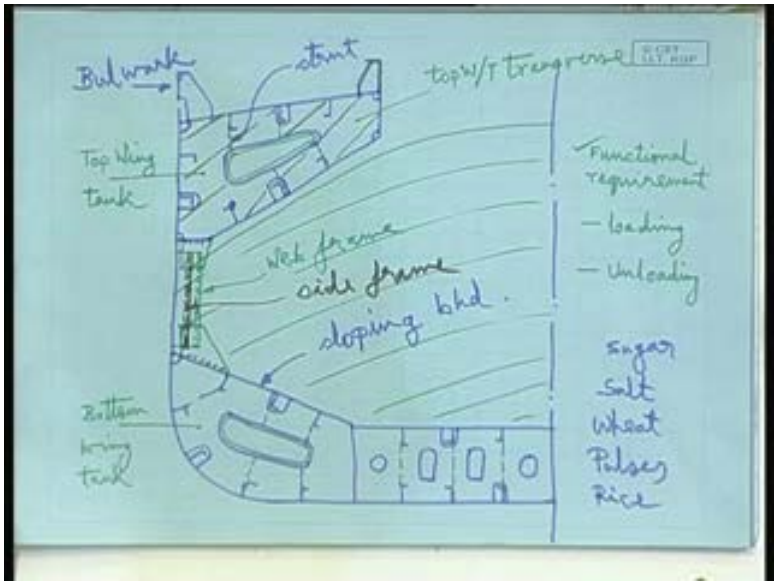

In between what is that?In between they are the bracket floor.Here, there is nothing normal frame again nothing; nothing means, equivalent to that of the bracket floor.In bracket floor what was that?As you can recall that only two brackets at the edges two

plates were there, as if two brackets.Same thing happens here only this much of the plate would be there - this plate - and here this corner plate, this is start I have drawn.

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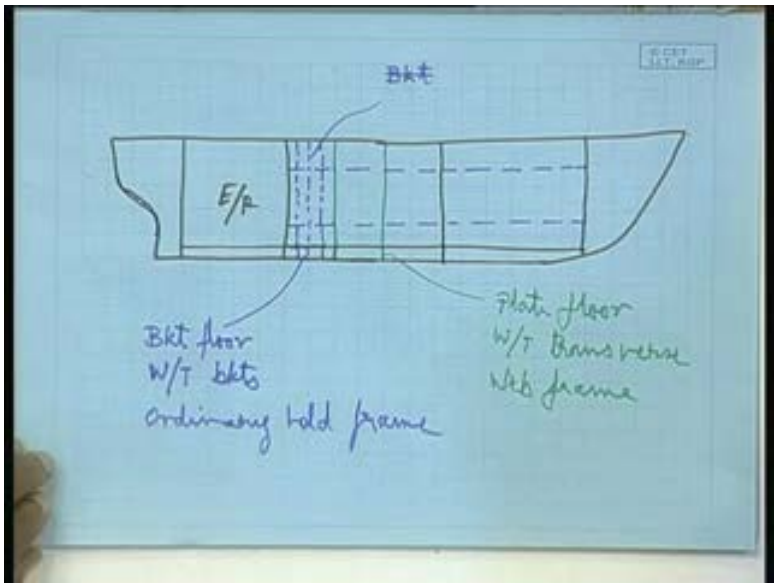

When you have a bracket floor similar arrangement in the wing tanks, the idea isthese areprovided.This is my plate floor, in the same plane you have thewing tank transverseand in the hold you have side shell web frame whereas,in that way you have the bulkhead. At the fourth frame space you have a total ring of plate floor transverse, web frame, transverse,so this green lines are as if forming the ribs at intervals.What interval?3 to 4 frame space to be precise different classification society, they spell out not more than 3 meters, not more than 4meters such thing spacing.What does that mean?That means, any longitudinal member going it is span is not more than that,it is not more than the spacing between two such wings.

Here, this is your bracket floor.Let me write from this side, because then that gives you a similarity.This is my bracket floor then in the wing tank transverse only wing tankbrackets and ordinary hold frame not OA frame. You will have 3 to 4 sets of such bracket floor wing tank brackets ordinary hold frame then, you will have one plate floor water wing tank transverse, web frame,so that is how it goes.

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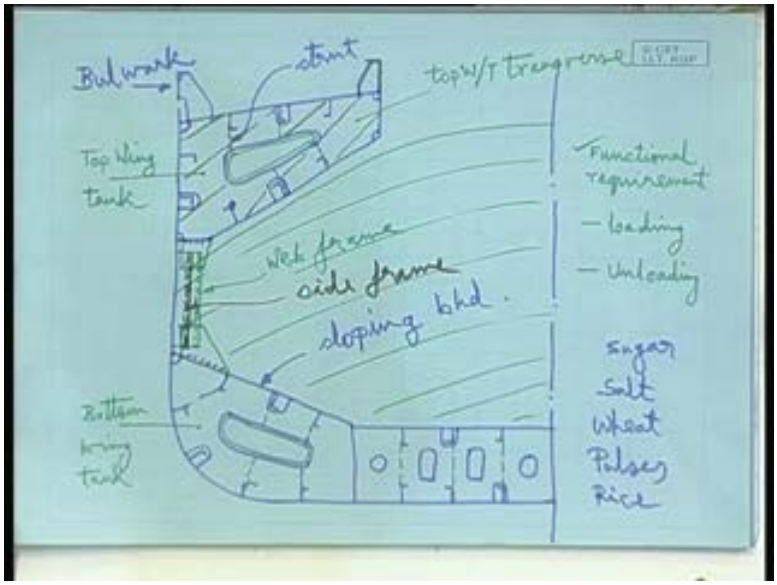

This is what thestructural arrangement - midship section structural arrangement for the bulk carrier. Obviously, on the deck you have hereis what is referred to as a bulwark.Here, you the hatch coaming, this is what is these are all you will have in all vessels.

We see here that in the bulk carrier, because ofdepending on the functional requirement your entire structural arrangement has been changed. Here, we see that we take advantage of longitudinal framing in all the tank head spaces, where there is a possibility of some liquid being carried; not liquid cargo liquid means, some functional liquid fuel oil or ballasting like that. In the side shell part of the hold it is transversely stiffened for the reason again, if I havelongitudinalframing system then that will hamperesort of that would may lead to cargo contamination that will lead to longeryour unloading time, will lead to higher corrosion rate.

Another aspect you can see here that the side shell frame,the connection details are it is connected with a bracket to the sloping wing tank bulkhead.This particular plate may be named as sloping bulkhead. Itis a sloping bulkhead of the bottom wing tank;similarly,this one is the sloping bulkhead of the top wing tank.Here, you can see the sloping bulkhead is coming and having a horizontal plate at the bottom of the top wing tank,but the bottom wing tanksloping bulkhead meets directlyto the shell, it do not put any horizontal plate there.Again for the same reason, if I put a horizontal plate cargo will

remain. These are very simple but detail issues because one will think to replicate whatever is there in the top wing tank and just in the bottom and for your information the most- I mean - all yourbulk carriers used to have like that.

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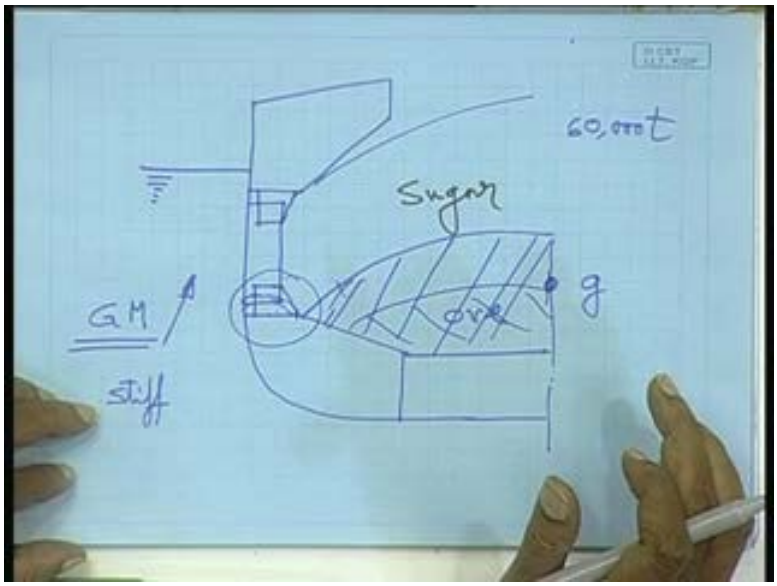

If you have that way then intuitively, because this comes like this; intuitively it is done the same way.Also you find that you are bracketing arrangement etcetera,becomes more convenient as if, is n'it?

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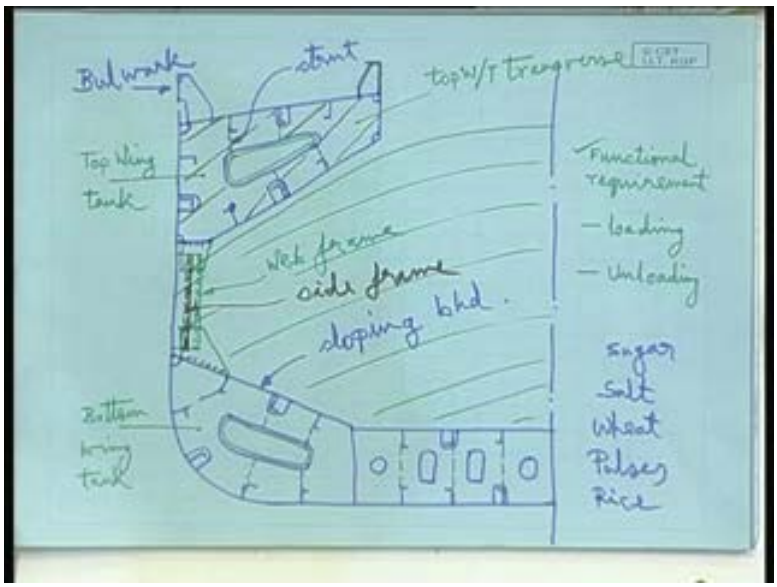

But this space creates a problem, so it is not done like this, instead it goesmid straight such that the slope remains and the bracket is connected.You can see the bracket toe of the bracket lands on a stiffener -on a longitudinal of the sloping bulkhead.We will not terminate it in between, because you terminate in between means what?That place get heavily loaded there is no support below, because this bracket is acting as a increasing the load distribution area.We can have a feeling that this wing tank as if is hanging over this, as if it is a cantilever type of structure hanging over the side shellwhich is stiffened.This entire structure is being supported by a shell structure with vertical stiffeners and this brackets,so that entire load comes and gets distributed over here.

Here also you will have to have the stiffeners,this brackets landing over the stiffener - the toe of the bracket.Well,one of the problem this bulkhead is structure they face after few years of service this region - this bracket at the bottom wing tank it - gets corroded heavily,that is one of the main problems-maintenance problem - of this bulk carrier.Can you tell me why this part corrodes? I mean, not other part there will be corrosion in other parts also but that is much lesser degree.Here,it corrodes so heavily that if proper care is not taken even one may find the total detachment of the bracket have taken place.

Detachment means essentially what is done?That this place is welded -this is welded.So, that entire joint has got detached- I mean - there is a physical gap between the bracket and theslopingbulkhead.

Here, what happens?This part is welded.Though, there is no cargo remaining there but enough dust particles remains stuck there.Compared to this bracketis also welded at the top at the bottom plate of the top wing tank, but that plate does not corrode at all actually does not corrode, but here what happens?Enough of dust particle remains there, enough of salt grains remains there.So, that way this place remains continuously moist and all these dust and salt whatever they hydroscopic in nature. So, continuously moist and that moistureforms a galvanic cell - I mean - that moist dust works asthe electrolyte.

Since, this is welded here all the corrosion prevention mechanism that means, proper painting etcetera is also difficult;difficult means, not up to the mark as compared to other plane area.So, deterioration - I mean - the corrosion sets in much first at this places and the rate of corrosion is also higher.In addition to that you have problem ofwelding since it has been welded you have residual stress.So, the stress level is high that leads to

further rate ofincrease in corrosion rate - all these leads.So, that this is one of the major problems for bulk carriers, this bottom wing tank,this bracket, the bracket detachment takes place, so that is bulk carrier.

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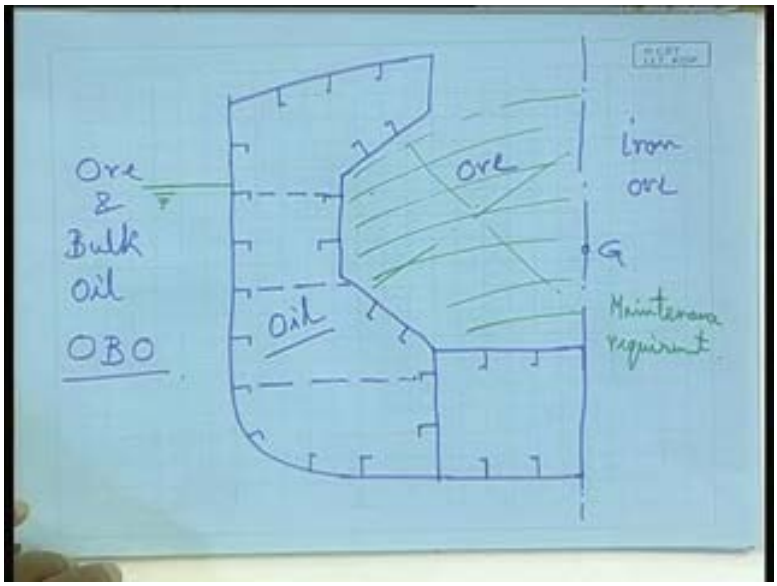

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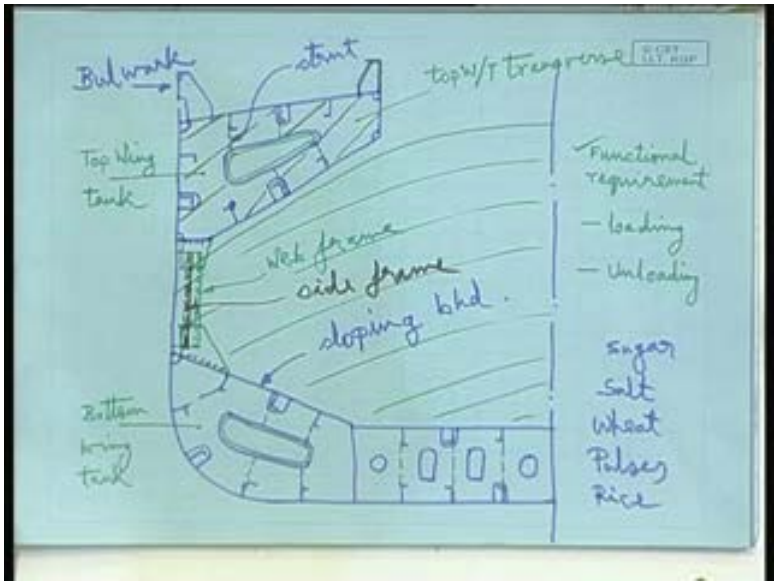

Now, along with bulk carrier we have talked about the OBO carrier;OBO is Ore and Bulk Oil - I mean -that is how it is named.In this particular vessel we had been taking aboutcargos likesugar, salt, pulses, wheat, rice all in bulk - in lose.

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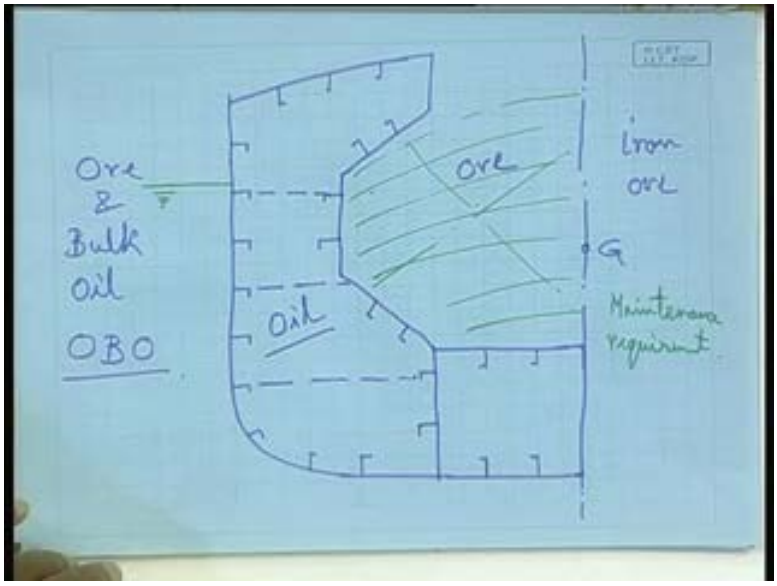

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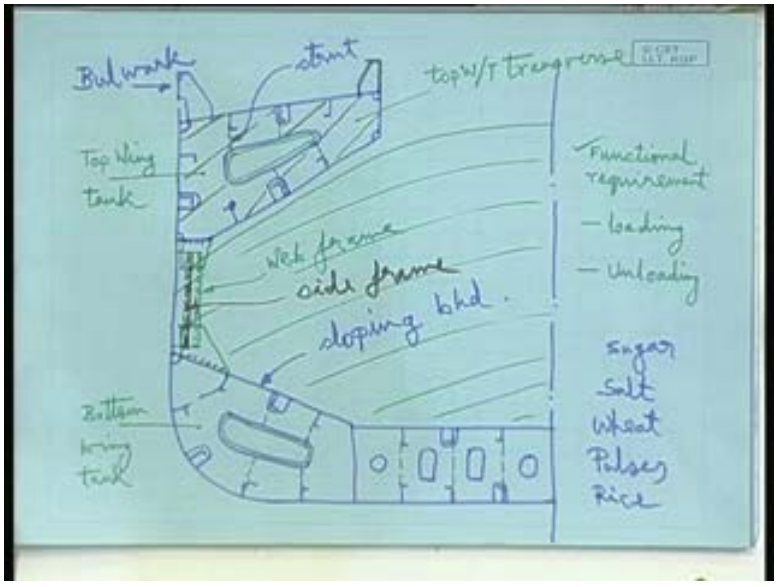

Alsoore is carried in bulk say iron ore and other ores like manganese ore whatever. Can you carry those ore cargo also in this bulk carrier,What do you think?Physically yes, because I can carry.What would be the basic difference?Say, in one voyage I am carrying sugar and in the next voyage suppose I am bringing back iron orein the same vessel, what would be the basic difficulties want me face if any?

First is obviously contamination- the other way - that means, suppose again in the next voyage the cargo pattern is such thatsome country issay,I am importing sugar and

exportingiron ore if that is the trade same vessel I used. When I am bringing back iron ore whether it is mixed with some sugar does not matter but, the reverse it matters heavily it cannot do that is number 1.What is the number 2 - second property?Well, one may say that I will clean it thoroughly, which is again not very wise but,what could be the other problem?

((Student Talks))Why?No,you mean to say in the hold.No, in ore also- I mean - look fromthat perspective the sugar is very fineparticles - seas particle.Well, here these particleswill have much bigger dimension but,overall when I take it is also a fairly good uniformly distributedload I meanthat will not matter much.What you are saying that basically like, one extreme is the liquid cargo is absolutely uniformly distributed load, another extreme could be coal or ore kind of thing, where thechunks are of different size or but overall average it will be fine.

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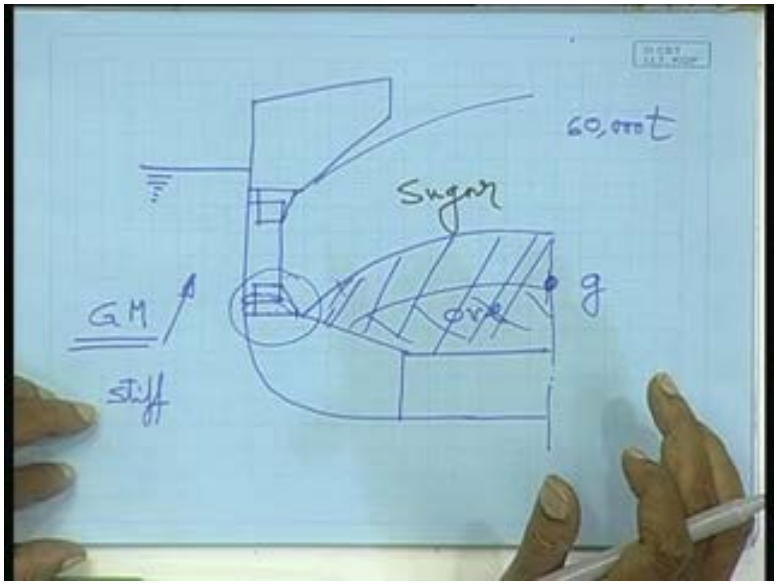

What weight?Does not matter,thing is thatI have my load water line here defined that means, beyond that I cannot load.So, I go on loading and when I find that it has touched the load water line I stop my loading. So, it has taken in suppose, the bulk carrier is designed for carriage of 60000 tons of cargo,when it touches this line means I have achieved those60000 tons.

The difference would be in case of sugar it will get filled up like this.In case of ore, it will get filled up only like this. Thiswould be the probably the ore andif I take sugar well

this is little exaggerated, but stillwhat is the basic difference means, density of the cargo is highly different - substantially different - the order could be 6 or5.

No,that is a different thing -I load in all holes, so there willnot be much problem of shear.Yes,that is coming next,so what is happening?If I put ore then hardly some space it will occupy within the hole,isn' it?At least some space will occupy say, at best it will occupy this muchand so much of space will remain empty. What is the problemthe vessel may face? That again shifting of cargo, when you are planning the cargo may get shifted andthe same problem will be there of listing.

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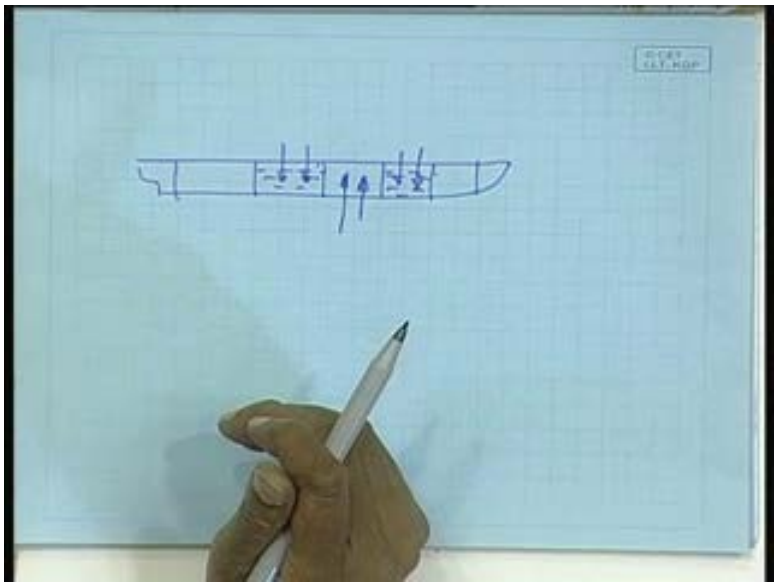

What would be the solution?One solution could bealternate hole.Then, I can fill to a much greater depth, so then that shearing problem will come.If alternate holes are filled up then what is happeningphysically it would look something like this.

That meanshere,I have cargo loaded, empty, againcargo loaded, empty like that. Here, you will be having huge loading and here only the buoyancy force is acting, so there will be shearing problem in between this.So that is also not a good solution,so then what to do?

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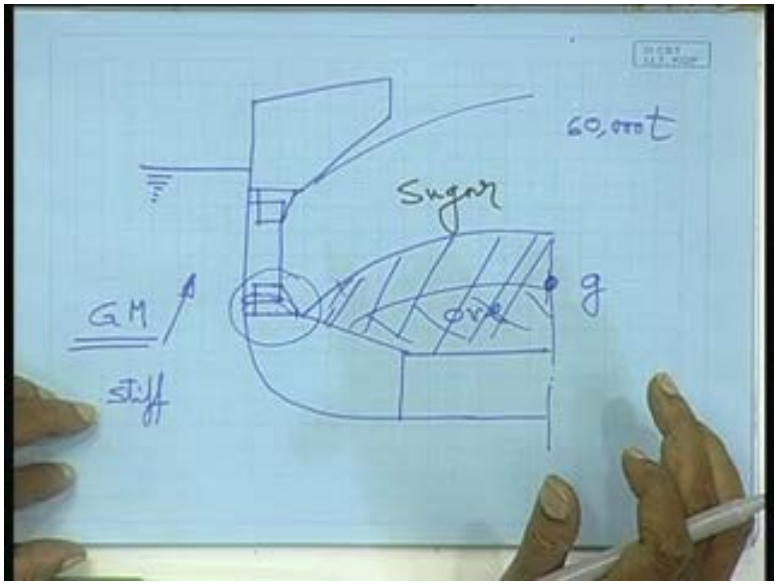

Another aspect what happens because the cargo is very dense, so your c g ports position also comes somewhere here, c g position also goes down.Once your c g is much low and physically location is low that may lead to that value GM high, because your position of the metacenter is depended on the geometry of the outer house.It is irrespective of what cargo or what you are carryingis geometry of the hull. So,M is fixed somewhere,that will lead to a ship which may have a very high frequency of oscillation means, rolling period will be low - it will roll very faster.That is referred to as stiff, the vessel is stiff.Vessel is stiff means your rolling period is low, it oscillates faster, so it becomes uncomfortable for the crew as well as dynamic loading.

The dynamic loading in the structure increases because it is oscillating - is executing - some acceleration in the motion, so forces are generated. It will lead towell,one is physical discomfort for the few then, higher possibility of failure due to fatigueall these things and also higher possibility of whole cargo shifting to one side.

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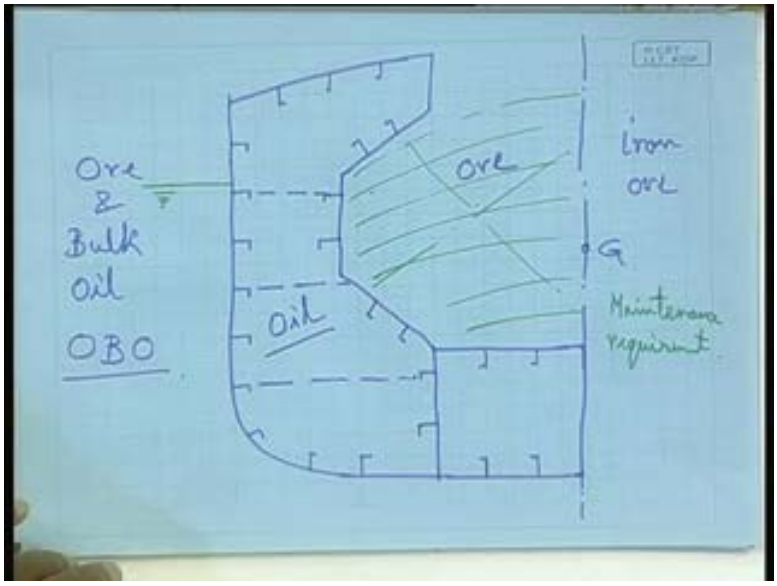

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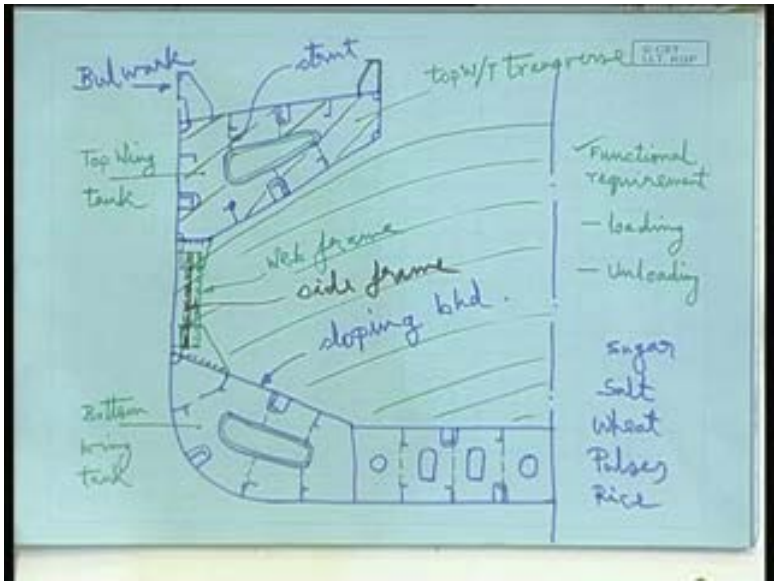

What is the solution?Solution is that you cut it off and make aarrangement something like this means what has been done, if I compare with the bulk carrier the top wing tank and the bottom wing tank well, added a side tank also. Assume, as if there was no side tank as such suppose, I have a bulkhead herethen it becomes a side tank and this volume becomes less.As well as, I raise the double bottom height,increase the double bottom height and add a side tank thereby, I make this space smaller- this is my cargo space.

When iron ore is being carried, I carry only here in a small space and what happens this that way I achieve the necessary draftmeans, it is loaded to thefull draft. Since, it is nicely filled up the cargo space no questing of cargo shifting and those problems are solved. Then, what about the GM?GM is also well taken care of, because I have increased the double bottom height thereby, position of G has gone up; position of G has gone up because I have increased the double bottom height.

The vessel will not bear the same way otherwise, it may have been head.If I would have taken ore or high density cargo, is not the question of only iron ore,it is a low density cargo or high density cargo.If I would have carried a high density cargo in the ordinary bulk carrier, so that is what is done. Now, I have another added advantage is that I have a entire tank head space on the side.

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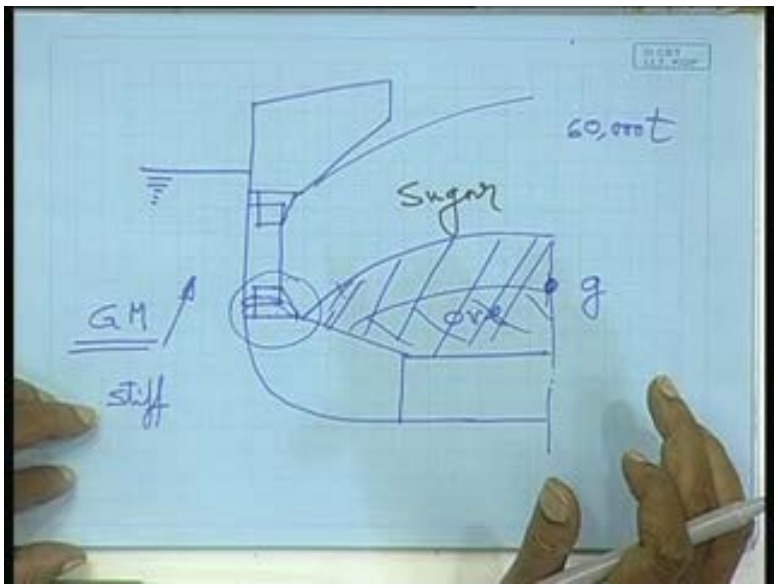

In one voyage I can carry ore, in the return voyage I can carry oil; some kind of oil some kind of liquid.That is the advantage otherwise, it would have been a bulk carrier then if I carry iron ore in the return voyage I will have to carry either coal or equivalent some such product nothing else can be carried not even oilbecause they will contaminate.

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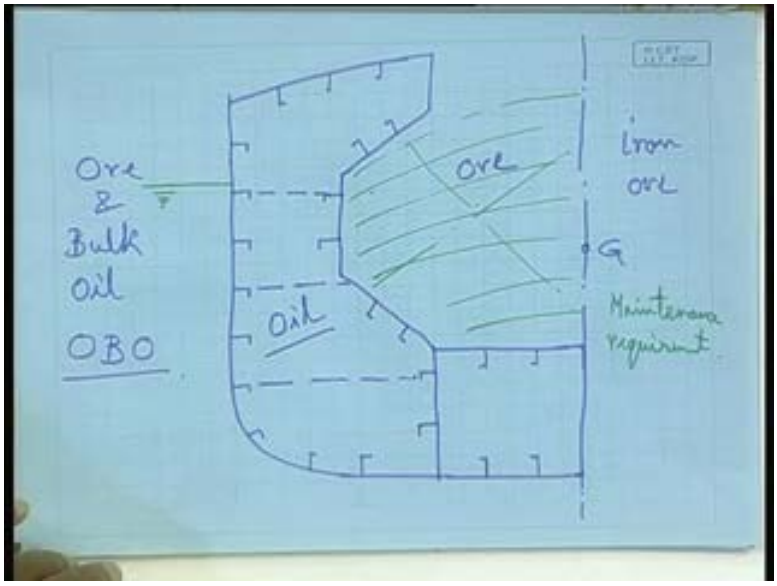

Here, my two dedicated places remains, this place in one voyage I carry ore, return voyage here I carry oil.So, there is sufficient space also thedrop utilization - I mean - that capacity utilization will be fairly good.Well, now the question comes whether really I can use this for what kind of oil? Crude oil probably no, because in the event of accident I do not have any protection.

Now,from the pollution control point of view in oil tanker, also you have to have a double wall - a double bottom- and all the restrictions are there. If I provide a double wall here then again it does not make any sense. So, probably edible oil well in bulk edible oil can be brought because, even if that is leakedcargo lose is there but not pollution.

So, this is one of the waysor well the vessel comes empty at least, you are safe from the problem ofhigh edge GM,safe from the problem of directional stability. This isore and bulk oil carrier which is written as OBO carrier. Also here, you can see I have just shown the framing system since this entire part some form of liquid will be carried, so you have all longitudinal framing system - entirely longitudinal framing system.Obviously, at intervals in the transverse planealso you will have platforms in betweenthat means, horizontal platformswithin the tanks, the reason is simple,if they are not there then can you imagine, how we are going to maintain the entire structure, because maintenance is

required.If anything is happening to this longitudinal or some collisionis taking place some repair, so this will be horizontal platform such that people can walk through this.

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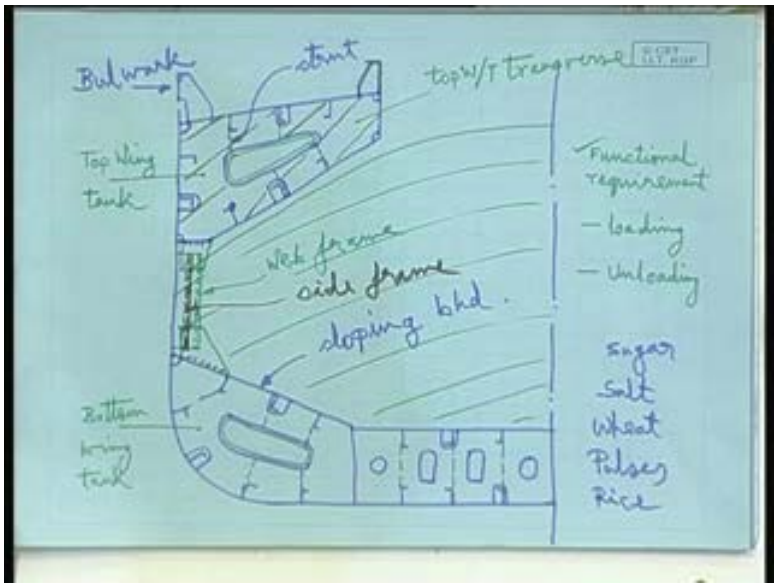

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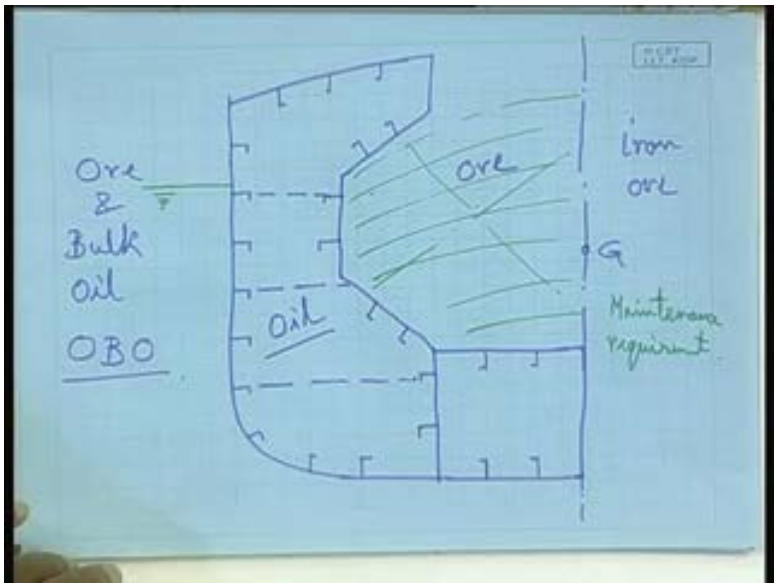

That is how the structure arrangement will be done that means, so what we see that the structural arrangements are done based on functional requirements.Second is first and foremost well structural arrangement is this one on the criteria of strength,also in functional thing.

Here, these we have added from the maintenance point of view- maintenance requirement.As we can see thatif we only care for your,what you calledstrength requirement then you have some problem inloading unloading stage of cargo that means, it is interfering with the functional requirement. If you take care of both then again we see this is one of the casewhere similar thing will see in some other vessels also.From the maintenance point of view again it becomes a huge problem, because if I do not use such horizontal platforms then accessibility is not there at the top part of the structure.

So, these platforms I am providingfor maintenance in view but also they are providing strength, because they will be part of the strength members also.Though functionally as such is not required, but from maintenance point of view again they become useful, so that is what is thebulk carrier.Next class will look into container ships.