Hydrostatics and Stability

Prof. Dr. Hari V Warrior

Department of Ocean engineering and Naval Architecture

Indian Institute of Technology, Kharagpur

Module No. # 01

Lecture No. # 30

Bilging - II

We will continue with our lecture on bilging. In the last class, we talked about the flooding and damaged stability analysis. We will finish that off and then we will do the flooding analysis. We said that there are two ways in which you can handle a flooding or damage stability analysis, they are known as the method of lost buoyancy and the method of added weight. As I told you, what happens during flooding is that, let us assume that the ship has a few compartments, one compartment, I mean it can be any compartment or more than one compartment.

Let us assume that one compartment gets flooded means it is completely filled with water. Now, what will happen as a result is, water fills that compartment. Now, what did we have initially? We initially had that compartment volume. In that ship, what is now come, there is an added weight of water now? That is the real thing that is happening that is water has come into it.

Now, there are different ways in which you can see this problem of flooding. First we can say that we can do all the analysis using the assumption that the new weight, it is like a new weight that has been added to the ship that is one way to look at the flooding problem - that is the weight of water. Water is added to the ship and the weight is used in calculating the final calculations or you can assume that this weight of the water that much of volume means, the volume occupied by water, that much of volume is now lost by the ship. Why do we say that? See that weight is now acting downwards instead of that we can say that much of volume is from the buoyancy so from that much of volume we can assume that much of volume is lost, that is the buoyancy lost.

These are the two ways in which you approach the problem, either you say that the buoyancy is lost or you say that the weight has been added. So, they are known as the method of lost buoyancy and the method of added weight.

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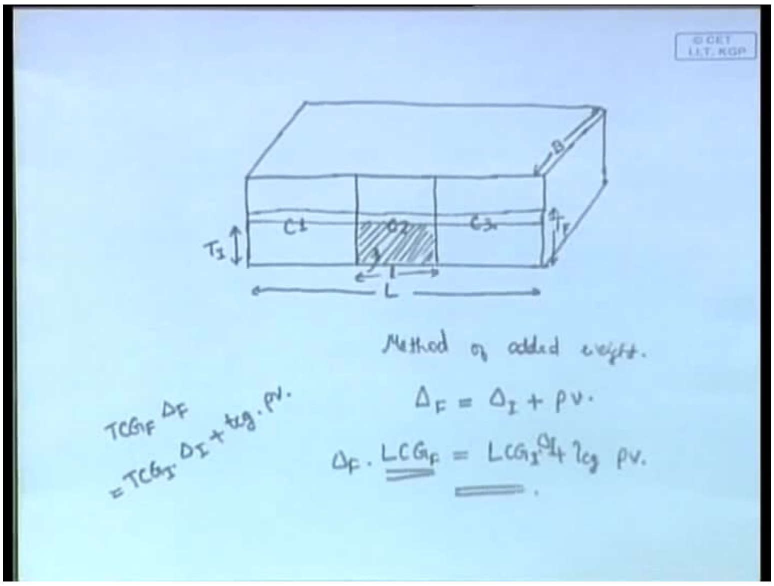

The problem that we are going to consider is that of a box shaped barge, we have already discussed box shape barges. You have to draw it would be more like this (Refer Slide Time: 03:15). If we assume that this is the length - I hope - I can draw it like this. You have a box shaped barge; it is just a box. For this problem, we will say that it is a box that has 3 compartments; compartment 1, compartment 2, compartment 3 - there are 3 compartments in it. It has water filled up to a particular draft, not filled but floating at some particular draft, let us call this T initial and this is the breadth of this box b and L is the length of this vessel capital L.

Now, this compartment 2 is going to be flooded. Let us assume that the length of this compartment 2 which is this length is small l, this is the length of this compartment which is going to be flooded. Now, what is happening is water is entering here, so this gets filled with water (Refer Slide Time: 04:54). Now, you will see that due to this water entering, buoyancy is lost but still remember the weight of the ship - let me explain, first of all, there is a ship itself and it has components in it and weight of the ship, it has a particular weight. Water enters, so it is weight of the ship plus weight of the water that is the total weight acting down or that is one way of looking which is the method of added weight. In the other method, you have the method of lost buoyancy which is, you have the weight of the ship as such but some buoyancy is lost.

Remember, even though after it lost its buoyancy, the ship still has to finally come to a state of stable equilibrium, where the weight is equal to the buoyancy, it has to happen anyway, otherwise something is moving; the ship is moving, so that does not happen. The weight becomes equal to the buoyancy anyway, how can this happen? Some buoyancy is lost. That means, there is some more weight acting, how can that be compensated for? It can be compensated if the ship sinks a little that means more volume comes at the top. That means buoyancy increases, so that increase of buoyancy and the decrease of buoyancy will cancel out and ship reaches the final stable state.

This is the initial box shaped barge; this is flooded as a result the draft will increase, so that it is final weight equals buoyancy will come, somewhere here it reaches the final draft T final, so this is the problem as such (Refer Slide Time: 06:18). Two ways that is if you take the second way, you will see that is the method of added weight and method of loss, we will do both now. One thing you can see is that the method of added weight will imply that is, in the last class I showed you that method of lost buoyancy has some points. The displacement of the ship does not change means, the method of lost buoyancy displacement of the ship does not change. Even though water is added, water is not considering part of the ship, what you are considering is that volume is gone from the ship. Weight of the ship as such it does not change only the volume is gone from it or buoyancy is gone from it.

Now, displacement does not change, I mean the weights are at the same position as a result of which the LCG does not change. The LCG of the ship does not change similarly, the other thing VCG, TCG, none of those changes. TCG is the Transverse Center of Gravity and VCG is the vertical center none of those things change. So, it is like this, but in the method of added weight, what happens is that we assume that ship is there buoyancy is still the same but new weight is added. It is the same concept again, I mean you are doing the same thing, in one place you are adding, in one place you are subtracting but still it is the same process.

Instead of assuming that the buoyancy is lost, buoyancy is the same but weight is added. Again because of it a new weight has come, buoyancy is not able to balance it, so it has to come down, process is the same you will get the same draft, two methods of doing it, but in the method of added weight some things will change.

For instance, you will get your new displacement; the final displacement will become the initial displacement plus the weight of water added. If v is the volume of water added rho is the density of water then rho into v will be the weight of water added. So, final weight of the ship will become delta F will be delta I plus rho into v, so this will become the final weight of the ship.

Similarly, LCG in the final case will become LCG in the initial case plus LCG of this volume. If you have the water added, if you find the LCG of the water added for instance, in this particular problem we had a compartment in the middle LCG would be somewhere in the middle, it will be in the middle not somewhere in the middle, it will be in the exactly in the middle of that compartment. So, that will be the LCG of the weight of the water added that LCG of F is equal to LCG of x delta initial - I wrote on it delta final, it is like this.

Just we are equating the moments, so delta F is the final displacement. Delta F into LCG F is equal to LCG I is the initial into delta initial plus small lcg is the LCG of the weight of the water added into the weight of the water added, so this will give you the final LCG.

Your LCG has now changed as the result of the new water that is added to the ship. Of course, you can write similarly, TCG final into delta final will be equal to TCG initial into delta initial plus TCG of into rho v. In this case, you have the transverse and similarly, you can write for the vertical center of gravity. So, this is what happens in the case of added weight.

In the case of added weight, what has happened is that we have added new weight to the ship. The volume of water added is the weight of added, nothing has changed, buoyancy is still the same and nothing has changed in the buoyancy, so buoyancy remains the same but, new weight is added to the ship. So, LCG delta of the ship changes that is the displacement of the ship changes, longitudinal center of gravity, transverse center of gravity, vertical center of gravity, everything changes and then an additional think comes.

See this water is now a part of the ship. You have the ship and it is like a tank containing water that means, you have to consider the free surface effect that is the movement of water. If you remember there is a formula to calculate small i, that is the i of the tank and then from that i there is a formula to calculate your lever, there is the free surface moment and free surface lever that there formula was there.

Using that you can calculate, the thing is that what will it do? Free surface effect what is its effect? It effect is on GM. GM will decrease, so the total GM if you have to measure in this case will be the initial GM of course, that KB plus BM minus KG that will give you 1 GM and you have to subtract the free surface effect lever from it and then you will get your total GM that is your final GM, but in case of lost buoyancy you do not have to do that because what we have assumed in that is we have assumed this volume is not part of the ship. So, that water is not part of the ship, so there is no free surface moment.

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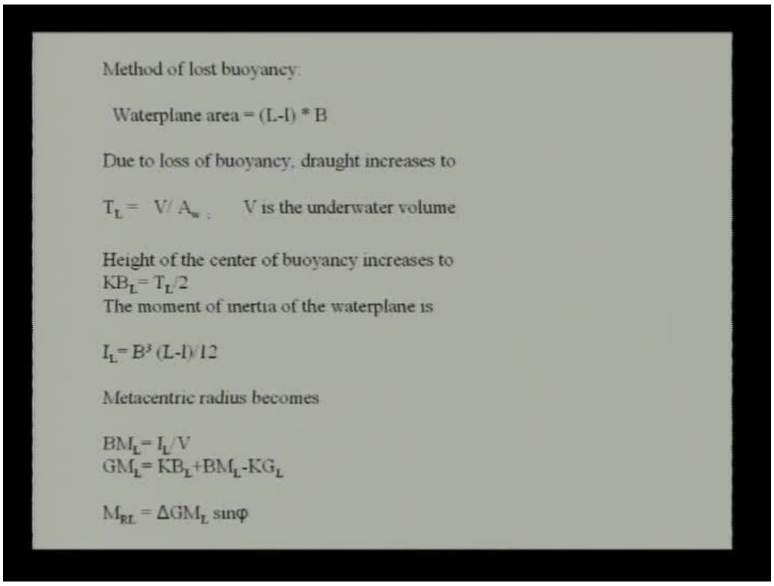

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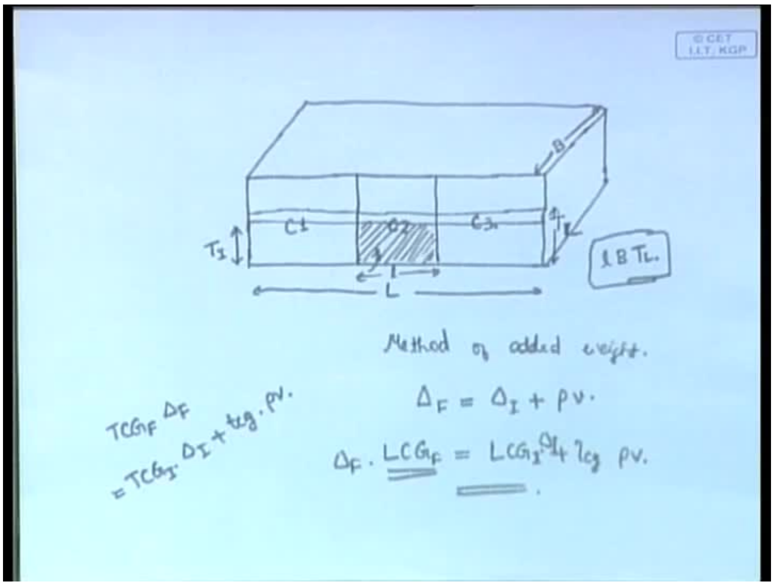

We will just see these thing, this will explain that is the whole set of calculations that you need to do. Now, it is the same problem, so it is this same barge you have a length l barge of capital length L and breadth. Looking here this capital B represents the breadth of this barge, L is the length of the barge a compartment of length small l is bilged or flooded, damaged, water enters it and initial draft is T I final draft becomes T L and then that is all.

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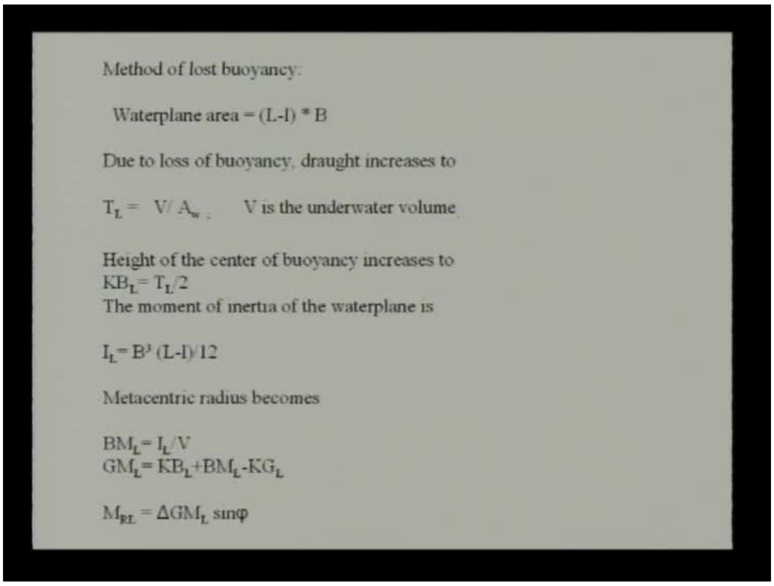

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What is the total amount of water that come in? The total amount of water if you want to put it as volume, if you look here it will be this l into B into T L, this will be the final volume of water that will be in the compartment yes, correct.

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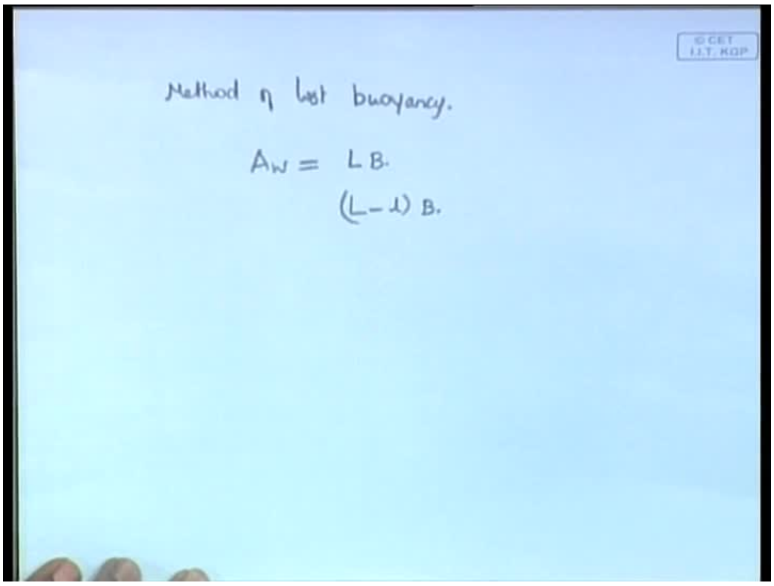

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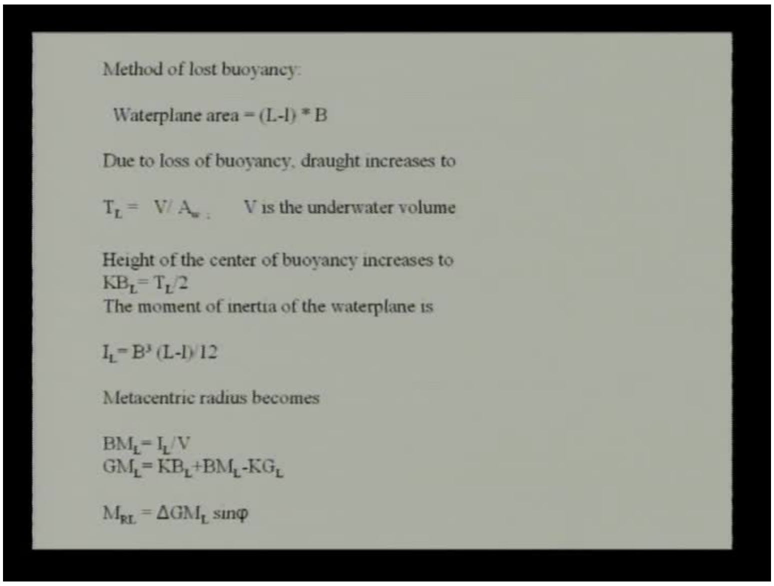

Let us look at this, this is the way in which you proceed, so this is using the method of lost buoyancy. First of all, let us find the water plane area of that box shaped barge total is L into B and the water plane area of the lost or the flooded region is L - of the flooded region is small l into b and the water plane area of the remaining section is L minus l into B. So, this is the water plane area of the remaining flooded ship.

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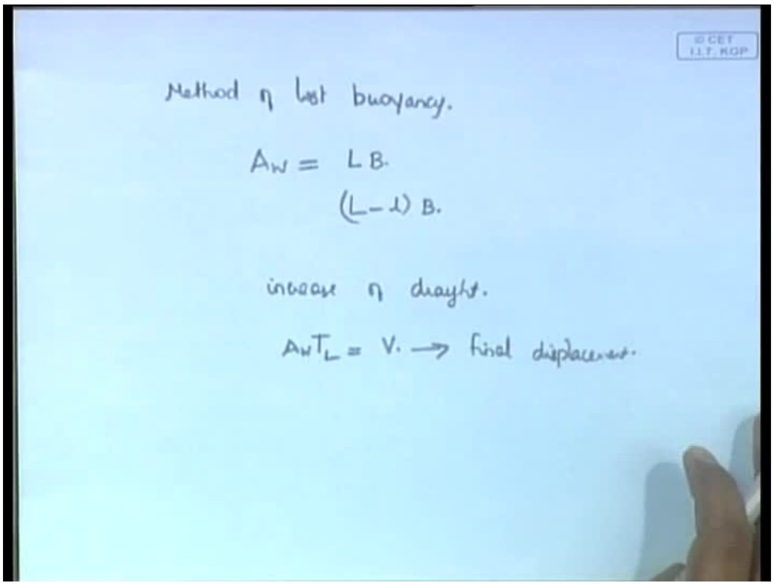

There is an increase in draft, the final draft A W into T L will give you the final volume - this will give you the final under water volume that is the final displacement. Note that in this particular case, the weight of the ship is not v, if you assume v to be the initial displacement weight of the ship is not changing, so v remains the same it is the displacement.

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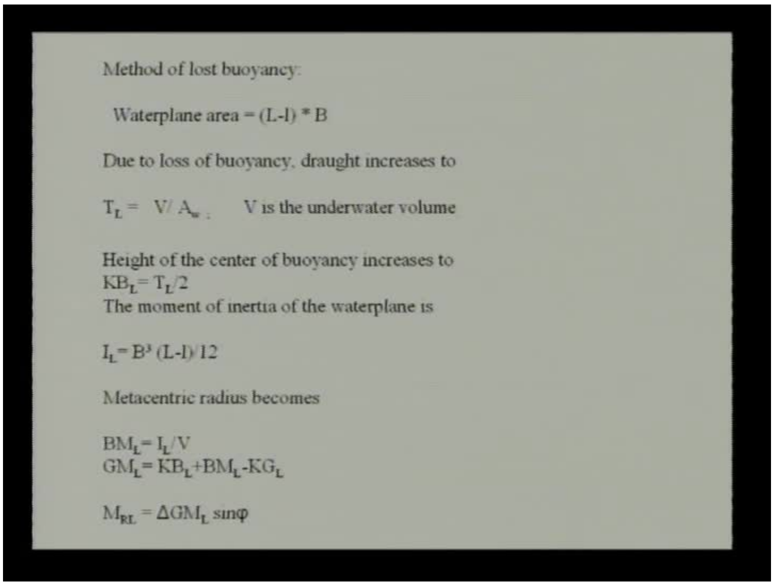

Now, like v divided by the initial water plane area, there are two cases: one is intact, one is the damaged this is method of lost buoyancy in which del remains the same. Del means it is written here as v that del remains this v, this is del actually the displacement. So, del divided by L will give you the L divided by the initial A W which is equal to l into b will give you your initial T - T initial. Del divided by L minus l into b will give you your final T L, is it clear what I said? I will write this if you want.

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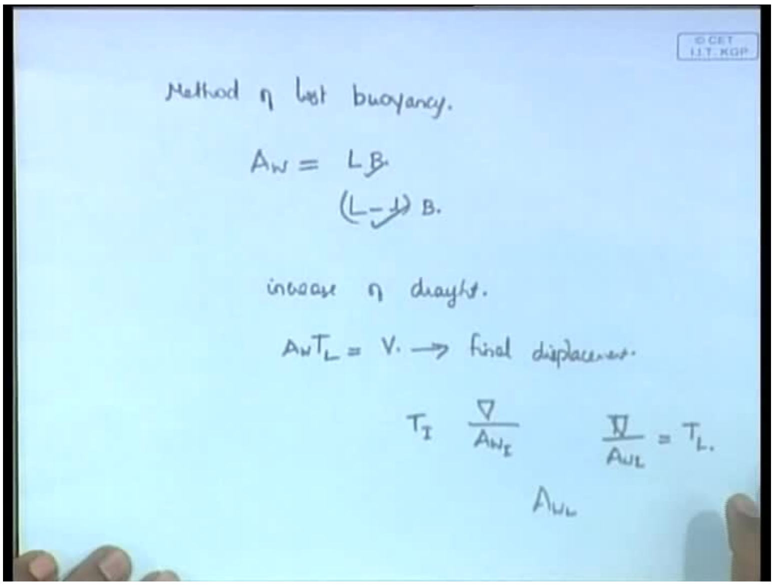

Del divided by A W initially will give you T initial, del divided by A W final in this case L will give you your T L. A W L is this, this is an initial A W initial and this is A W final.

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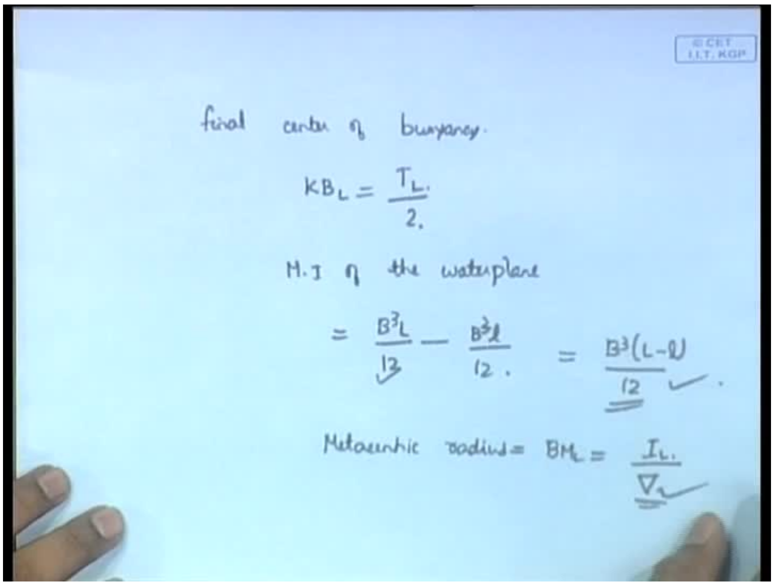

Now, as you can see the final center of buoyancy rises. It is not difficult to find the vertical height of the center of buoyancy which we write as KB L, it will be equal to T final, L everything represents the final T L divided by 2 that always represents the KB that is the center of buoyancy.

Now, we want to find the moment of inertia of the water plane about the center line. It will be moment of inertia - this is for the damaged case, in the initial case, Remember, this is actually the second part of what we did last class. Last class, I took the same box shape barge and I did all this calculations, I did all your KB, BM, I calculated I, BM, del finally, even the righting moment we did all that same thing, I am doing it for the damaged ship which has some parts lost in it.

Now, for that ship the moment of inertia of the water plane will be this minus this B cubed. This is the initial moment of inertia if the ship is full, now what has happened? Some part of the ship is gone from the ship this is method of lost buoyancy. The two methods you have to very clearly understand the differences. In method of lost buoyancy one part of the ship is not there, if you look it is like the bottom part of the ship, so this is not there.

If you are taking it is moment of inertia this does not have a moment of inertia only this much of moment of inertia is there. The moment inertia of the whole thing is B cube L by 12 and B cube small L by 12 will remove the moment inertia of that middle portion.

So, this will give you the final moment of inertia B cube into L minus l by 12. The metacentric radius becomes BM L, this is the final metacentric radius, it becomes I by final I divided by del; del has not changed del is the same.

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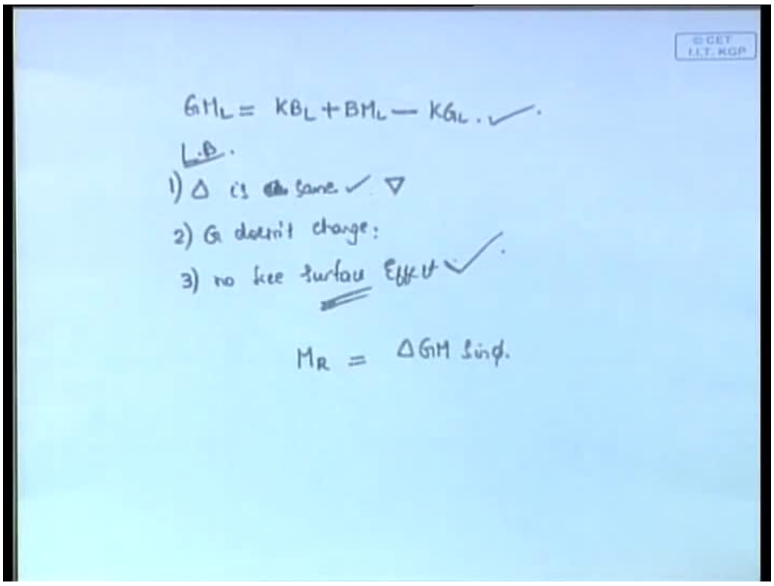

You know this IL; I L is given here, del you know, we have already done this in the previous thing we got L del. Then, we can use GM L is equal to KB L plus BM L minus KG L this is just the whole formula. I wrote it very clearly in the last class, what were the important points associated with these two methods: method of lost buoyancy and method of added weight, if you just remember those then there will be no confusion, because when you do the problems, you will see it happens all the time, you will use some of the formula like, some weight will be added here and buoyancy will also be lost sometimes or one thing or other you mix the two. So, what I wrote last class is very important that is like this.

In the lost buoyancy method this is same is not changed; delta does not change, G does not change then, delta remains the same means del remains the same G does not change then there is no free surface. This you should not take the free surface effect in the case of lost buoyancy, when you are doing the method. When you are given a problem, you do one of the methods, I will give you the formula, we will do some problems it will become clear.

In this case, you do not take free surface effect but on the other hand, if you do by the method of added weight it becomes different in this delta changes, G changes, free surface effect has to be taken these are the exact differences between the two. In this case, in method of lost buoyancy we got GM L using this formula then M R in this case, the righting moment becomes delta into GM into sine phi. If you do that you will get your righting moment.

Actually, just look at the text, you we will see that they have done it for that box shaped barge with given values of L, B, T, etcetera, they do it using the two methods of added weight and lost buoyancy. They get exactly the same righting moment but, you will get the same only if you do this properly means, if you take the free surface effect in one case you do not take it in the other case and you take the weight displacements everything properly, then you will get the same righting moment. So, this is the way in which you solve the case of lost buoyancy. Now, if you are doing the same thing by the method of added weight it comes like this.

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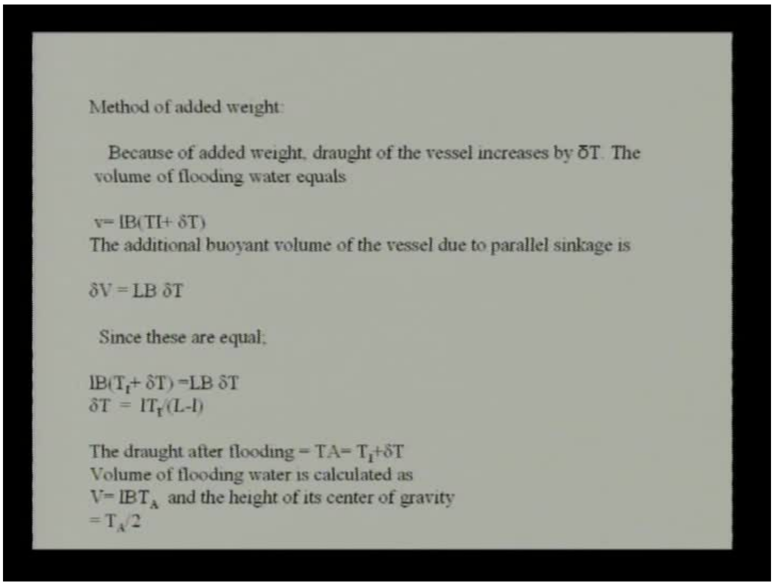

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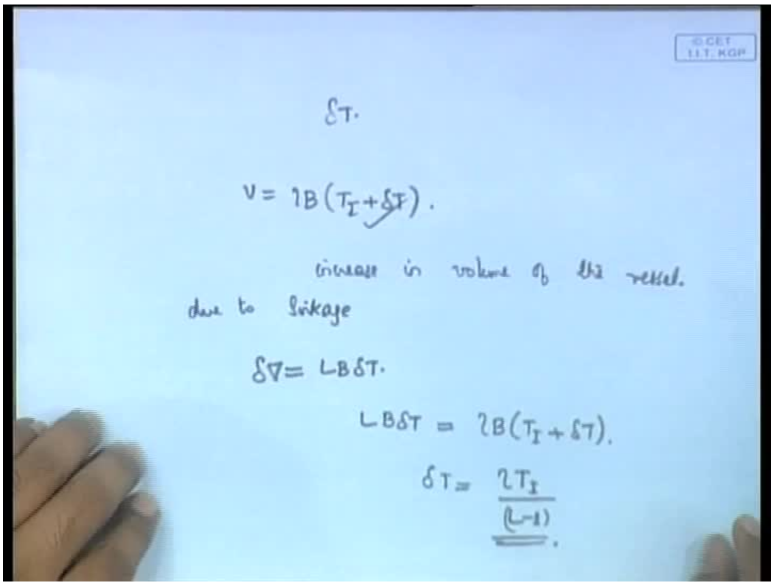

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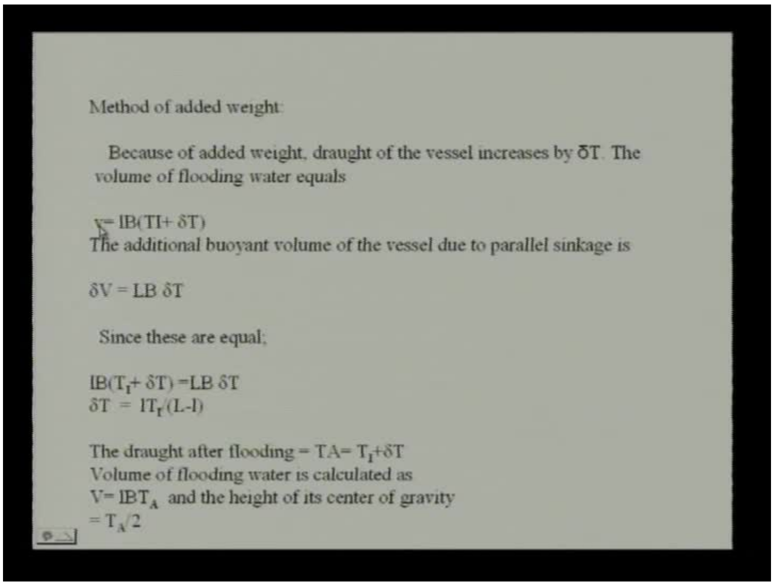

Now, in this case the problem is slightly simpler infact that is you have the ship, you are adding a weight to the ship that is the problem. You are adding the water to the ship and the ship sinks, so there is an increase in draft. In this case, let us assume that the increase in drafts is delta T and then, you can see that what the volume of flooded water is. So, that is what we just said the volume of flooded water if you look here is v is equal to l into B.

The volume of water added is small l which is the length of the compartment into B the breadth of the compartment into T initial plus delta T that is the total amount of volume that is what you have said same thing that is the volume of water added. There is a change in buoyancy of the ship, the ship is there and weight of water is added, it sinks. How it sinks? It sinks by an amount delta T which is the change in draft. As a result there is a change in volume of the ship which is delta del equals LB into delta T, where L is the whole length of the ship, B is the breadth of the ship into change in draft. That is the change in volume.

Now, this increase in weight of the water is what is producing this increase in draft, so they are equal increase in volume. So that increase in volume is equal to that increase in volume of water or increase in weight is due to the increase in this weight, is it clear? Increase in buoyancy rather is due to the increase in this weight. They are equal in magnitude because one is happening due to the other. So, LB delta T which is the increase in volume of the vessel, LB delta T will give you the volume of water added is LB into T initial plus delta T.

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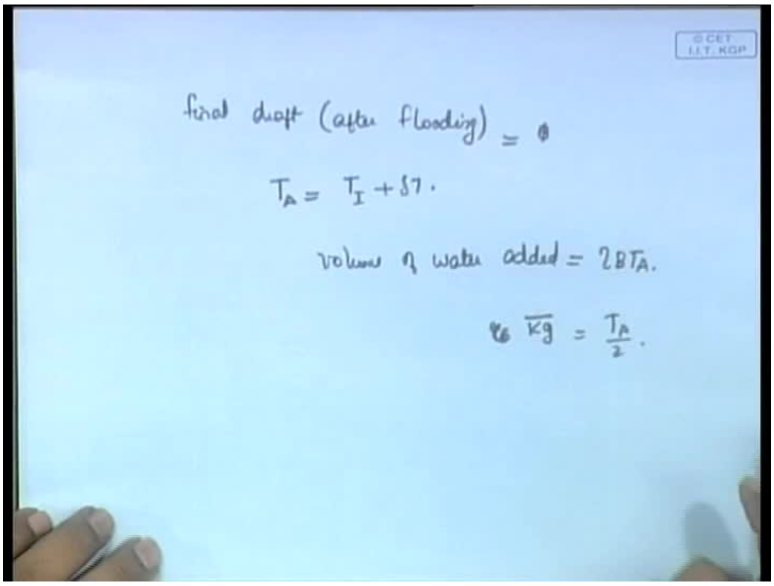

Now, you can equate them and if you manipulate this, you will get delta T is equal to L into T initial divided by L minus l, so this formula we will keep. Now, the final draft or the draft after flooding is equal to - let us write it as in this case, T A is equal to T initial plus delta T. So, this is going to be your final draft after the ship has flooded.

Now, this can be written as the volume of water that is added as we wrote it last time is small l B into T initial plus delta T, which is equal to T A. So, this is the volume of water that is added to the ship.

Now, it is center of gravity; the center of gravity of this water is at KG, this is just for the water it is equal to T A by 2, this is the center of gravity of the water added. T A is the total height at which the water is added total height divided by 2 will give you the LCG or it will give you the VCG, the center of gravity of the water added.

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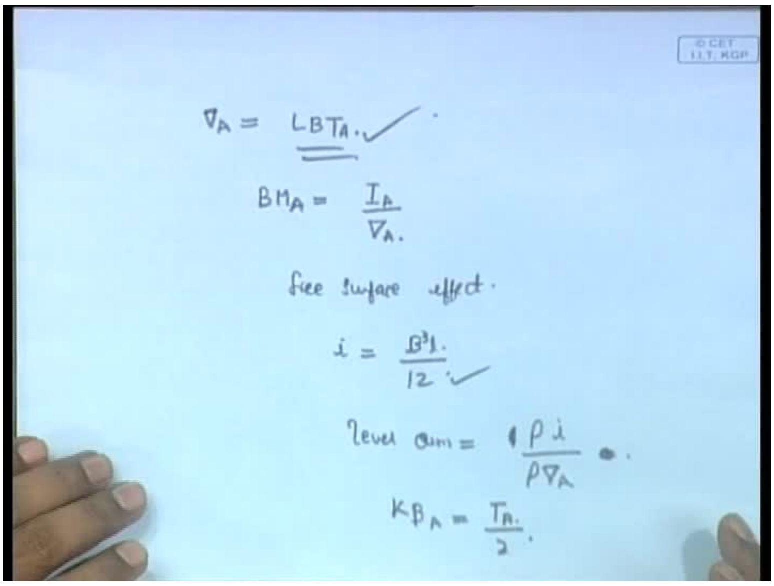

Then, the displacement volume; the final volume of the flooded pontoon the displacement volume is LBT A. This delta A is the final volume of the - after the ship has - I mean pontoon means that whole vessel in this it is a pontoon, it does not matter it is a vessel, so when the vessel is sink the final volume is LB into T A. Note that in this case, we are doing the method of added weight that means that portion is still a part of the ship that L minus small l concept does not come here. These are the differences between the two that should be very clear - I mean you have to keep reading it and make it absolutely clear.

The BM for this in the final case becomes I in the final case divided by del in the final case after the flooding. Now, I in the final case is the same, there is no difference, because I is the same and del in the final case we calculated; this one, this we have just calculated it is that changes. In this case, the I does not change but, del changes in the previous case del did not change but, the I changed at any case you are doing the same thing but in this case, there is an additional thing you have to take in case of added weight, because the water is now in the ship and it is a part of the ship, it is like that. It is almost as if we are assuming it is a tank that whole compartment is now like a tank, which is carrying the water. So that means we have to consider the free surface effect.

Free surface effect needs to be considered and you know that the moment of inertia that needs to be considered is the moment of inertia of the compartment or the size of the tank. We assume that the whole compartment of length small l, breadth capital B is flooded. So, its moment of inertia is B cubed into small l by 12 about the center line.

Now, this we have done, this is the amount of the lever arm or the amount by which the GM will change that figures and all we have done in the previous section. Lever arm due to free surface effect is given by - in fact rho into I divided by rho into del, this is the I by del. That is an amount by which your lever arm will change; lever arm excess. So, this i you know, del A also you know, so I is this del A is this. Once, you know this, this much of lever arm exists and the final KB is the same as in previous case, it will be T final divided by 2, this is the final KB of the ship.

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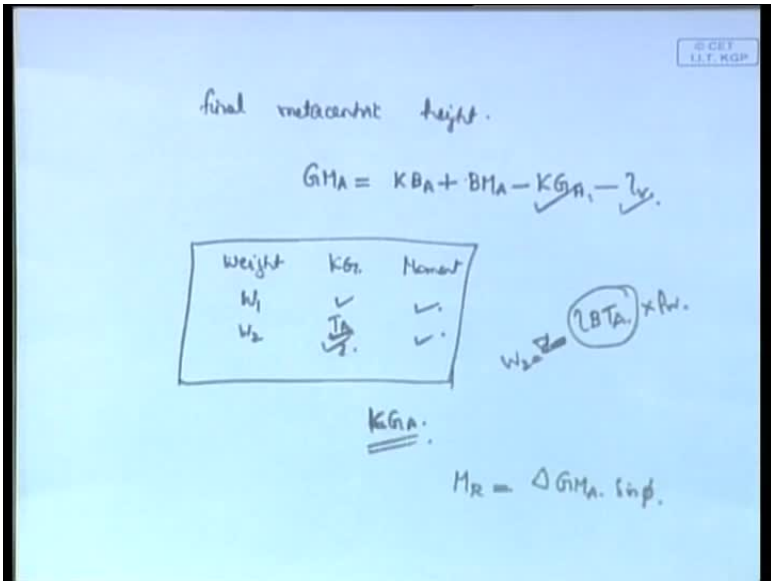

Now, once you have this, you need to find the final metacentric height. The final metacentric height can be written as GM final case is equal to KB in the final case plus BM in the final case minus KG in the final case minus l v that is note that KG actually changes. How do you get the KG of the final case? You can make a table like this I mean the usual method. You have the initial weight KG moment, so first you have the initial ship, you have the weight of the ship whatever it is let us call it W 1. You know the initial KG of the ship, you will know it. In this case, it is very simple k it is a box shaped vessel, so you find the total volume and half of it - I mean the total depth half of the depth not the draft, half of the depth will give you the KG of the vessel.

So that is the initial thing and W 1 into this distance will give you the moment. Now water is added, so let us assume, you can find the volume of water added that is L into B into T A this gives you the volume of water added into density of water will give you the weight of water added so that is W 2; this will give you W 2 that is the weight of water added. This will be T A by 2, this will give you this, you get the moment and then you find the net moment divided by the net weight will give you the final KG. So, this gives you the final KG.

Lever arm, we have already calculated l v this is due to free surface effect now, when you do all this you will get the final GM of the vessel after flooding. The only additional thing probably you have to do here is that of the free surface effect, so it may be easier to do the lost buoyancy method, it might be easier so we can do that also. Once, you do that you find the MR the righting moment using delta into GM final into sine phi.

Now, see what will happen is that delta is different in both the cases; in both the cases means del in the case of lost buoyancy and in the case of added weight delta is different. In one case delta is the original weight of the ship, in the second case method of added weight, delta is equal to weight of the ship plus the weight of water added. Now, if that product has to become same MR, GM will different; GM will be different for both the cases as a result of which the product will become same. So that is the two methods of lost buoyancy and added weight.

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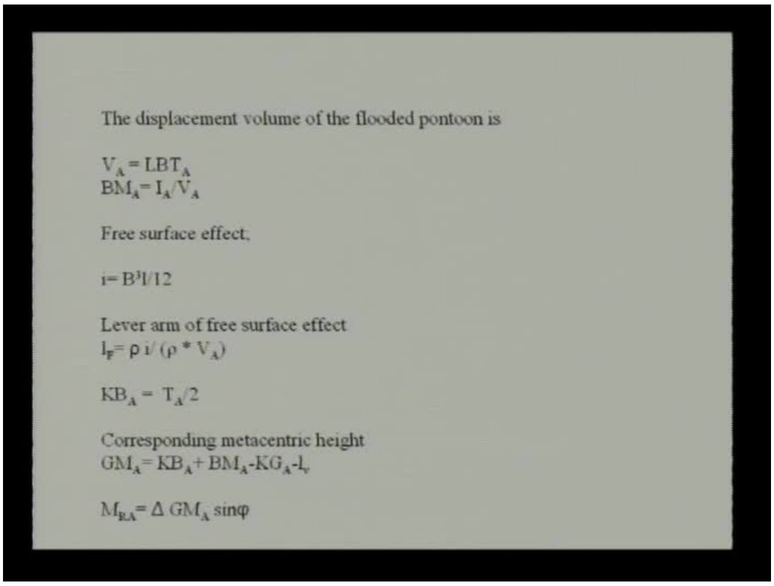

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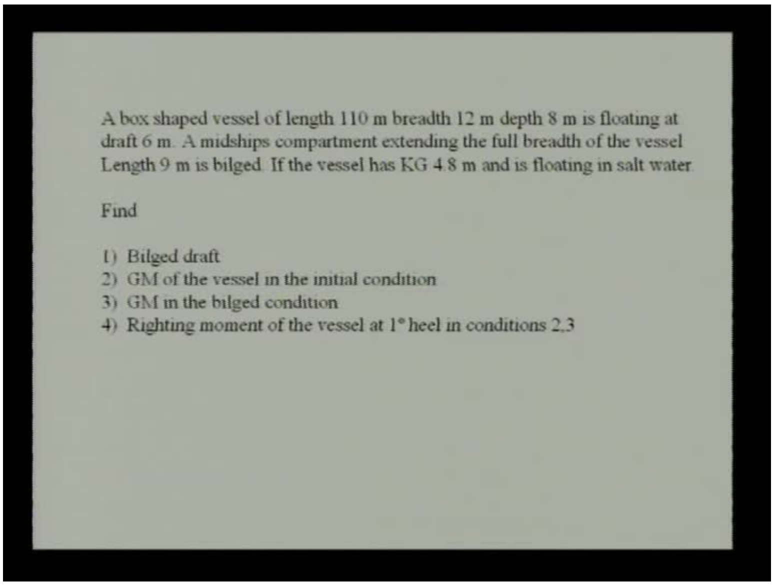

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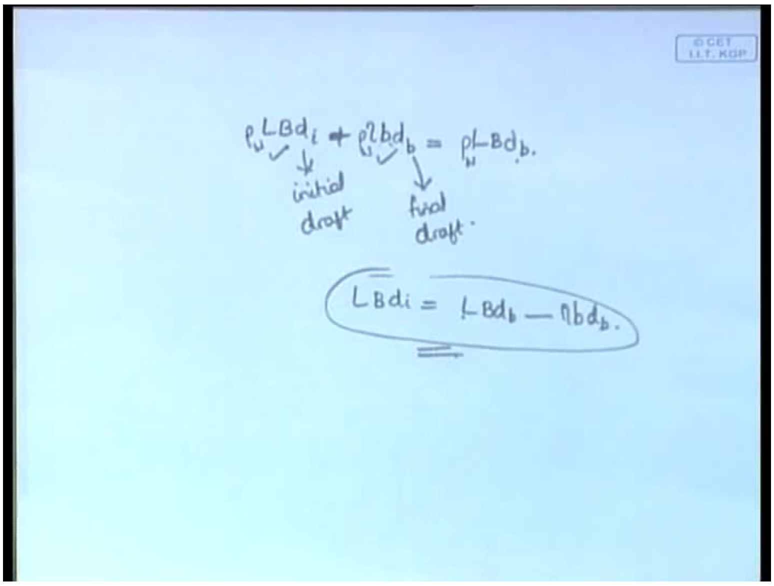

Now, what we can do is see, we can write a formula like this for instance, LBd i some notations are different - I mean last time we used, it is because of the difference in books. The other books uses T for draft and this uses small d for draft both are draft; d i represents the initial draft d b represents the final draft that is all this is the initial draft d b represents the final draft. We are doing all these problems for box shaped vessels only we are not going to do it for real ships, because the problem becomes slightly more complicated because finding the volume and all that.

These problems are with the box shaped barges. Here, what this formula says is that LBd i will give you the initial volume. Now, initial volume of the underwater in the ship multiplied with the density of water will give you the weight of the ship using the Archimedes principle. So, LBd i into rho give the initial weight of the ship, I am just removing rho from this completely.

If we will just put it because it is easier to think of weight than volume, initial weight of the ship is this, this represents the weight of water added, rho l l is the length of the compartment, b is the breadth. In this case, we just write it general we assume that the whole breadth is not bilged maybe; only part of the compartment is bilged so only some small b is bilged. If d b is the final draft, so what has happened? Water has entered and the ship has sunk and it has come to a final draft of d b.

Therefore, initial weight plus this represents the weight of water added represents is equal to rho w into L into B into d b this represents the final weight of the ship. So, all these equations represent really is that initial weight plus weight of water added is equal to the final weight of the ship. When you read it you can do it in many ways, it is means you can usually, this is what the equation represents and it is easiest to see it in that fashion. So, I explained that so that there is no confusion with the equation as such.

Now, we can see it as a loss of buoyancy. It is not that it directly you cannot think that think of it as a loss of buoyancy it is slightly more difficult instead of weight. What you are saying is that this represents the initial buoyancy is equal to - this is the final buoyancy minus the loss of buoyancy at any rate this is the equation.

Now, I think, you can just remember this equation, so that you can apply to the problems. This equation is enough really if you want to do problems on bilging this equation is enough. What I said before about method of that is just to show you what the method is to be followed but, this equation is all you need. Not just know the equation, you know what the equation means, like this equation way initial weight plus weight of water added is equal to the final weight. Just make sure that you do not confuse these d b s di s and all that. If you really understand then you would not confuse it. So, this is the equation that we need and using that we can do some problem.

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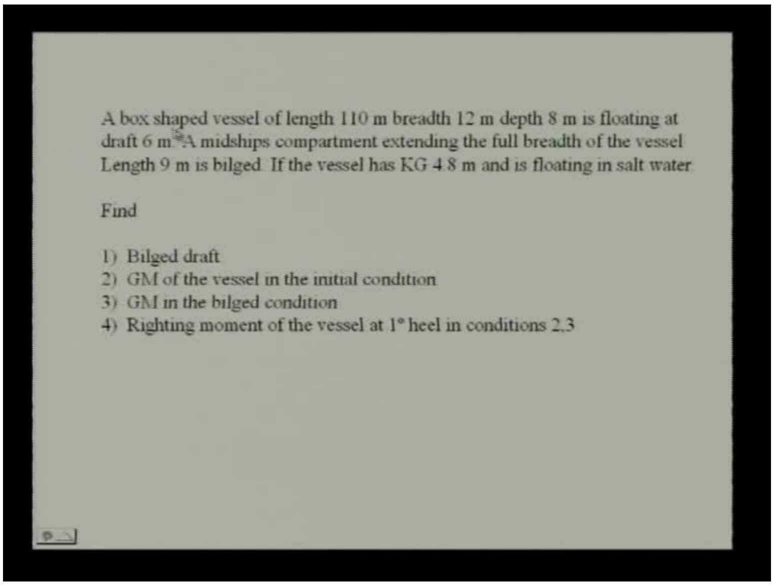

For instance this one says that there is a box shaped vessel, which has a length of 110 meters, it has a breadth of 12 meters, and depth of 8 meters is floating at a draft of 6 meters. The mid ship compartment extending the full breadth of vessel of length 9 meters, so the length of the compartment is 9 meters and it is extending the full breadth of the vessel is bilged.

Now, you are told that vessel has a KG of 4.8 meters and floating in salt water. Now, you have to find the bilged draft. GM of the vessel in the initial condition, GM in the bilged condition and the righting moment at 1 degree of heel in conditions two and three means, in the initial condition and the bilged condition, so this is the problem.

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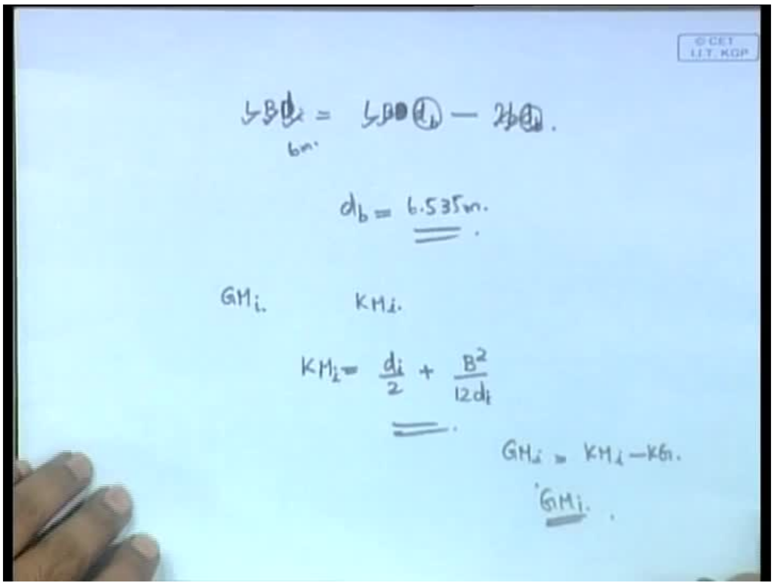

Now, what we can do is we just apply this formula LBd initial is equal to LBD not this small d LBd in the bilged condition you can say minus LBd in bilged condition. This formula if we use in this case, let us see, L is given length of the vessel, B is the breadth of the vessel is given then d initially is the initial draft that is 6 meters that is given. Now d b we do not know, so this we do not know, this you are given you are told that 9 meter is the bilged and the whole breadth is bilged, so B is also the whole breadth. Straight away it is very straight forward problem d b is equal to - you will get 6.535 meters so this gives you the final draft of the vessel. So, the initial draft was 6 meters it increases to 6.535 meters.

Now, the first question is the bilged draft that we have done. Then next one says, GM in the initial condition GM initial now, for that you need to find KM initial in the initial condition. Now, remember this is the box shaped vessel you have that formula for KM; KM is equal to d by 2 plus B square by 12d, there is this formula for box shaped vessels. We have talked about the initial condition or the intact condition, so the intact means initial condition. So, KM is equal to d initial, so this is KM initial, B is d i. You just do this you will get your initial KM, this gives initial KM of the vessel then, GM initial will be therefore, KM initial minus KG. KG is fixed; KG is given as 4.8 meters - so nothing to do - so GM, this is the GM in the intact condition. Then you are asked the GM in the bilged condition.

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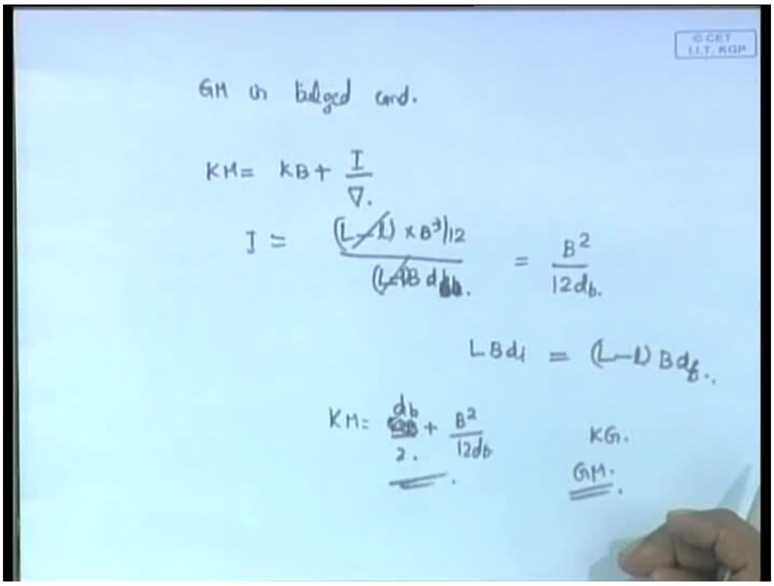

For that you can do it this way, you can actually do it in two ways: KM I will tell you can do it as KB plus BM that is one way of doing it KB plus BM or you just can apply the formula but, if you do this way KM is equal to KB plus BM is I by del. Therefore, the question is what is I and del? In this case are we following lost buoyancy or well, they have followed the method of lost buoyancy. If we followed the method of lost buoyancy this becomes KM is equal to I becomes L minus l into B cube by 12 divided by volume is L into B into d; d this is in the bilged condition d final, so d is in the bilged condition.

We have already calculated the d in the bilged condition, sorry I think made a mistake, no this will be d initial, why is the question. See the thing is you can write it in two ways, we have seen this is the method of lost buoyancy. So, the method of lost buoyancy we say that the displacement does not change, so we are talking about the initial displacement so LB, you are wondering why? Now, this will become equal to L minus 1 Bd f. If I had to write it in terms of d b like you said, I would have to write here. That may be is the better way to write it but, at any rate you have to see, what the volume is. Both you have to use the same concept that is the thing means the numerator and the denominator; means I and the del it does not matter, you can use either the method of lost.

See this is the general formula KM is equal to KB plus I by del is the general formula it is true for all cases, because KM is equal to KB plus BM. Now, this I by del when you are doing it you have to be careful. This I by del either you do both using the method of lost buoyancy or you do both using the method of added weight. Let us take the method of lost buoyancy in this case, then I will become L minus l into this thing what I have written and del is the original volume; volume does not change in case of buoyancy, so it is LBD initial or L minus l b into d final.

So, this L will cancel out and B will cancel out, so d b, actually it will just become this B square 12 d b that L minus l will cancel out. You can just do it this way KM is equal to KB plus B square by 12 d b, where KB is again half of that so it just becomes that formula only d b by 2. It is just that formula but, when you do it like this you will see what the mistake is in the thinking process. That is only confusion in lost buoyancy and added weight. So, you do this that will give you your KM.

Once you have your KG, you find GM then what else is asked righting moment; righting moment is very straight forward nothing in it. You can calculate two righting moments: righting moment you can have in the intact condition or you can have a righting moment in case of bilged condition.

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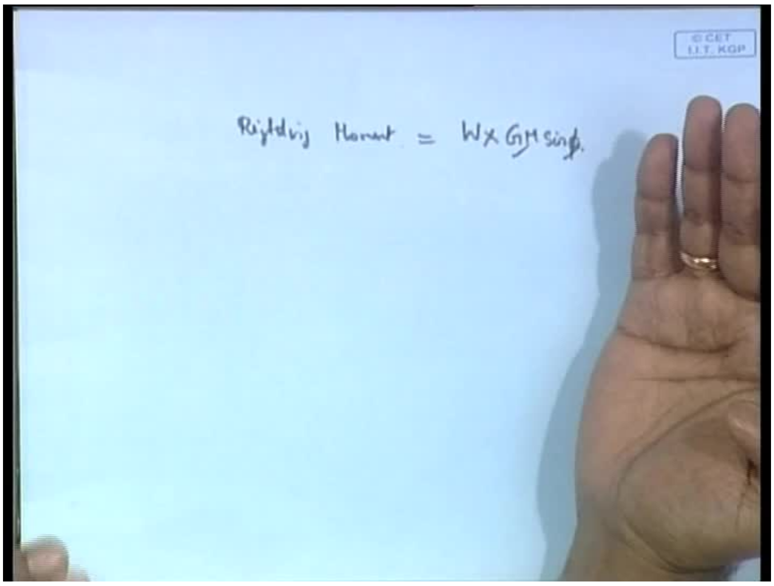

The righting moment is given by the weight of the ship into the GM sine phi. You asked the righting moment at 1 degree heel, so phi is known, GM we have just calculated if you use the one for the intact condition you get for intact righting moment and the other one you get the damaged righting moment. Now, as you can think by intuition itself, you will see that when always you have bilging the righting moment decreases as a result of bilging.

Righting moment is a tendency for the ship to come back to its original position, so greater the righting moment it is like greater the ship is stable. As the name itself suggest, when you have damaged the stability decreases and it is true in this, if we look at the numeral numerical value, you will see that the righting actually decreases as a result of the ship, because of the bilging or the flooding of the ship the stability or the righting moment decreases other than that it is almost same.

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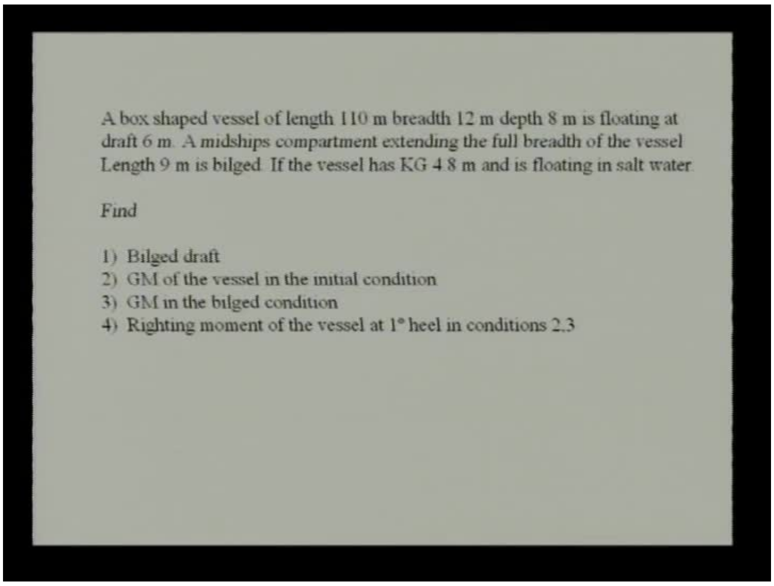

Then note that even though you have in this case flooding, you are not going to get negative GM. That does not mean anything; it means even though the ship is flooded in some point some compartment is flooded of course, it is in a damaged case but, GM is not negative. GM is negative in very extreme case, it is a very crucial critical case when GM becomes negative then it is highly unstable and may be even capsizes that is different. This does not mean anything you will still get positive GM, the ship is still stable as such but, it is flooded that is all. The only thing that has happened is there is increase in draft the ship has come down.

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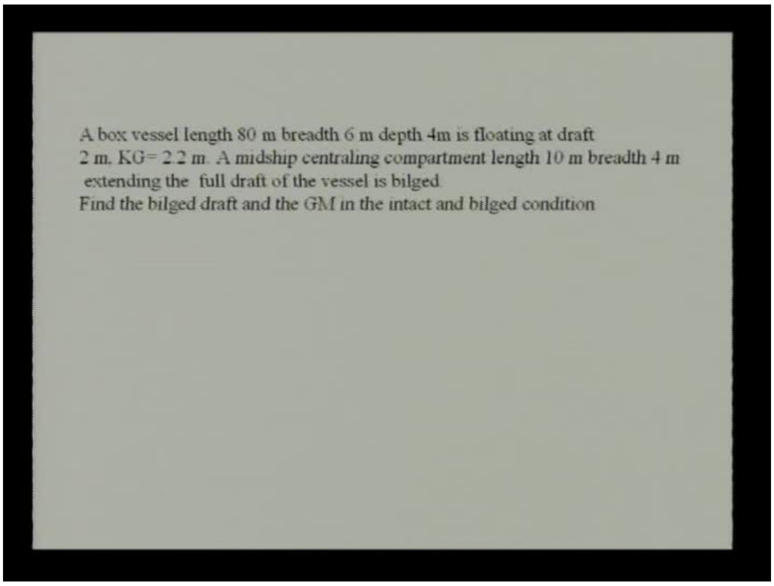

Then this is a very similar problem, you are told that there is a box shaped vessel of length 80 meters with a breadth of 6 meters and a depth of 4 meters, it is floating at a draft of 2 meters KG is given to be 2.2 meters. Now, in this case, a mid-ship means central part of the ship centraling compartment, so in the mid part of the ship a compartment of length 10 meters; so that is the length small l is given as 10 meters, it is breadth is 4 meters, extending the full draft of the ship is bilged. So that does not in fact goes without saying extending the full draft then, you are asked to find the bilged draft and the GM in the intact and bilged condition.

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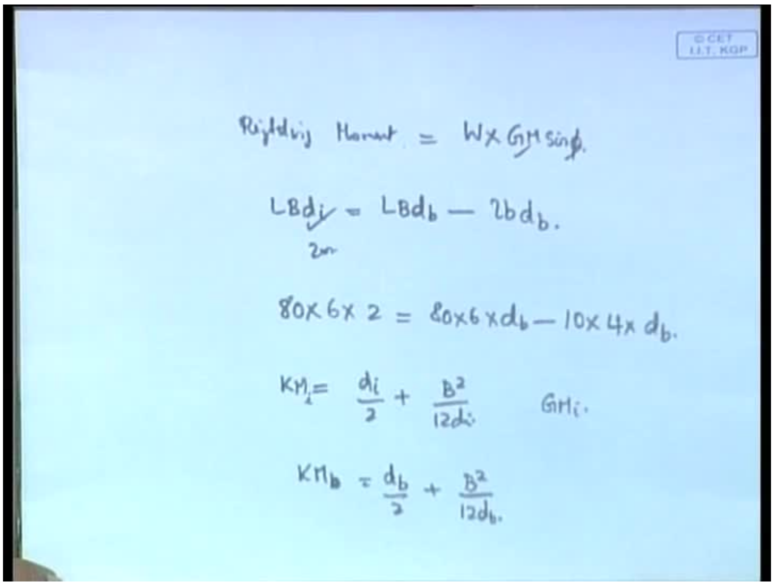

At any rate please write this formula at least when you starting this problem. At least this formula should be absolutely correct that is LBd initial is equal LBd after bilged minus lbd after bilged. So, this gives you the formula that you need to do this problems infact I think all the problems can be solved just by using this formula. Of course, really knowing what is the method of lost buoyancy and the added weight, if you know the concept otherwise, you will make errors in I and del like, we did last time I by del that some mistake, if you take one to be lost buoyancy and other to be added weight it becomes a mistake.

Once you have this LB into d i is equal to this, you can use - I think let us see L is given 80, capital B is given, depth is not required, this is the draft 2 meters, so d initially given 2 meters, so 80 into 6 into 2 is equal to 80 into 6 into d b minus l b, l is the length that is flooded that is 10 into 4. Now, only thing that is different is that the whole breadth of the ship is not flooded only 4 meters is flooded. So, 4 into d b that is all you can straight away calculate d b, which is your draft (Refer Slide Time: 50:50).

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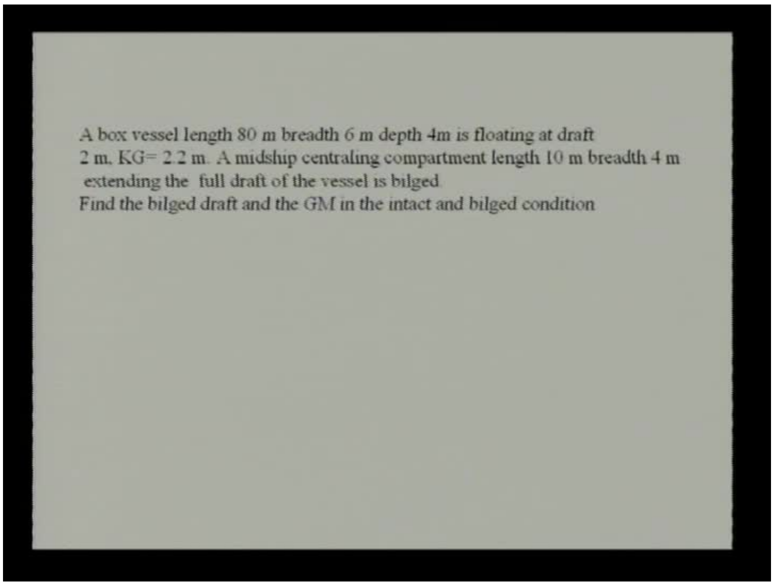

Then rest is actually same thing that is KM; KM, you can calculate in both the cases in the intact condition and in the bilged condition. KM in the intact condition becomes same thing it is di by 2 plus B square by 12 d I, so this will give you KM in the initial intact condition and you can even calculate GM I which is your GM in the intact condition. Then you do for bilged, you will get KM, you just do KM b; KM in the bilged condition d b by 2 plus B square by 12 d b that is the bilged condition. You will get GM in the bilged condition then well that is only thing that is asked. You are asked the GM in the intact and the bilged condition and you are asked the bilged draft. Actually this is quite simple, the next problem we cannot finish it today. So, we will stop here, thank you.