Marine Construction & Welding

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Lecture No. # 07

Decks & Shells

We will take up decks and shells, before doing that, once again let us take a look back on the bulkheads, what we did last time.

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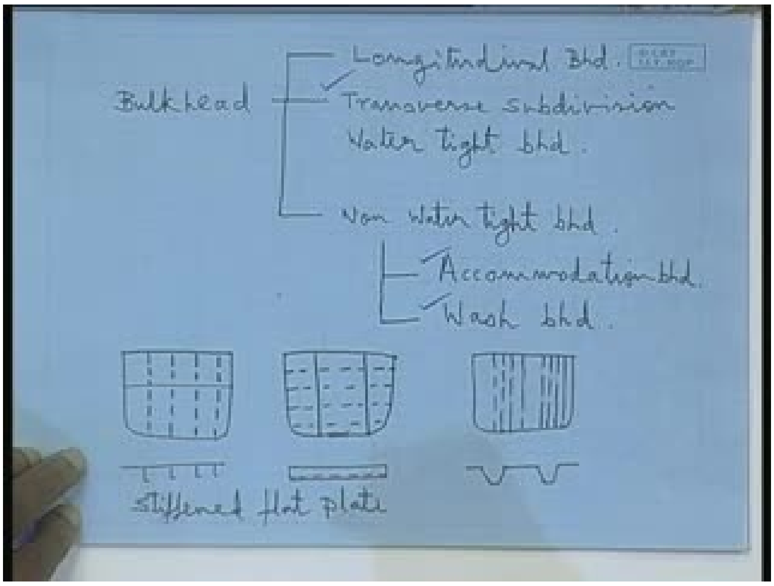

As we have already talked about accommodation bulkhead and wash bulkhead, those are essentially nonvolatile bulkheads, and you have transverse sub division bulkhead or longitudinal bulkhead, they are the water tight bulkheads.

So these bulkheads either are stiffened flat plate bulkheads like this, these are stiffened flat plate bulkheads; that means, the bulkhead cross section is essentially a plate which is having stiffness, either the stiffness are vertical or horizontal, depending on where you get the minimum - I mean - where you can achieve the minimum section modulus for a given situation.

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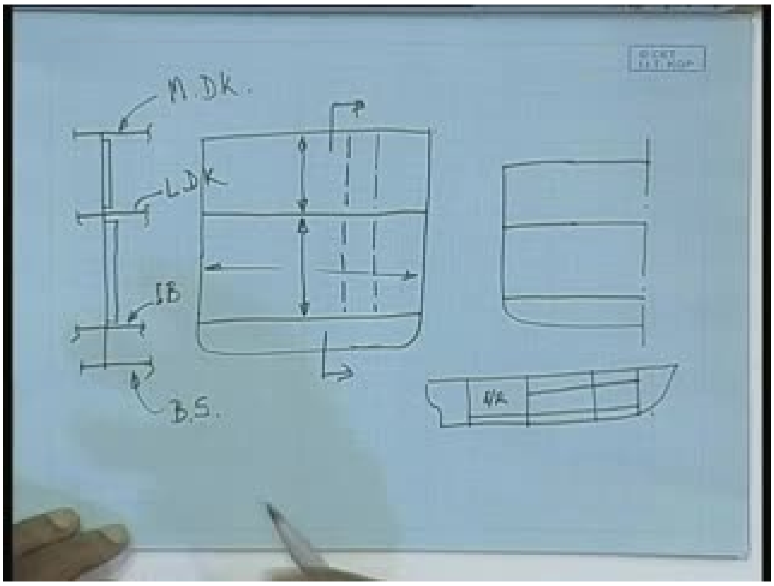

May be we will take a little more look at these two cases of bulkheads where we have either vertical stiffness, suppose, the bulkhead plating is like, if it is a case of a general cargo ship. A general cargo ship section, if you look it is somewhat like this; that means, you have inner bottom plating, double bottom is there, you have a lower deck, and you have a top deck.

This is in way of hatch opening, where the hatch opening is not there, obviously it is a continuous plate, the top deck as well as the lower deck and there by your bulkhead. Suppose, if I see the profile, you have the bulkheads like this, you have your double bottom going like this, then if I assume this to be a engine room, then I have my lower deck running here, so there by the lower deck is coming somewhere here in the bulkhead, the double bottom is coming somewhere here.

What we see here is that this particular span, this length as well as this length they are much smaller compared to these lengths, isn’t it? So, that makes us - I mean from this we get the clue that, in case of a flat plates stiffened bulkhead if it is used for general cargo ship it will have stiffeners in this direction, why? Because in that case, I have spans are less. If I take a section here, the section would be this is my bulkhead plate, well suppose this is the bottom shell, inner bottom shell - this is the lower deck, this is your main deck, this is your lower deck, this is a inner bottom plating, bottom shell.

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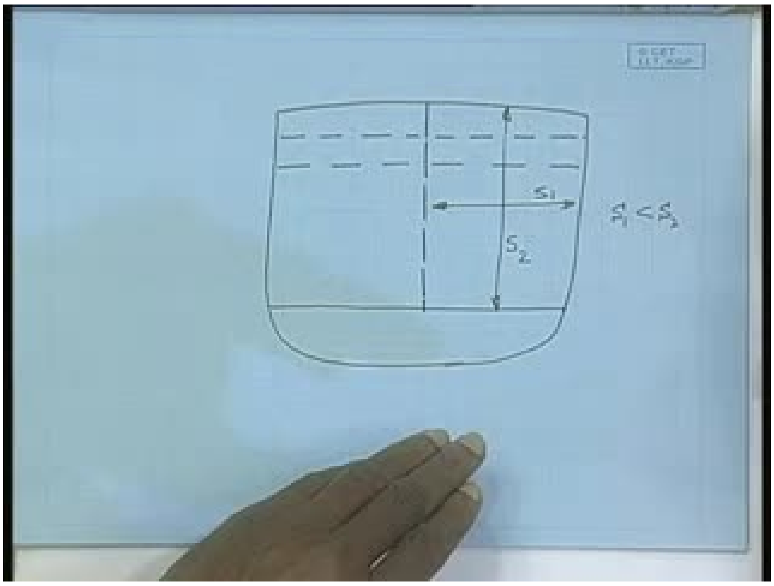

So, the stiffeners are like this (Refer Slide Time: 04:54) that means, the arrangement of the stiffness will be like this, vertical stiffness. Now the same thing in case of - let us take a case of - another vessel say an oil tanker.

An oil tanker is small oil tanker rather by small - I mean - not those very large crude carriers but small oil tanker, an oiler. Oiler is nothing but, a small oil tanker which carries oil for the replenishment. Suppose, you have to make an offshore plat form, you need fuel replenishment or you have those, what you call those big naval vessels which are generally out at the sea. For fueling of those vessels, an oiler will go from the shore, take the necessary oil and it is supplied there; that is also nothing but an oil tanker of smaller capacity smaller size.

There it may not go for a double wall construction, so it can be a single wall construction with necessary double bottom because, today for big oil tankers it is mandatory that you have double wall construction; that means you have the outer shell, you have inner shell.

Any way oiler is like this and well, there you may need a centerline bulkhead. Apart from the transfer bulkheads, you may also have a centerline bulkhead dividing the compartment for some other purpose, some other reason which is called to reduce the effect of free surface. When a liquid is there it generates a free surface, so to reduce the effect of free surface we may need a centerline bulkhead. Once the centerline bulkhead is there so, what is happening? If we again see as well as the stiffener orientations are concerned, now here we do not have any lower deck.

So, this particular span or this height is definitely more than this height isn't it, it will be always more because here you have the support point is the bottom, inner bottom plating and then the top deck whereas, if I take the stiffener in this direction that means, if I stiffened the bulkhead with stiffeners, then stiffeners will run like this. That means here, the support point is the side shell and the centerline bulkhead, so this is less, so this particular span say S 1 and S 2, obviously S 1 is always less than S 2.

In that case, we will prefer to have the stiffeners in horizontal direction. So, stiffeners for oil tanker if it does have what we call a flat plate transfer subdivision bulkhead with stiffeners. Stiffeners will be arranged horizontal fashion, tell me why I will not go for a stiffener having span S 2? May be some one of you can say, here we are saying bending moment will be less, what will be the effect as such as for the structural arrangement is concerned?

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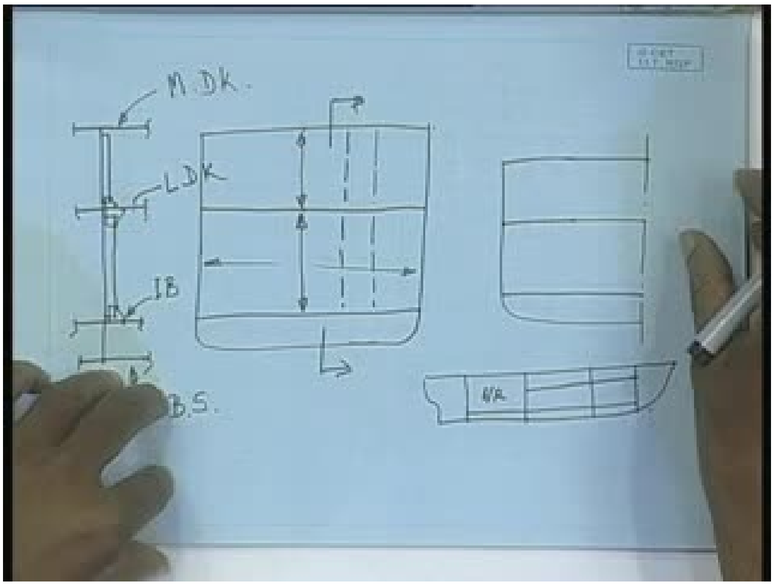

If my span is more, here also we have said that, we go for a span we go for the stiffener arrangement where the span is less. In cargo ship I had supported the main deck, then supported the twin deck as I can see in the section, these are suppose let us assume bracketed and connected. What is happening? That means, span is becoming only this much roughly in bottom plating to the lower deck that is the span. In twin deck area it is from the twin deck lower deck to the main deck, so we are saying that we will prefer stiffeners where the span is less, why?

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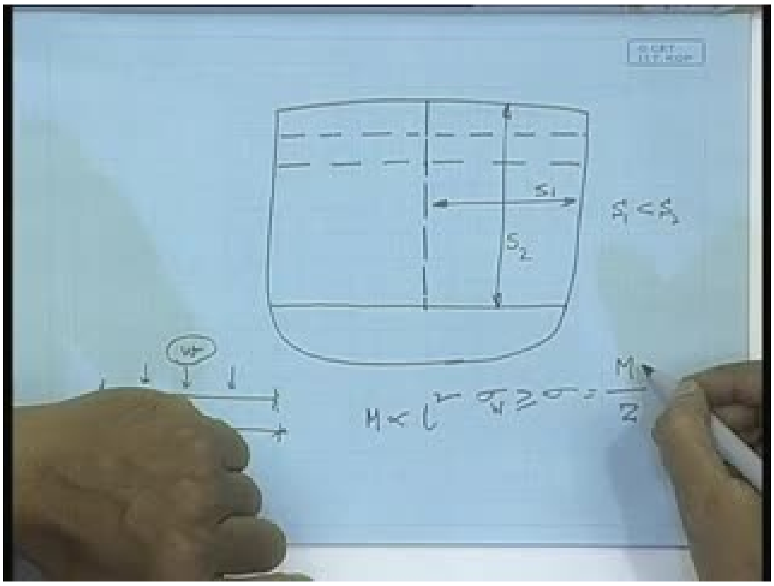

Because you see from this example once again, say a case of a beam ends can be clamped or supported whatever it is acted upon by load. It has a span of l, some load is there so, what happens? Your bending moment for that given load w is proportional to l square isn't it.

As someone of you are saying, that bending moment will be less when the span is less obviously. What is happening? If the span is increasing for the same load, for the same loading condition, the bending moment is increasing the function is square of the span; that means, the increasing trained is much higher for the same given load.

What that will mean? That will mean that you will require a higher section modulus of the stiffeners because, your stress is given by M by Z, Z your section modulus and the stress should be less than equal to your working stress; that means, my stress is what stress level should be there or what stress level is permitted is fixed, that is, the working stress I cannot exceed that.

What will be the w or the loading condition? That is also fixed because, I have to carry that much amount of cargo or the structure will be subjected to that much amount of load, I cannot change that. These two are not as such variables for me they are fixed quantities as if variable is span, if variable is section modulus so I will choose such a variable of span which gives me less section modulus. Here, we can see that if I have the span less that means I arrange the stiffeners such a fashion where in I can achieve lesser span, I achieve lesser bending moment. So thereby, I have lesser section modulus that means weight the structure will be less, cost of the structure will be less somehow.

So that is how this stiffeners are arranged that means oil tanker generally will have horizontal stiffeners for the bulkhead whereas, in general cargo ship we will have vertical stiffeners.

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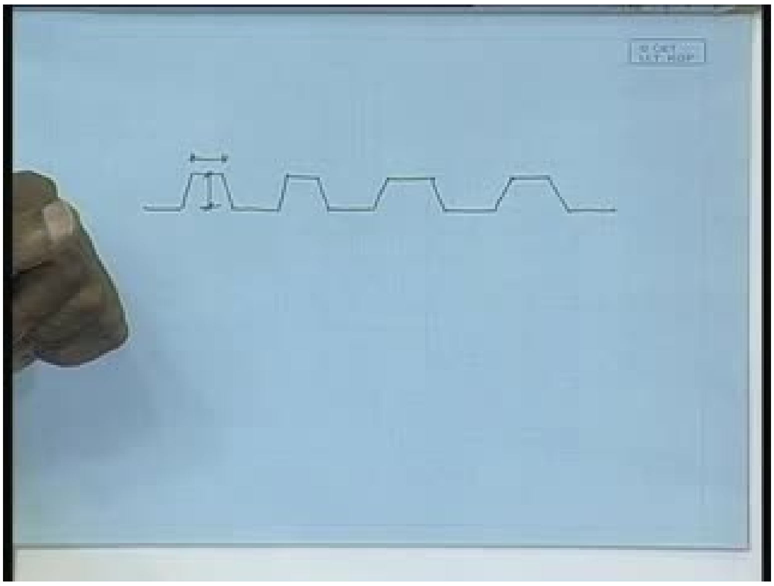

So, these are flat plate stiffened bulkhead, same thing can be achieved by way of corrugating the plates; that means, we just provide corrugations in the plate and instead of providing a welding any stiffener to it, the flat plate is corrugated.

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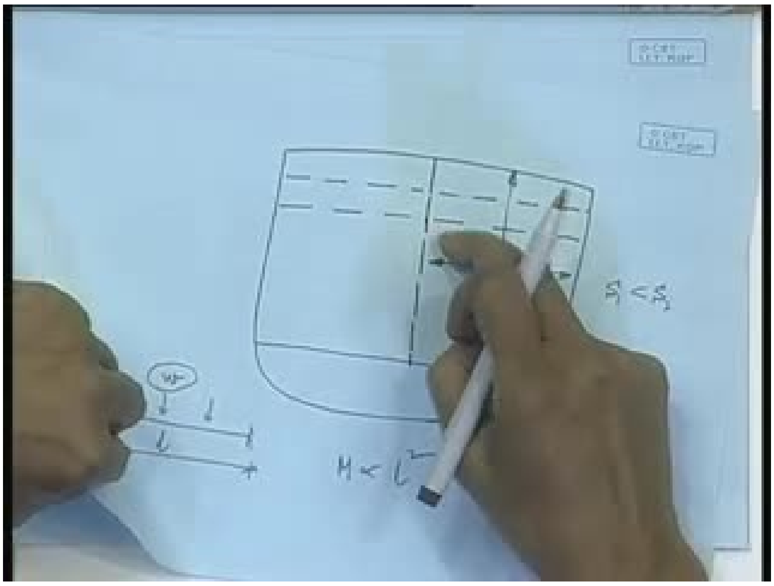

So, what is done here is basically, the parameters are how much is this length, what is the depth, this determines the section modulus requirement like in case of flat plate stiffened bulkhead. We calculated the plate thicknesses as well as the stiffener section modulus.

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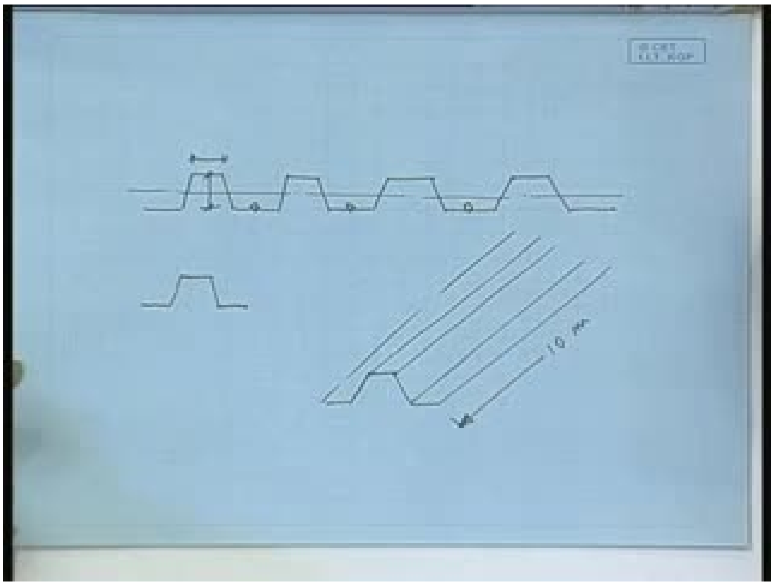

Here, we will calculate the section modulus of this arrangement; it is referred to as corrugated bulkhead. The advantage here is, fabrication wise it is easier because if we have the necessary hydraulic phases wherein, these corrugations can be developed; that means, from one single plate say each single plate gives me this corrugation.

Essentially, it is somewhat say like this; that means, along the length, the plate has been corrugated. We have said that plate length is around 10 meters standard length, so this is in fact 10 meters. This dimension is walked out from the available width of the plate that is 2 meter or 2.5 or 3 from that we will have to walk out this thing.

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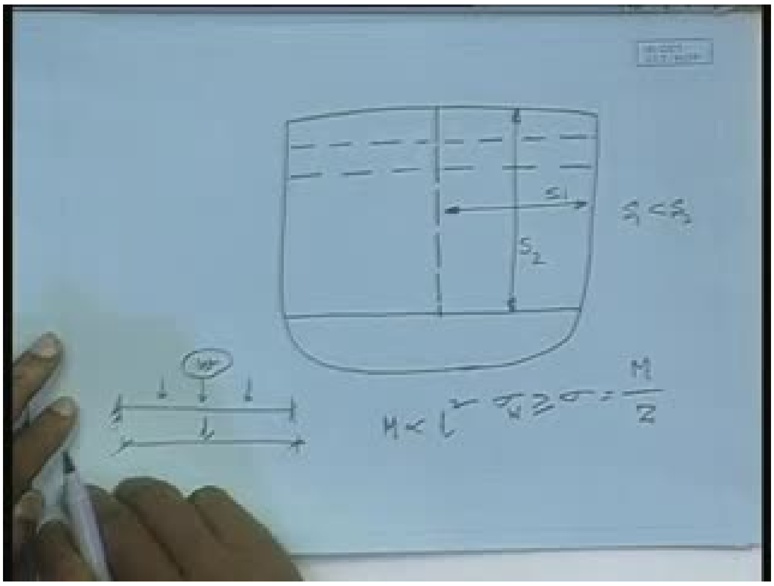

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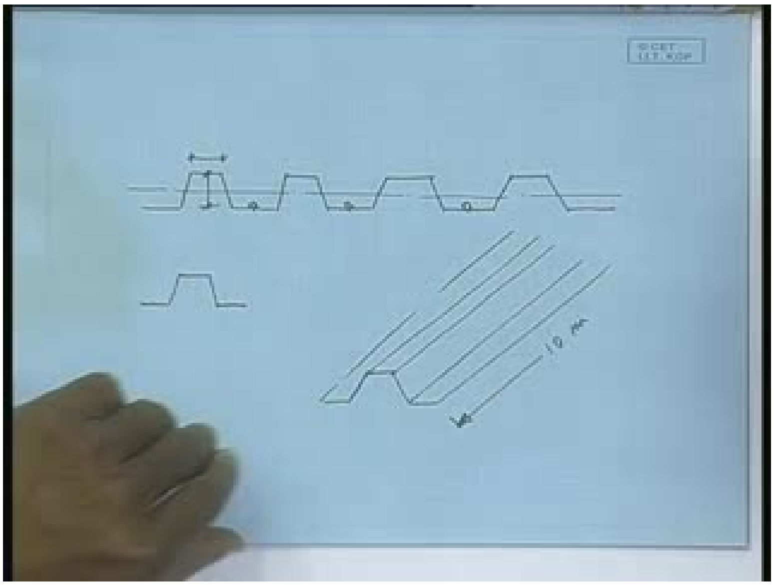

So, each plate will give one such corrugation suppose, then you put them one after another and they are welded; one long welding, you get the whole bulkhead manufacture where as in stiffened bulkheads, you will have to weld so many stiffeners. So, thereby it is easy to manufacture, provided you have facility to give this corrugations; that means, required hydraulic press, required die all those are need.

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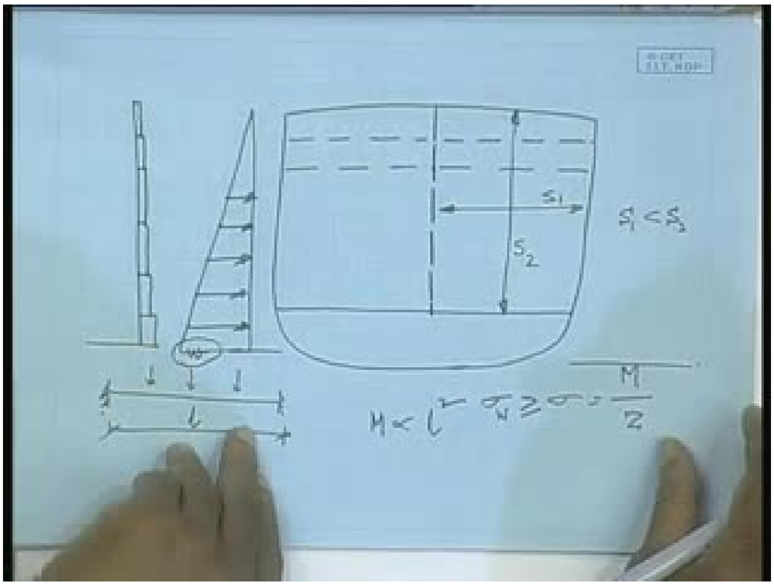

So, that is what is the corrugated bulkhead, these are generally used in bulk carries. In bulk carrier, the transverse water tight bulkheads are generally corrugated bulkheads if in oil tanker we have corrugated bulkhead. Another aspect here, for transverse water tight bulkheads the plate thickness as we go up from the bottom to the top.

Obviously, it will go on reducing; that means, if I see the plate thickness in a little exaggerated fashion, you would see somewhat like this; that means, gradually as the plate thickness is going down, obviously because the hydro static loading; the bulkheads are subjected to what? Hydrostatic loading, when? It is always only in the event of failure.

In the event of sort of any damage to any compartment, there is water ingress then only the bulkhead is subjected to a hydro static loading. The hydro static loading I mean would be somewhat like this (Refer Slide Time: 16:30) obviously, not too fully to the top of the water line only wherever the vessel is floating up to the water line we will have the hydrostatic loading. As you can see that loading will be obviously as I go up will be less, so I can afford to have plate thicknesses gradually going down.

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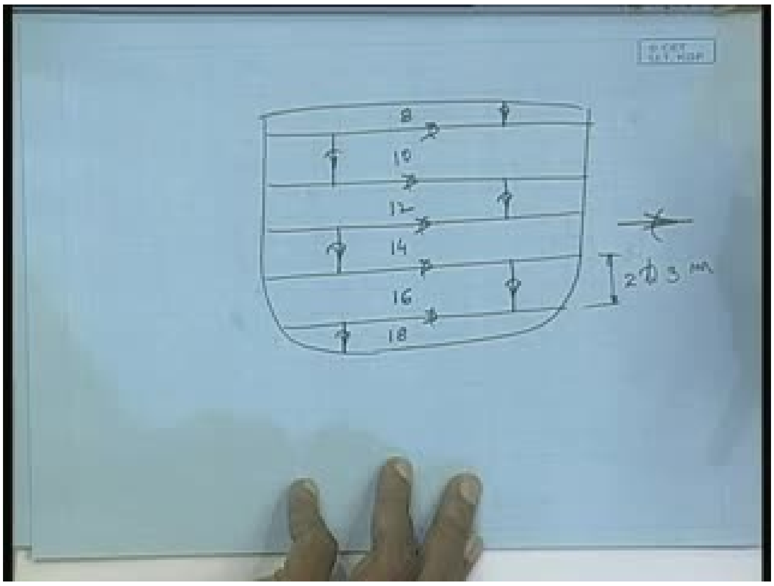

That means, the plate arrangement if you see in case stiffened bulkhead, in the flat plate bulkheads, the plate arrangements could be let us assume this is the horizontal streaks or plates. These are buntlines, this symbol indicates that it is a buntline - a welding line two plates have been welded along this line.

So, these are the symbol means, these are the various plates depending on the breadth. If breadth is more than, say, 10 meters then obviously, you need additional plates. Here it is nothing but the welding lines are staggered; that means, this one piece is around 10 meter, this is additional say 2 meter or 4 meter, whatever depending on the breadth of the ship.

So here, what we have seen is that suppose the bottom most plate is say 18 millimeter thick, then maybe you can provide 16, 14, 12 and so on, not necessarily it has to be in this fashion. What I want to say is, I have shown some arbitrary thickness but the thickness gradually is going down as you go up.

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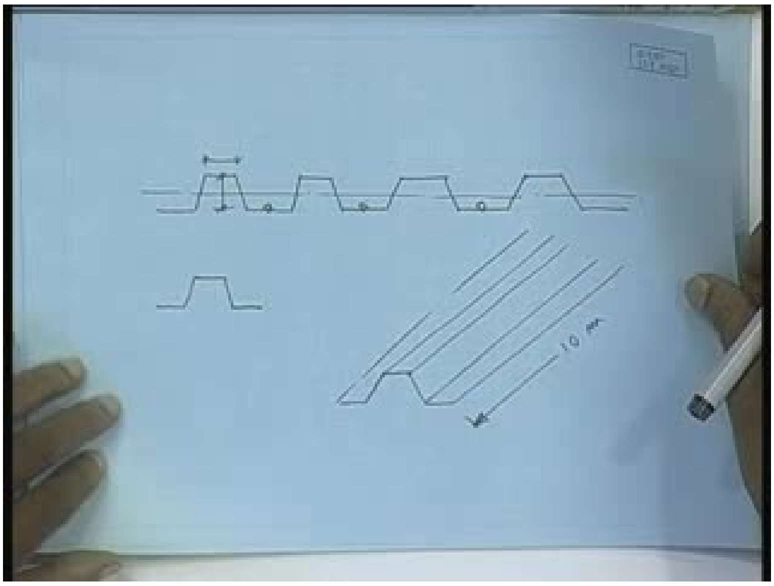

Every 2 meter I am reducing the thickness, because taking advantage of since the plates are being provided put in the horizontal fashions, so this breadth will be of the order of 2 to 3 meter. This is the breadth of a standard size of plates, so every 2 to 3 meter I can reduce the thickness thereby I reduce my weight, whereas in case of a corrugated bulkhead that facility is not there that advantage is not there because the corrugations are put vertically.

If they are put vertically means, for the full 10 meter I have only one thickness, I cannot change the thickness. So, thereby, corrugated bulkhead the advantage is from the fabrication point of view, if we have the facility of bending it, giving the corrugations but it is rather way little heavier structure compared to the flat plate bulkheads.

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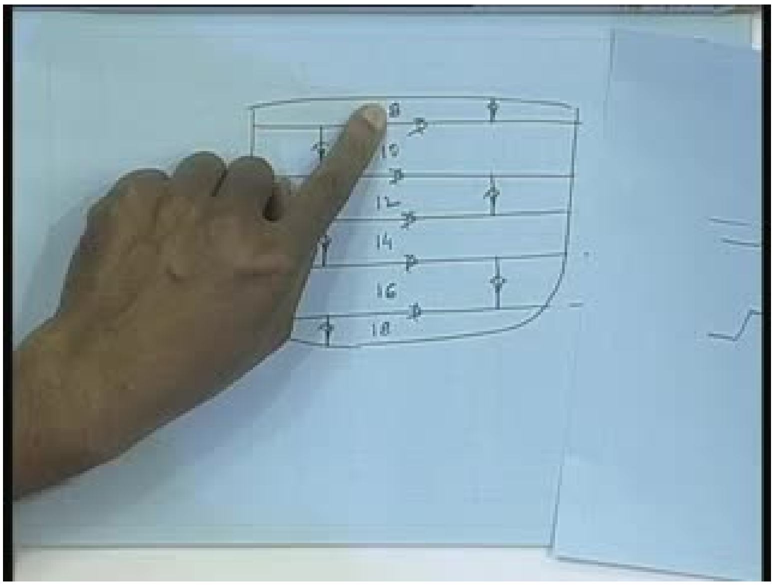

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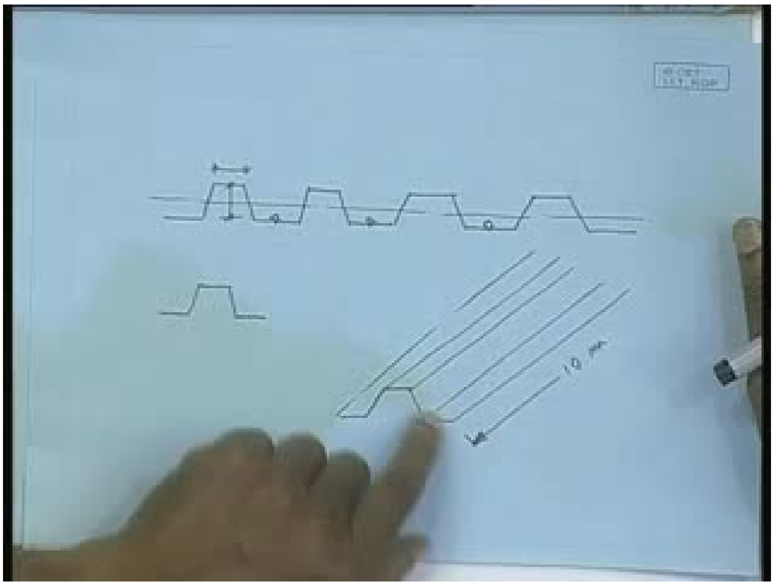

Because there I can have the advantage of reducing the plate thickness but here in corrugated bulkhead like cannot. So, they are the small; so called advantage, disadvantages aspects and as far usage is concerned generally, they are used in the bulk carriers, oil tankers, these corrugate bulk areas.

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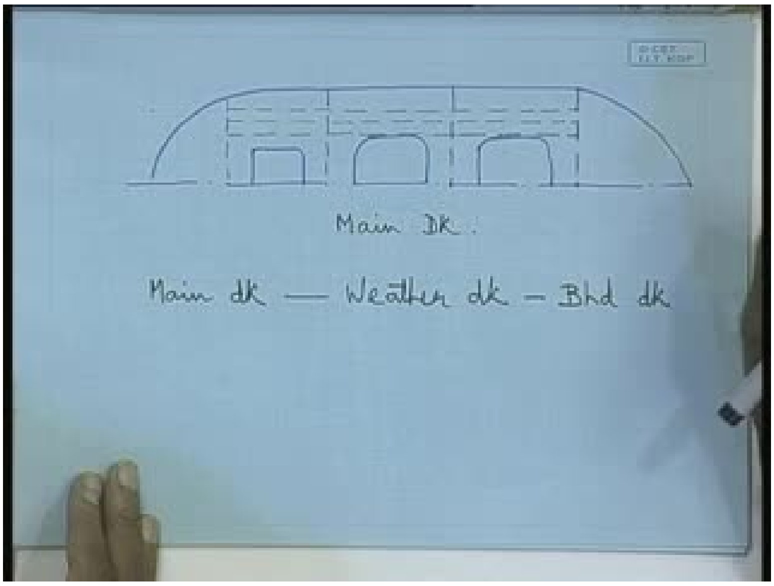

Now, let us come to the decks and shells; by deck and shells what you meant is this is a half breadth plan of, say, a main deck of any ship. The way I have drawn it appears that it would be either a bulk carrier, deck of a bulk carrier or deck of a general cargo ship, because I have a fairly smaller hatch openings.

Fairly smaller hatch openings, there is even smaller opening for the engine room and so what we see is that these decks. Before going in further detail, let us see how many types of decks are there generally in a vessel. What are the decks which you may encounter? One could be referred to as main deck; that means, which one is main deck? How to define a main deck? The outer most deck, so there is another term which comes is called weather deck.

So, main deck can be a weather deck also, means the deck which is exposed to weather. Then, another term comes which is referred to as bulkhead deck, bulkhead in short written by BHD. Bulkhead deck is the deck to which the transverse vertex bulkhead is attached.

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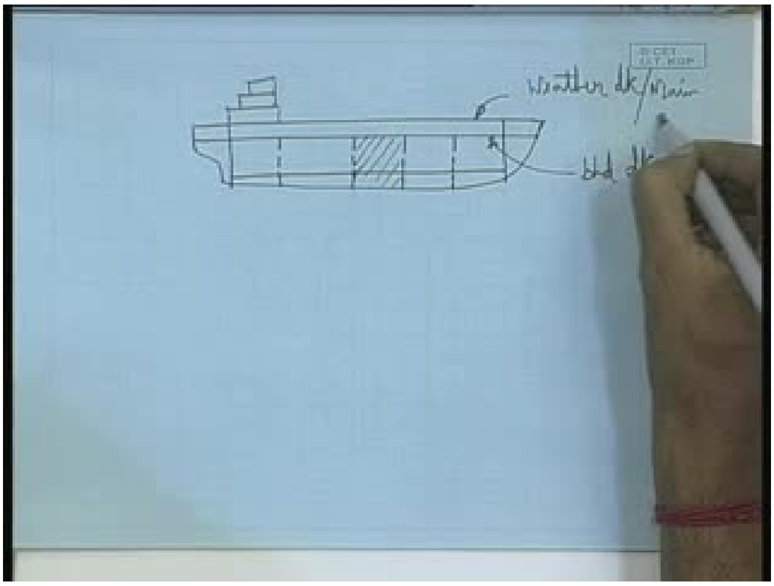

Suppose, there is a situation of a vessel, for some reason it is like this, it has two continuous decks r and my bulkheads and let us assume that these are two big bulkheads between which I have my double bottom and the other subdivision bulkheads are like this, these are my subdivision bulkheads.

Below the subdivision bulkhead, you have the water tight floors. Now, this deck and let us assume that I have my super structure here and so on. In this case, this deck becomes your weather deck, because that is exposed to weather and that deck below is deck not exposed to weather, but my bulkheads are only extended up to the deck which is below the weather deck, so this then becomes my bulkhead deck.

All the floating calculations everything will be done based on this bulkhead deck because in the event of floating, in the event of any damage a compartment getting floating, the floating will remain confined up to the bulkhead deck naturally because to that deck the bulkheads are extended. So, that is how this main deck weather deck, bulkhead deck. So here, this weather deck will be referred to as a main deck because, main deck is nothing but the deck which you are mainly using; mainly using means, which is exposed. So, these are some of the terminologies but, there are the just certain differences in worst majority, these three will be the one at the same.

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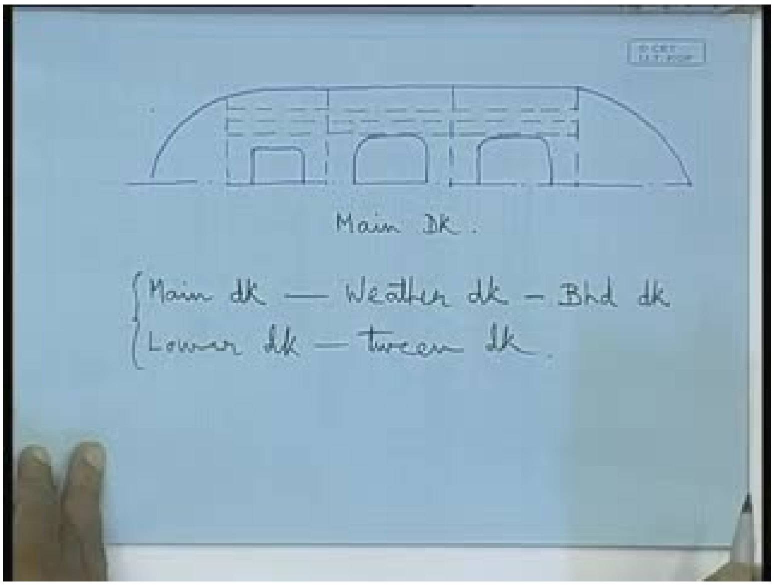

That means, for all practical purposes unless, some very specific requirement is there; all vessels will have a main deck which is a weather deck, which is a bulkhead deck. Then, you have lower deck or also referred to as twin deck. Twin deck is a specific case of lower deck or second twin deck, first twin deck also one can say. When there is a multi decker ship, they will be several lower decks. If it is a general cargo ship, it generally has only one lower deck that is weather deck or the main deck, lower deck. In a Ro-Ro vessel where you have those automobiles coming in, it will have a multi deck vessel, because you need places for stacking the cars. So, several lower decks, if it is a bulk carrier there is no lower deck, oil tanker no lower deck, so that is what is the lower deck.

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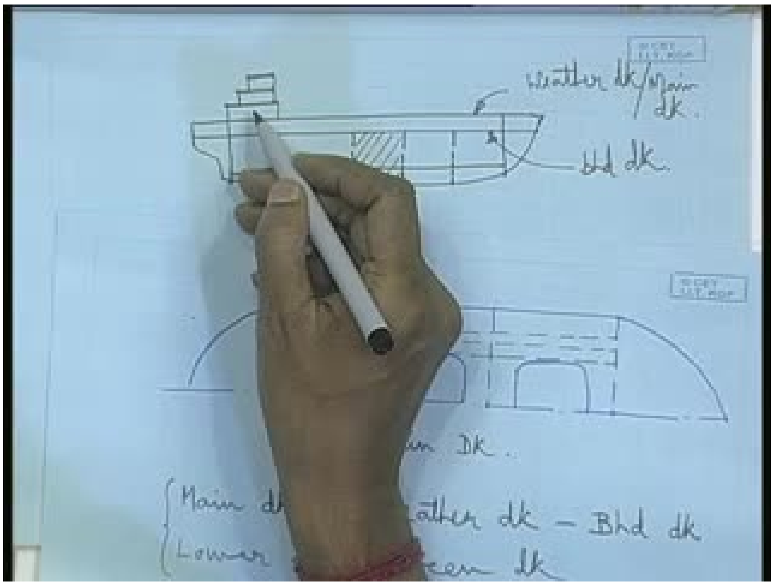

These decks whether it is a main deck, lower deck, weather deck, bulkhead deck all these and of course, there is another kind of decks one can say in the accommodation structure in the so called super structure, where you have the accommodation region. So, those decks are also referred to as accommodation decks, these decks are also deck, accommodation deck.

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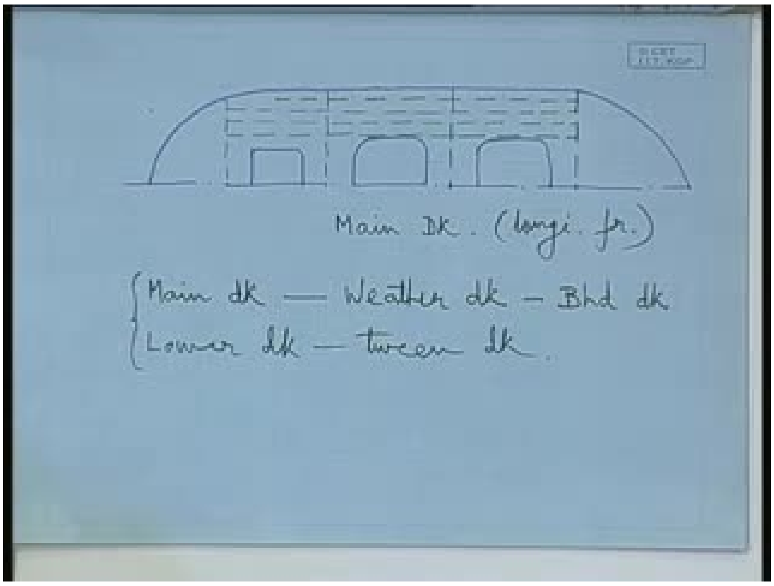

We will be primarily, this decks which contributes towards the strength. The accommodation deck which is there in the super structure, they are not contributing towards the overall strength of the ship, but these decks we are talking about the lower deck, main deck, these are contributing towards the strength of the ship because they are continuous over the full length. They are discontinuities in between but, otherwise it is continuous about the full length. Since they are continuous, they need to be properly strengthened because it is two way thing; in one sense, we say that the deck will provides strength to the ship structure.

For a ship structure, for hull girder the entire hull is there, which all structural items will provide strength towards its against longitudinal bending because, we have seen the hull girder is subjected to one of the most severe loading condition is longitudinal bending. When it is supported on the web traced and all that, so what are the members which contribute towards that strength? The members which are continuous in the longitudinal direction which are they weld the main deck is one member, the side shelves, the bottom shelves, shell inner bottom plating and all the longitudinal stiffeners, all the members which are running longitudinally; so they are contributing towards longitudinal strength.

So, a deck will be able to provide, it has its own strength; that means, it should be suitably stiffened. Now there is a other aspect also which members are providing strength? Like suppose, in this case, this is a main deck which is longitudinally framed, this particular sketch which we see, this is a just plain view of a main deck which is longitudinally stiffened. What do I mean by longitudinally stiffened? That means, it has primary stiffening members or longitudinal. That means deck as longitudinal stiffener, this black lines are longitudinal stiffeners, this green line is the hatch side girder.

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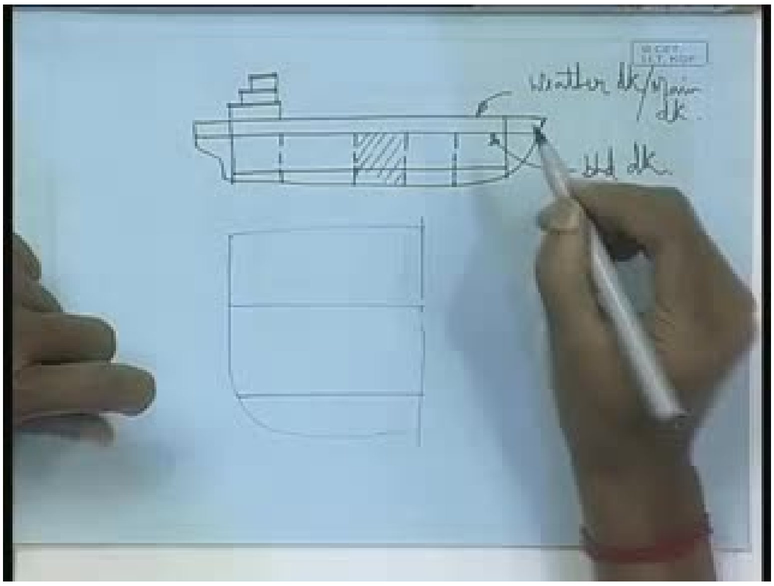

Then we have talked about some more additional members because as you can see, if I have only longitudinal deck is suitably then longitudinally stiffened but, the span is becoming very high from one bulkhead to another bulkhead. So from one bulkhead to another bulkhead, it could be 20 meters 30 meters I mean depending on the vessel size. If that huge span it becomes, then you can again well imagine what would be the scantling of each longitudinal? If the span is very high, your scantling needle will be very high; if the scantling is very high then, what happens?

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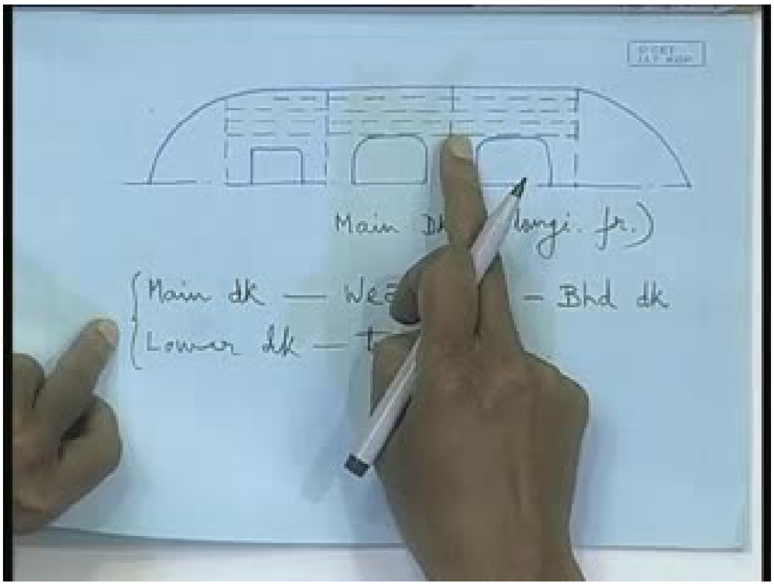

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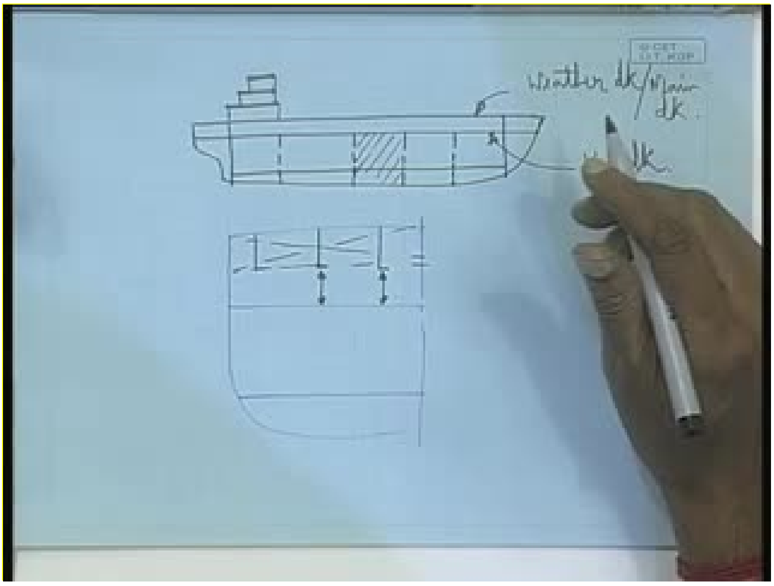

If I see a section, suppose you have the deck like this (Refer Slide Time: 29:59), say again a general cargo carrier, you have a main deck a lower deck. So, if I have such huge span from bulkhead to bulkhead, then that longitudinal may look like this. What I am trying to show here is then, wherever the longitudinal are there, you will have a clear height of this much, so you are losing virtually this space from views edges, isn't it, so that will not be a very good design.

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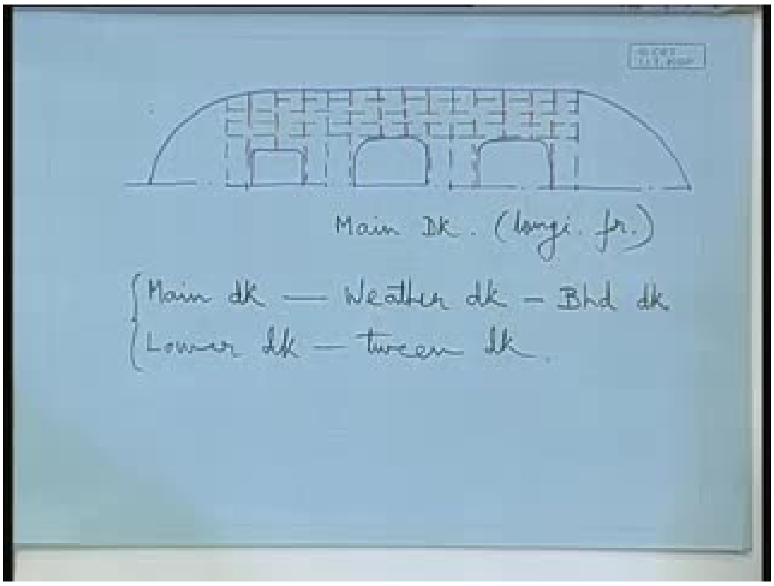

How to handle that? That means, if we can provide some supports in between, automatic supports are also there, we have the hatch end beams we have talked about it. Automatically it is becoming less then also between the two hatch end beams, this hatch opening can be quite big. So, depending on the requirement, we provide more intermediate transverses, this is red ones are called transverses. They are supporting the longitudinal we have talked about this, isn't it? We have shown how intersected that means the longitudinal are supported by this transverses.

So, that is how the structural arrangement looks - I mean - it looks like that it will have transverses, it will have longitudinal, in case of a longitudinal framing system it looks like this (Refer Slide Time: 31:46). Now the question comes, what about these zones in between the hatch openings? So, whether we should have the longitudinal running like that, because within the hatch openings they have to be cut, it cannot be continues, so weather it is worthwhile to have the longitudinal like this, how that should be?

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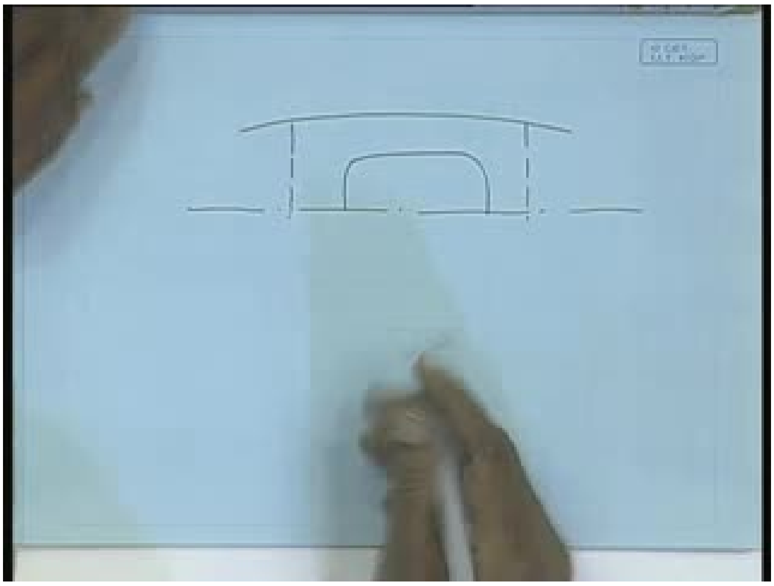

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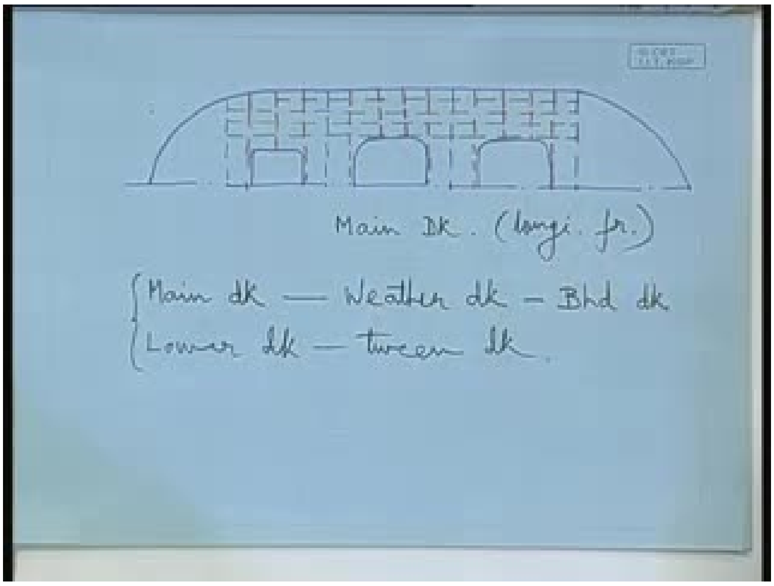

Let us draw this for sake of comparison and see what it means. Let us draw only that part, where this is occurring that means only a part of the portion of the deck.

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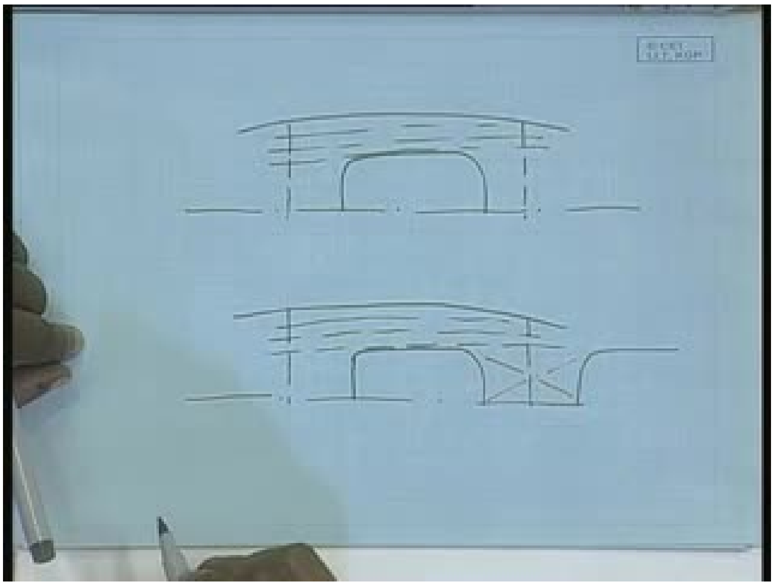

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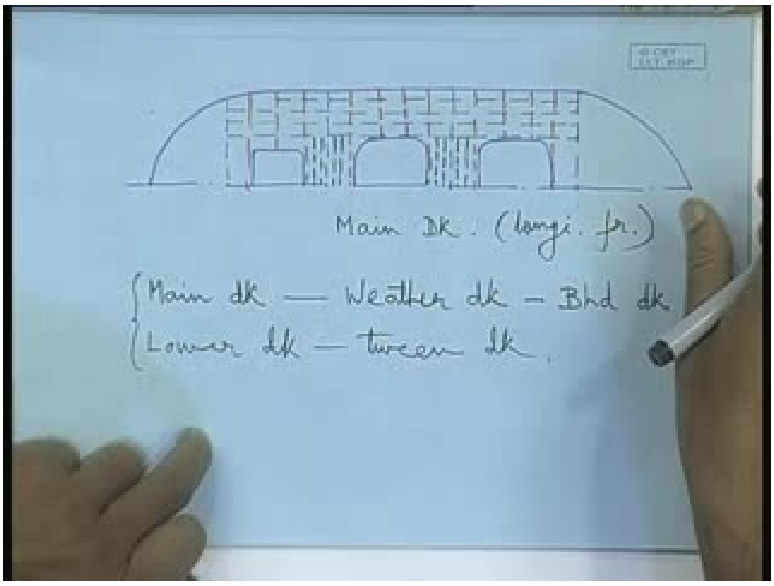

So here, you have the bulkhead, now the shell running the bulkhead and you have here hatch opening. We have seen that it is longitudinally stiffened, so stiffness is running like this. Now, what is happening to this place, because another hatch opening is coming right here, so what will happen to this place? How you think the stiffening should be done for this place, why? In real sense, actually since I mean from the common logic otherwise I would not have ask. Common logic says that it will not be longitudinal, it should be transverses, otherwise, I did not ask because, they are generally interpolation would have been that longitudinal, here you have cut it down.

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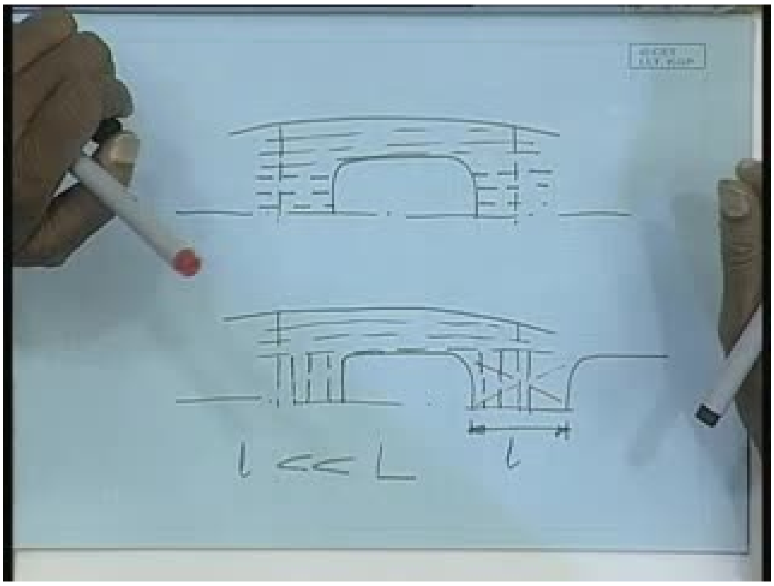

In actual practice the framing would be like this, the stiffening. There will be port like this, now why? Why not that here also it could have been like this? That means, the longitudinal outside the line of opening are continuous, inside the line opening they are terminated; could have been but, it is not done that way instead there sort of put in the transverse direction. The reason is this particular length; that means, opening from one hatch opening to the other hatch opening, this small length is much less compared to the full length of the ship.

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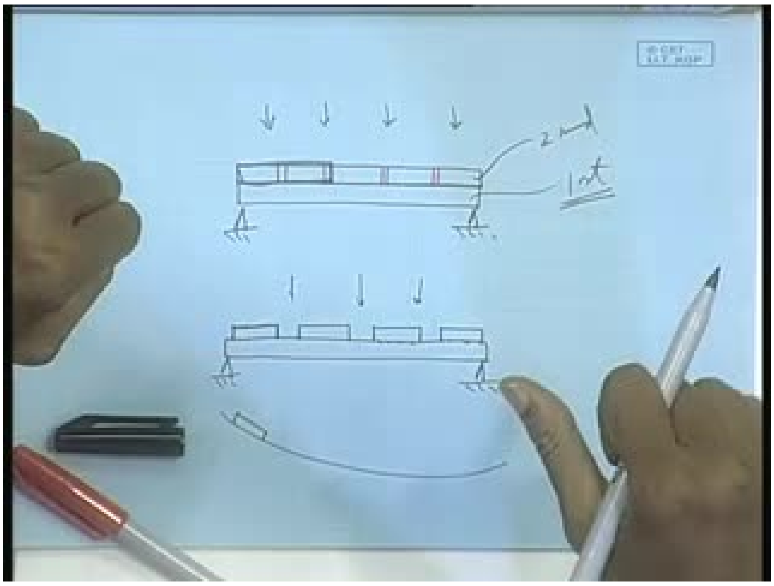

Now, let us look into aspect like this, suppose, you have a beam, say a beam simply supported in and is acted upon by load, I am purposely drawing the load on much above. So, what will happen you will try to bend? If I put another beam on top of it and rigidly get them connected, welded so, what has happened? Secondly, the section model has increased under the same loading, the depletion will be less, and stresses will be less.

Now, I do one thing that this top beam I cut it off, this red marks are that I make small gaps or in other words, you have the beam as it weld originally and over that you connect small pieces of beams. Suppose, a situation like this, these are thoroughly connected, will it give the same strength as that of a continuous beam? Definitely not, it will not give; what will happen is when you apply that the forces these small additional beams will take the bent ship like that means when the beam will bend, it will bend along with it.

When I am providing over the beam, another beam of the continuous same length, I weld it perfectly what is happening?

That second beam is opposing the bending or opposing the action of the forces; that means it is providing strength to the primary beam number 1, the first beam. But, now instead of that if I put small elements weld it and try to apply the same force, I will find that there is a marginal increase in the strength of the first beam. Marginal increase, why? Because, I will see if I observe I will see that whatever small pieces have been welded they have taken the bent ship, they have bent - I mean - instead of opposing the process of bending they have actually aligned itself with that bent ship. Now, you go on increasing the length of this cut pieces, first I put only this small I make it double, triple, at one point, I will see it is gaining strength.

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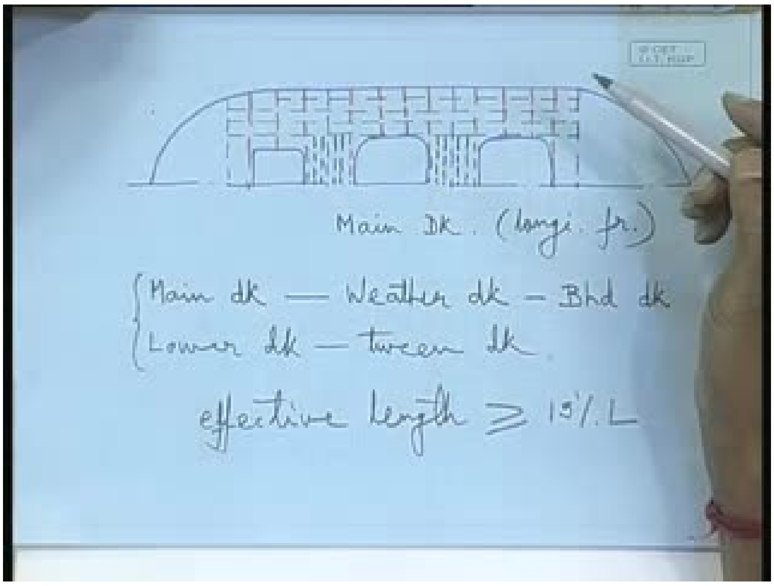

So, when you talk about that there is a continuous longitudinal member which one will contribute towards longitudinal strength and which one will not contribute to a longitudinal strength, is a function of the overall length. There is some term called effective length, if the effective length of the structure is greater than equal to 15 percent of the length of the ship then, it is taken that particular member, a longitudinal member will contribute towards longitudinal strength. In other words, when we are going to calculate the section modulus at a section of the ship, say, at this section which all members you will take? The members which has a length more than 15 percent of the length, so you think of a section in this along this line that means in between the hatch openings.

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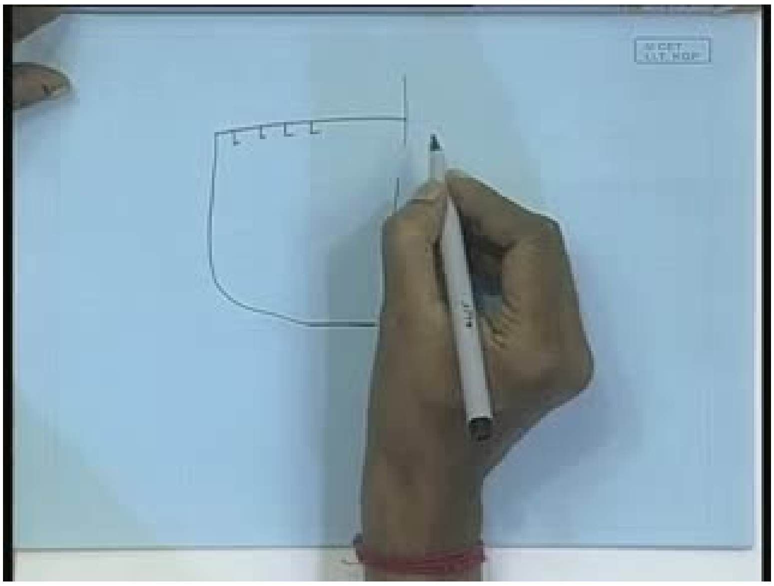

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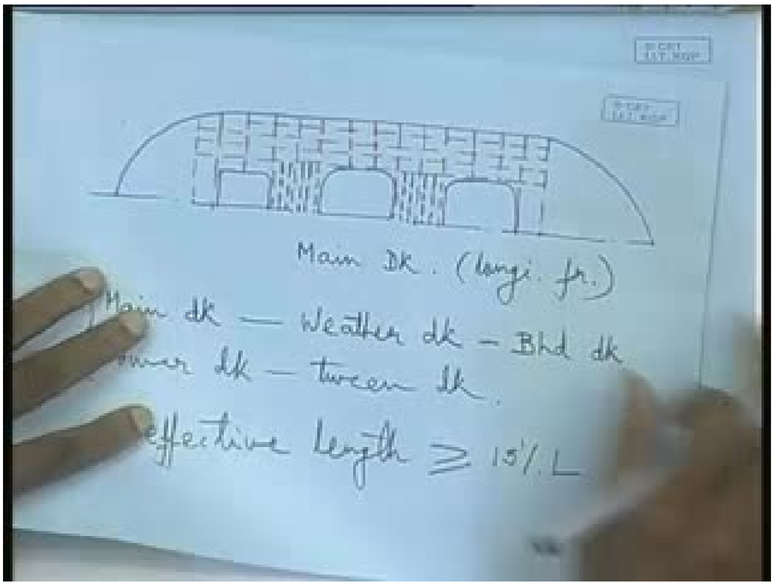

So, if I take a section along this line, the section ship could be you have the depth continuous; you have the longitudinal and let us assume that within this phase also I have longitudinal members.

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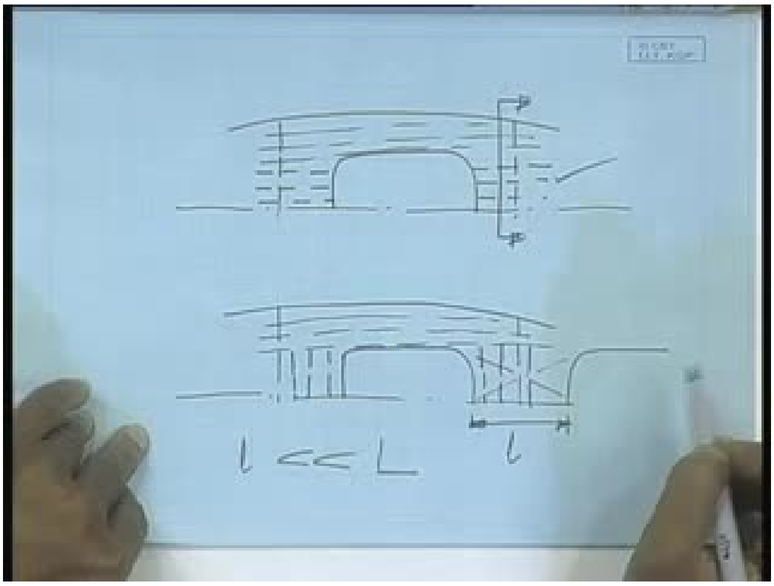

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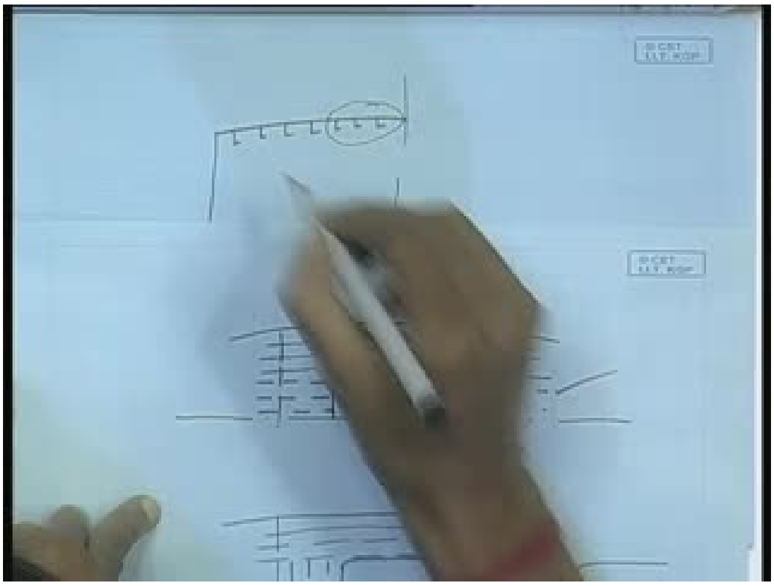

Like this longitudinal members, if I have longitudinal members like this then, how the section here would look like? It will be also like this. Now what is happening these longitudinal are coming in way of the opening this one's (Refer Slide Time: 40:14), so their length is much smaller than the effective length. So, they will not actually contribute towards any longitudinal strength, so their purpose is not at all served; this longitudinal will not contribute to any strength.

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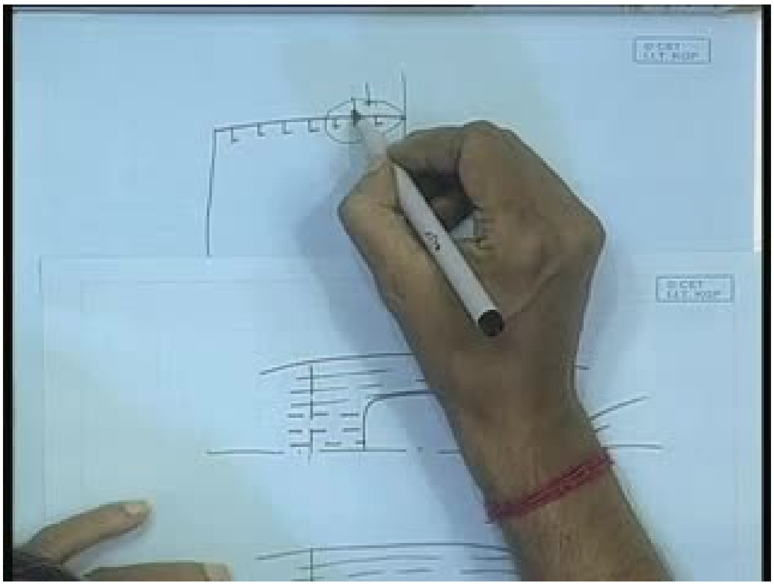

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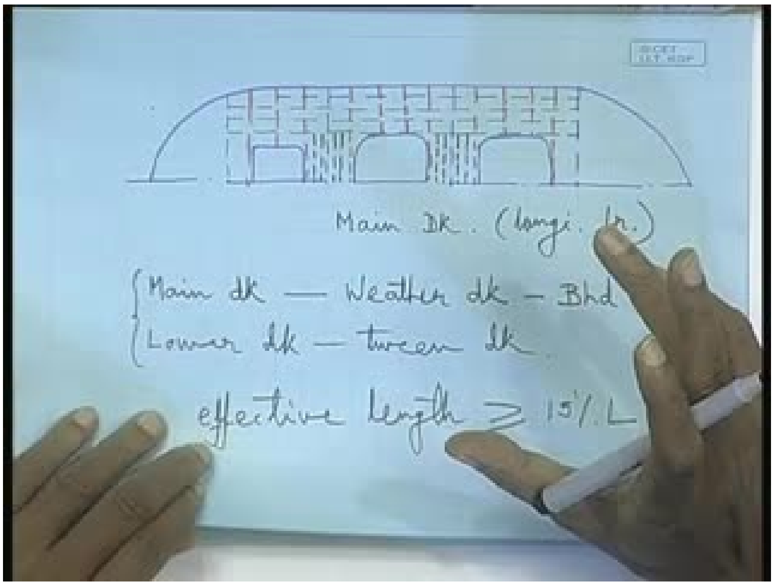

So, whether you have them or not, it does not really make much difference; of course, it will contribute towards local strength because, you do require local strength also here. So, it will only contribute towards local strength but not to the longitudinal strength.

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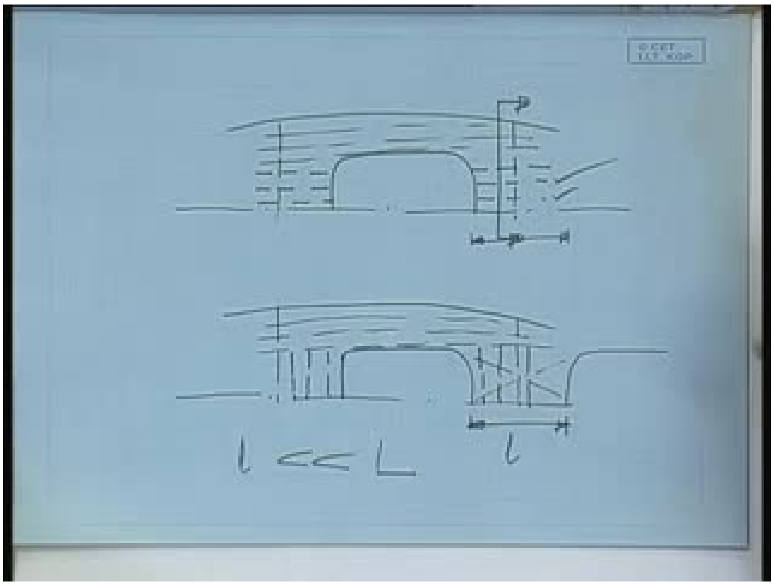

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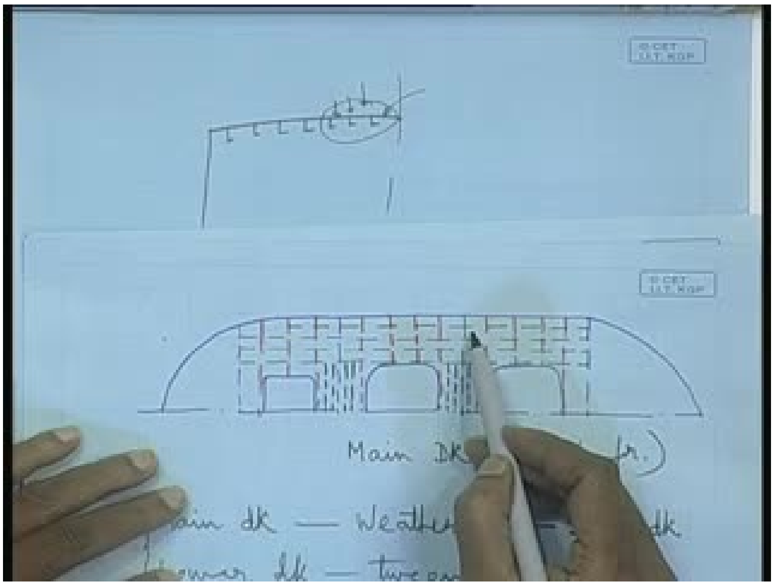

Now, what has been observed in addition to this is that at the same time what is happening? As these longitudinal are not contributing to local to longitudinal to overall longitudinal strength, so the section modulus of these will be much less.

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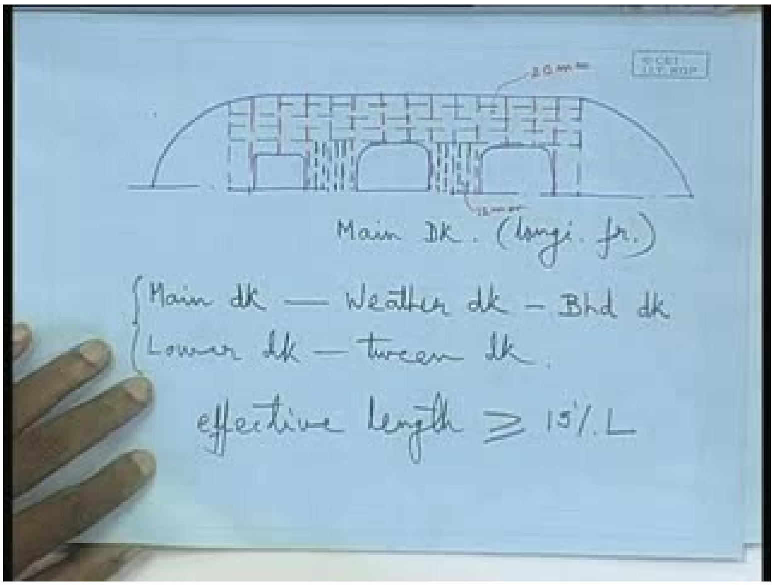

Obviously, section modulus will be less for same reason the thickness of this plate or the thickness of the plating here will also be much less compared to the thickness here - I mean - it can be in this region, the thickness here of this plate, suppose, if it is 20 millimeter, the plate thickness in this zone for a given ship could be as low as 12 millimeter, so what it means?

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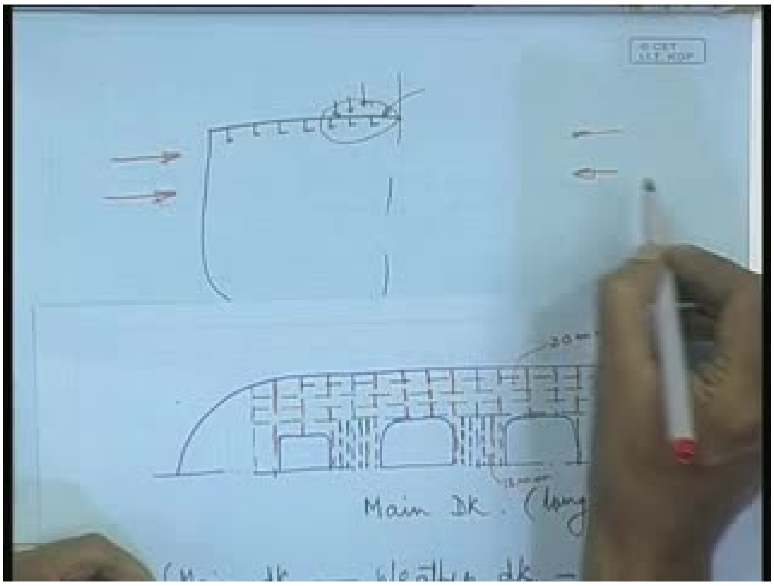

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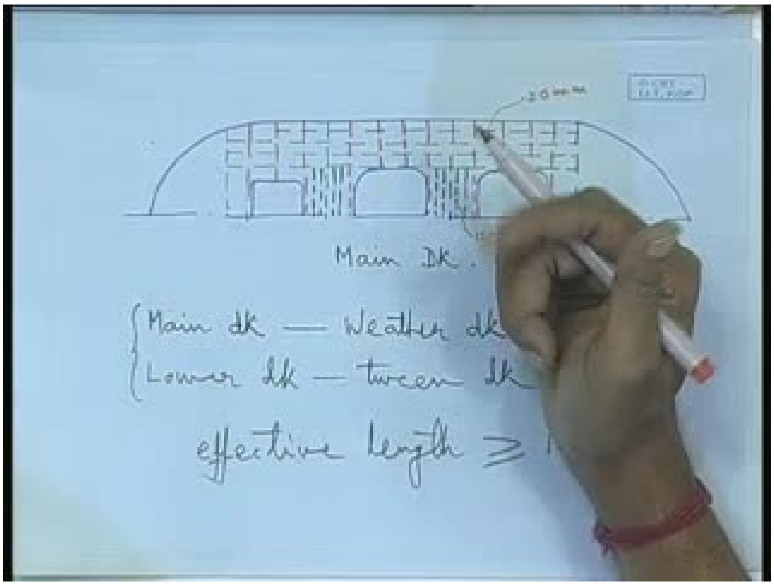

Here, the longitudinal scantling will be less that is fine enough to support the local load; plate thickness will be less, so by being plate thickness less what happens when the ship is well and in service it also undergoes loading in this direction isn't it, transverse loading, so the deck plate will be under transverse in plane compression.

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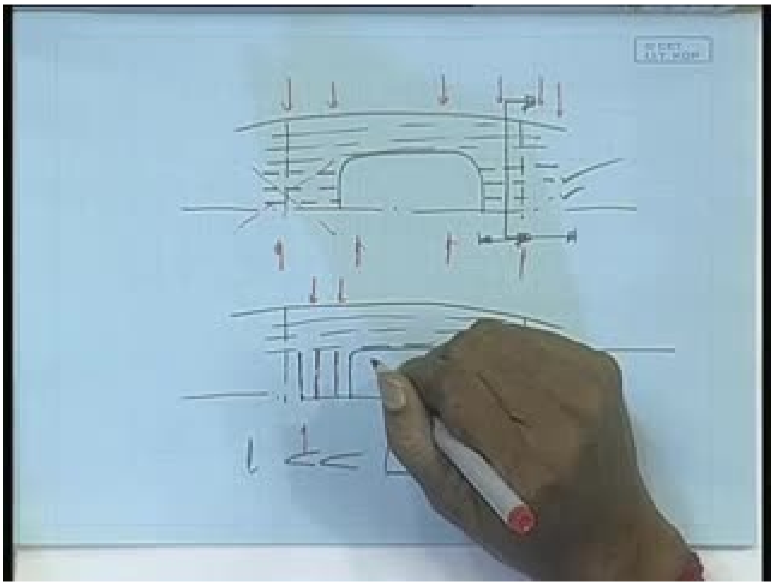

These plates may suffer or will suffer buckling, if the stiffening arrangement is like this so because of the transverse loading which is coming on the ship, this part of the plate will suffer buckling. So, it will be better, if I have arrangement like this, it will then withstand that force, why it is suffering buckling because, the plate thickness is less there. Now, just to resist buckling, I can increase plate thickness but that will not be a good design.

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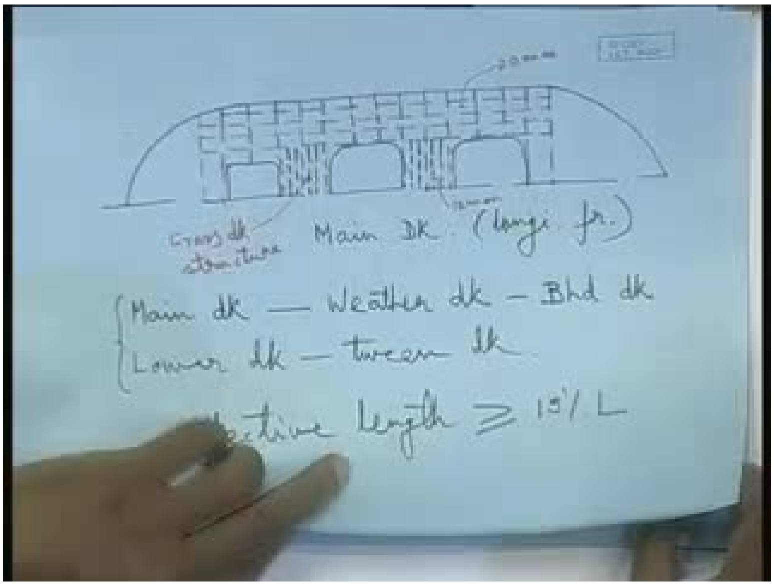

Instead, this longitudinal I turn them, put them in line with the action, in line with the forces, composite forces are acting, so instead of longitudinal members I put them transverse direction, so it solves the problem. This part of the structure, this area referred to as cross deck structure.

Now, interestingly, this looks very obvious that the length of that plate is less, it is not going to contribute towards strength, so automatically plate thickness will be less, obviously, the longitudinal putting in this, in the longitudinal direction does not make much sense. But, interestingly what happens is, it will look back in the early longitudinally framed ships, this cross deck structure use to have longitudinal; that means, here it is to be the longitudinal is to be in this direction; only in service or in people found the plate this cross deck structure is suffering buckling, then only people realize that what is to be done.

So, in these cases, what happens? Many things are obvious but you overlook them, why because you are bothered. One is bothered with the overall strength, this is a very insignificant area because whenever in a ship structure, whenever a member is not contributing to the overall hull girder strength, so that is not considered as the one of those major structural members.

So, the checks and inspections are somewhat of lesser degree in those areas. These are the problems anyway, so that is what is the cross deck structure has to be transversely stiffened. Other things as we see here, the decks a longitudinally stiffened and this particle longitudinally you can see, I have stopped it here may be it can further extended like this. It has a significance that means, I am not further extending it, if in this particular drawing if this last longitudinally if I further extend, it may hit the side shell.

Now, the thing is the structural arrangement should be such that no structural member should be kept as if hanging, the end connection should be there, why? Because the whole arrangement the ultimate goal is to provide for a good load path that is whatever load is coming that should get well, and even like distributed over the entire structure because the entire structure ultimately supported by a distributed force buoyancy force.

So, we generally will not keep any member as if hanging, it is not really hanging, it will be welded to the main deck but still the end is hanging as if so there should be a proper end connection. That means, end termination should be there, so where are the termination? This is a longitudinal member, this is a transverse member, so it terminates in the transverse member, this terminates is properly bracketed, properly connected so, that the end will have some connection.

Both are actually connected to the hull - I mean - hull means here, we are talking about the deck. Deck is stiffened by the longitudinal, now I am saying longitudinal is continuous; now by continuous means, what ship the hull is taking the deck is converging. At the side wherever it is converging, it is coming and it will terminate at the shell; so it cannot just terminate the shell, it should terminate at a frame.

At a stiffening member it cannot go entire over the frame, so the nearest stiffening member, it gets before the shell, so there it is terminated; that means it will be connected. In case of a longitudinal framing system, your transverse members will have higher scantling than the longitudinal members, why? Because transverse members will provide support to the longitudinal members like we are talking to make the span less, so this red lines are the deck transverses. The one which are at the end of the hatch opening we call them hatch end beam, others are deck transverses; so deck transverses they are - I mean - they are providing support to the deck longitudinal.

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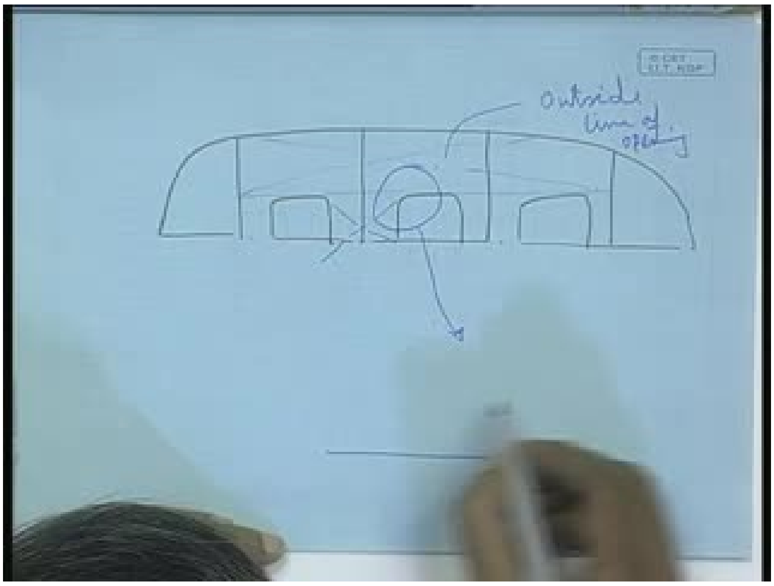

So, that is what the deck is, so the same philosophy will be used whether lower deck or main deck in old decks everywhere. Now, as you see the platting arrangement of the deck, we will see that the plate thicknesses, as I have said that places outside the hatch opening will have a higher plate thickness; that means, if we see the platting arrangement, suppose, you have this, these are your say the bulkhead locations, we have the hatch openings.

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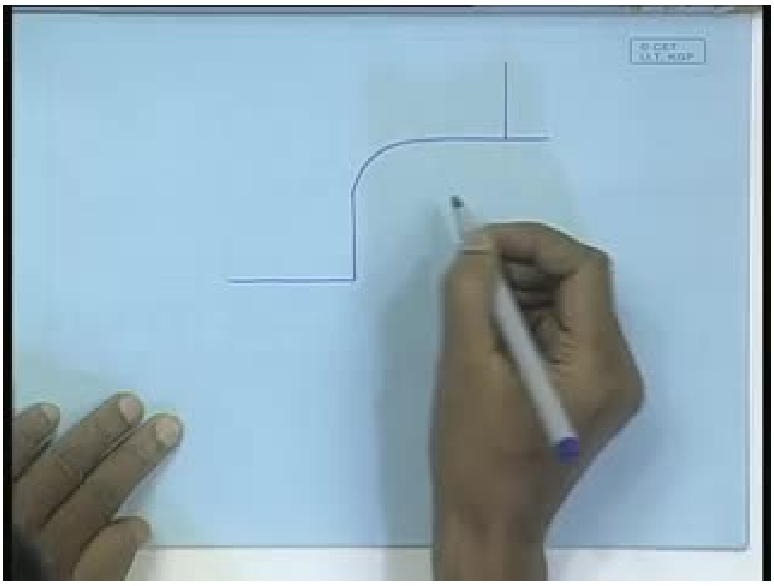

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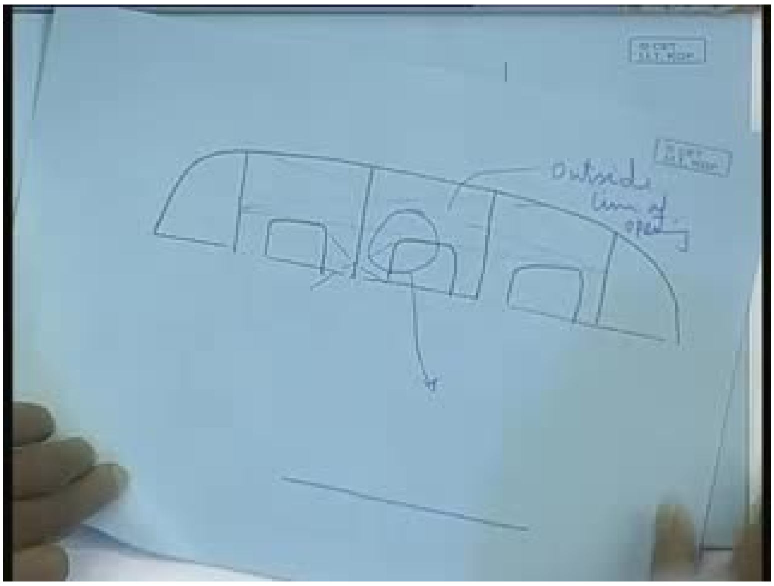

So, the area here, this particular area, this part of the plate is referred to as plate outside line of opening. This is referred to as outside line of opening, because this is inside line of opening. So, obviously, since these are small pieces of as this length is much less compared to the overall length. So, this is not taking contributing towards the strength, so the plate thicknesses will be less. If we take a closer look at this area, may be just more endless view of this corner of a hatch opening.

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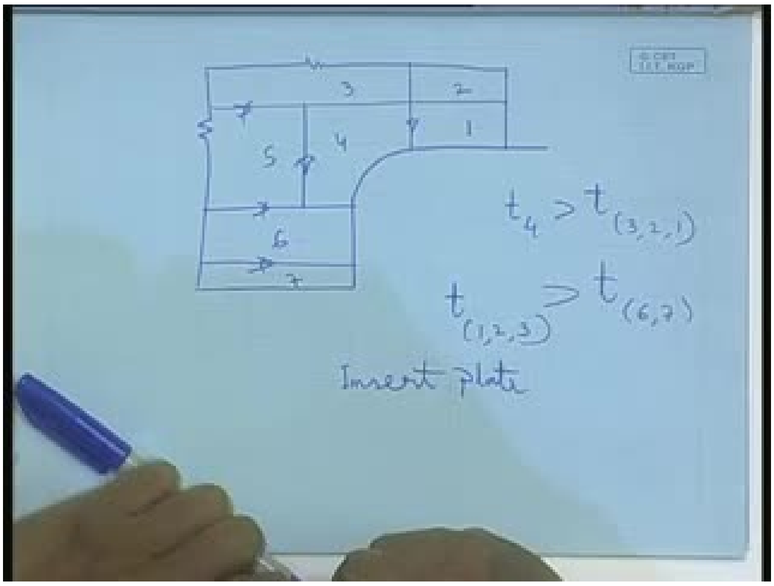

What we will see is that some plate is running, this is another plate now say these are my sim lines, this lines which I have drawn they are the welding lines; that the pieces of plates, say, this is plate number 1, plate number 2, 3, 4, 5, 6, 7 and so on, because the deck will be made up of several plates put together isn't it.

What we will see is the thickness of the plates, say, 1, 2, 3 will be much more compared to the thickness of the plates of 6, 7. So thickness of plates, say, 1, 2, 3 like this will be greater than that of this thickness of these plates, because they are the plates lying outside the line of opening. They are taking part in the so called the longitudinal bending whereas, this particular plate number 4 in the corner, it has additional role to play because, it is right in the corner and you can see the corner is rounded it is not curved to avoid stress.

It has been rounded to avoid stress concentration, minimize stress concentration but still it will have a higher stress level. So to withstand that, this particular plate number 4 gets a special name it is called insert plate, as if the plate 4 has been inserted there. What is the specialty the thickness of the plate 4 is greater than all the plates in that vicinity; that means, the higher plate thickness is where these 3, 2, 1 etcetera, is even higher than that; that means, you provide for a additional thickness of plate, additional thickness in the corner plate that is what is referred to as insert plate.

So, that is how the plate thickness is arranged I mean, what would be the thickness etcetera. Obviously, that is calculated through the standard rules whatever has been provided in the classification society rules.

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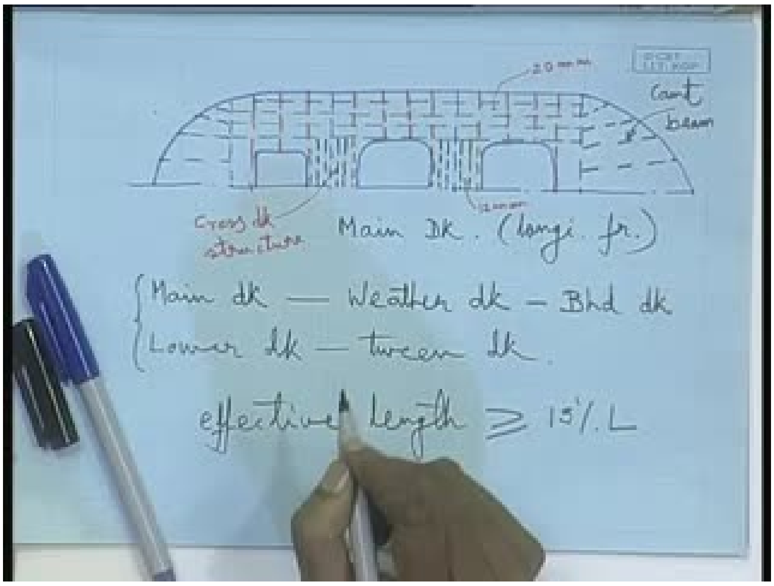

Then, as you come in the forward section obviously again here, as per the bending moment is less but because of local strength again the thicknesses are increased. So, as you go away from the centre forward or haft, there will be a gradual decrease in the thickness right, but again we will rise at the end because, it may suffer hitting of rain waters means waves. It will have to support the technician is the anchor winch etcetera, will be there, so local load.

In addition to that the framing system here is arranged like this, it is neither the long generation nor in the transverse direction somewhat oblige, they are referred to as cant beams. In the same plane, the frames are referred to as scanned frames, because you will have the deck longitudinal, side shell longitudinal or side shell frames; here we will have cant beams, cant frames in the same plane. It is done in this way because you see the forward deck will become narrow. So, taking the longitudinal and putting the frames in the plane of the longitudinals become difficult. So, that is why some radial arrangement is done similar thing also can happen in the haft, so that is what the deck arrangement is.

May be in the next class, we will see little bit about the side shell and the inner bottom plating, how the arrangements are? Essentially there will be either transversely stiffened or longitudinally stiffened for all practical purpose. It is worthwhile to have longitudinal framing system for any longitudinal member means the decks, inner bottom, the side shell, the bottom shell or longitudinally framed unless until it abstracts functioning or abstracts cargo storage or abstracts some other aspect if it is not there. It is preferable to have totally longitudinal stiffening all about. Next, we will see the shells and inner bottom plating.