Hydrostatics and Stability

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Module No. # 01

Lecture No. # 24

Trim Calculations -II

Yesterday, I derived an expression something like this.

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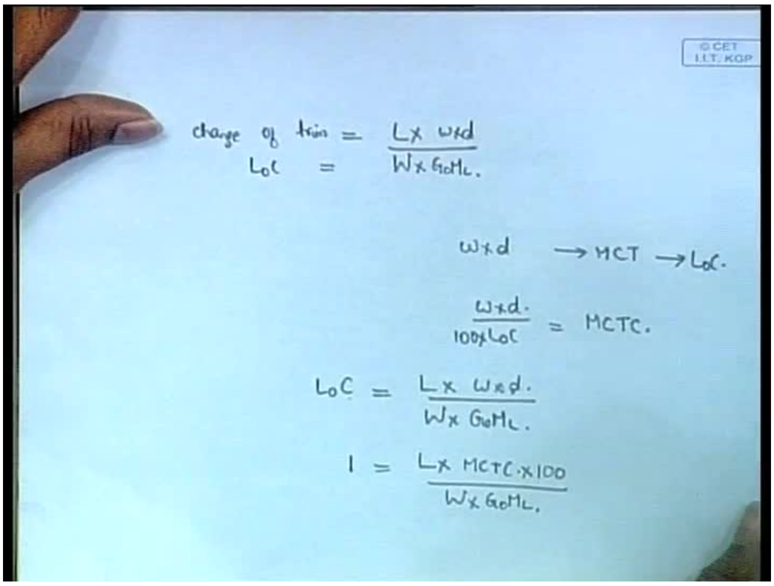

I derived an expression of this format; that is, I said that if there is a weight that has been shifted from the forward to aft side, there is a change of trim and we derived that. The change of trim, which was defined to be L 0 C, we said what is it? It is W 0 W L plus L 0 L 1. Like that we defined that L 0 C - the change of trim is equal to L into w into d by capital W into G 0 M L.

Now, we know that w into d is the moment causing trim, therefore it is producing a trim of L 0 C. Therefore, small w into d divided by L 0 C is the moment causing a trim of 1 centimeter. If w into d is moment causing a trim of L 0 C, w into d by L 0 C is the moment that is causing a trim of 1 centimeter; that is what we call - 1 meter sorry, everything is in meters here. Initially, we are giving in meters, so w into d by L 0 C is moment to cause a trim of 1 meter. So, the moment to cause a trim of 1 centimeter is this divided by 100; this is MCTC.

Therefore, if I say that L 0 C is equal to L into w into d by capital W into G 0 M L. Let me replace w into d by L 0 C, I replace it with MCTC into 100. Or the other way around L 0 C - let me do this, 1 is equal to L into w into d by L 0 C, which is MCTC into 100 divided by W into G zero M L.

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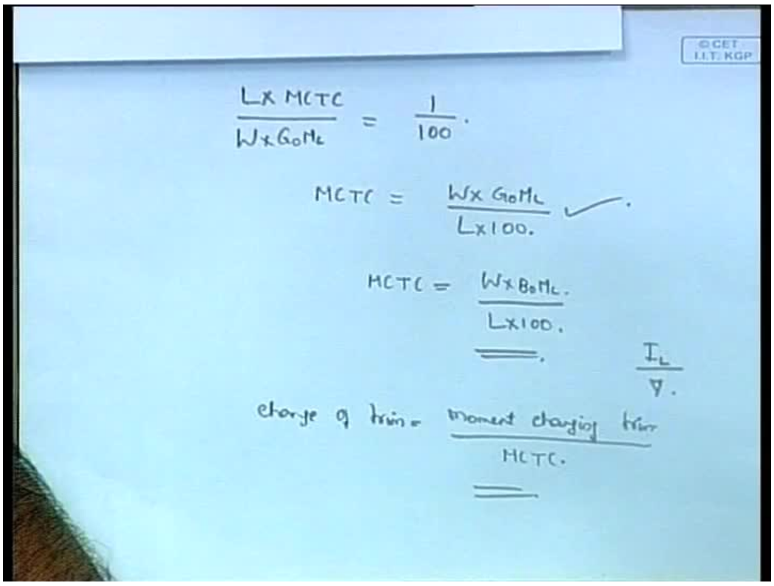

Therefore, L into MCTC divided by capital W into G 0 M L is equal to 1 by 100 or MCTC is equal to W into G 0 M L divided by L into 100; this is the final formula. In some case - what you have here is an expression relating to the - here note that we really are not requiring the weight that is moved. We already defined that a small weight - small w is moved from one side to another, without that weight we are able to calculate. If you are given the MCTC - moment to cause the change - moment to change the trim by 1 centimeter - if you are given that then you can calculate the L 0 C, everything using this formula.

So, first, you calculate M 0 MCTC is equal to W into this. In many cases, you will see that G 0 M L is many times replaced by B 0 M L, because the difference is not that high. That means we assume that G 0 and B 0 are almost at the same point, by that assumption - it is not exactly true, but some places this formula might be written as - the real formula is this, there is no doubt, it is definitely G 0 M L. But, you might seen it written as (Refer Slide Time: 04:31). This is to just facilitate some calculations, because B 0 M L that is another way to calculate B 0 M L, you know that. With this you can calculate B 0 M L.

Once you are given some parameters of the ship, like the length, breadth and all that, you can calculate I L. From that del also you can calculate and you can solve this equation. This formula is required;, now this formula is also required along with this and this I have already defined, I believe.

If MCTC is the moment required to produce a trim of 1 centimeter, if you have some M moment acting and then trim produced is M divided by MCTC - if MCTC is the moment required to produce a trim of 1 centimeter, if you have some M moment acting and then trim produced is M divided by MCTC. So that is a change in trim. The change in trim is given by this formula. So, these two formulas you need. Then, I think, I stopped here. Then, we will do a couple of problems.

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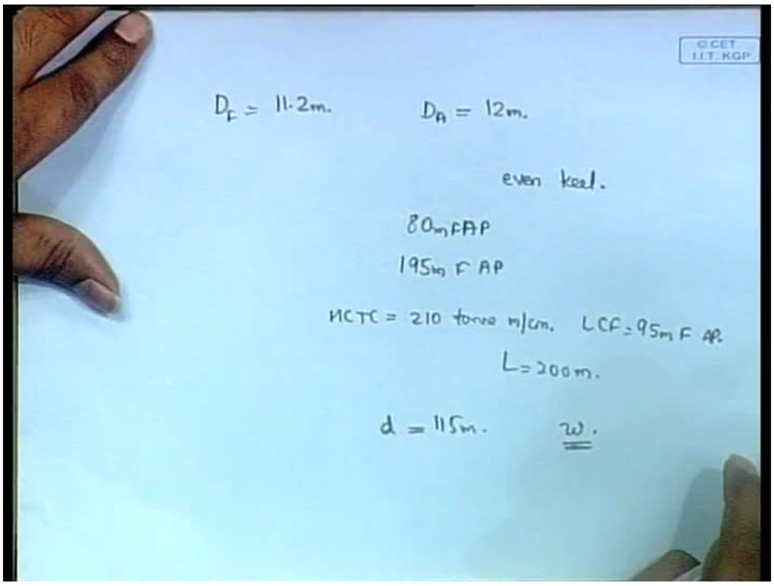

You are told that a vessel about to enter a port - this is not the port side - it is to enter a port, has drafts forward. So, draft forward equals 11.2 meters, draft aft equals 12 meters. If the vessel is to enter port on an even keel; that is your particular word, it is called even keel. Even keel means trim is 0, as the names itself you can guess it is even keel; you have trim equal to 0. So, if the vessel is to enter port on an even keel - that is a question.

If it is to enter a port at even keel, find the amount of ballast water, which needs to be transferred from a double bottom? Again, some names that you need to know.

Double bottom means a tank that will have - you are not doing any other naval architecture course, no. This semester are you doing marine construction and then I do not have to say that. So, from a double bottom, there is a double bottom tank, which has skin two layers. From a double bottom tank - ballast water is moved from a point, from a double bottom tank, which is 80 meter forward of AP to another tank, which is 195 meter forward of AP.

So, there are two tanks. There is a tank that is 80 meters forward of AP aft perpendicular and another tank, which is 195 meter forward of aft perpendicular. From one side, from one to the other, ballast water has to be moved, as a result of which, the ship should become even keel.

Now, you are given the MCTC equals 210 tone meters per centimeter, LCF 95 meter forward of AP and then the length of the ship is 200 meter. The question is how much ballast has to be shifted? First of all, we can find how much distance has to be shifted, 195 minus 80, so 115 meters. This is the distance through which a weight w of ballast water has to be shifted; this is what we need to find out.

Now, what is the corresponding change of trim? Of course, we are finding the minimum amount of trim - that is, rather what I should say, minimum amount of motion. Means, even keel it can happen in many ways. The minimum amount of motion required to produce an even keel that is what we find out.

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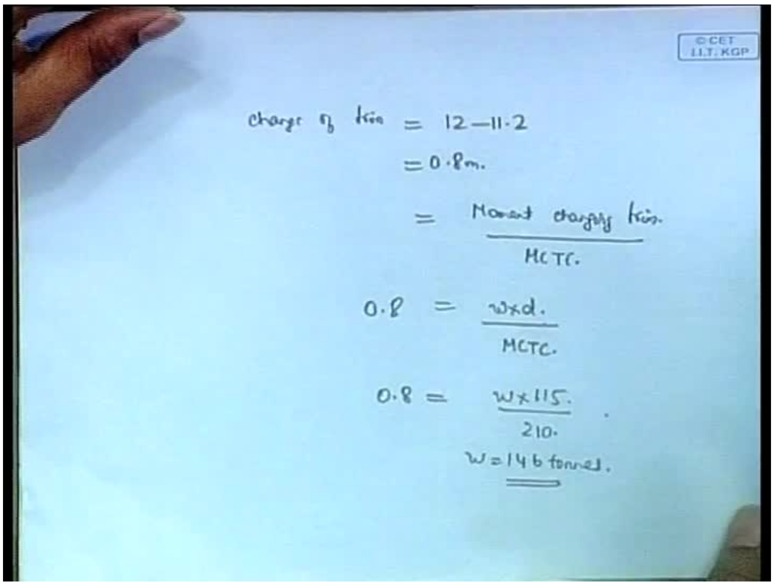

Therefore, the minimum will be the change of trim; that is, one is at 12 and the other is at 11.2 that much trim has to happen. Anyway it has to happen, whichever way it happens, means whether this goes down a little, this goes up a little or this goes down completely, whichever way it happens, finally this difference has to be sorted out. That difference should become 0, because it is even keel.

Therefore, the change of trim should be 12 minus 11.2, which is equal to 0.8 meters. This much of change of trim should be required. This formula, I think we have defined sometime before, should be this – this is that formula. Now, we have said that change of trim is equal to moment changing the trim divided by the MCTC, we have defined a formula like this (Refer Slide Time: 09:40).

Now, what is the moment changing the trim here; that is all, so the weight moved here is w, the distance over which it is moved is d; that we have already know. This is the moment that is causing the trim divided by MCTC. This w we do not know, but we know this, this is equal to 0.8 that is, it is just a solution, is equal to weight - we do not know - distance through which it moves is 115 meters, MCTC is given - 210 tones. So, this will give you w equals 146 tones; that mean this much of weight has to be moved from one tank to the other so that the ship becomes even keel.

I guess actually the question has a second part that you have to find the final draft. You have to find the final draft - aft and forward that is the second part of the question. If you want to find the final draft, what do you need to find? You need final draft - obviously you have to find it for the forward and the aft. From the problem, we know that it should become same in this case.

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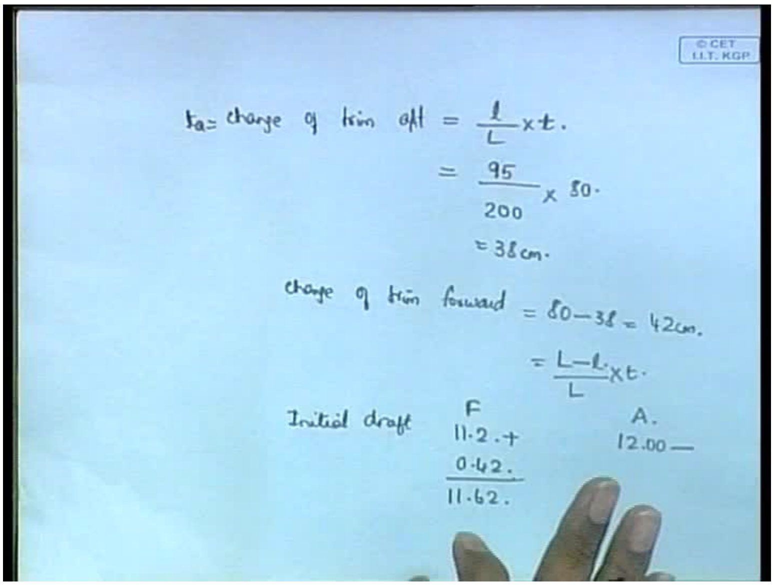

The final draft aft and final draft forward should become same, but how do you find it? But, obviously we find it separately, because yesterday we have derived some formulas to do them separately. For that we do it like this, change of trim aft side is equal to this formula - this is t aft is equal to l by L; l is the distance of - I think, center of rotation from the aft perpendicular divided by L is the total length of the ship into total change in trim. Total change in trim is 0.8 meters or 80 centimeters, so this will come to 38 centimeters. This is the change of trim aft.

Similarly, you find the change of trim forward. Actually that is very easy, you do not need to do it as such, you can just subtract from the total change of trim. Means, the total change of trim is 80, you subtract the change of trim aft and you will get the change of trim forward. But, the real formula is this that is again the same thing. This will give you the change of trim forward.

Now, how do you find the final draft? It is like this. You are told the initial draft - in the initial draft, let us take aft forward side. In the forward side, the initial draft is given to be 11.2; to it you are adding this trim. Aft - initial draft is 12, in this case, it is trimming -

this you have to check actually. Means, when it is trimming, one of them will always be positive and other will be negative, you have to see where the weight is moving.

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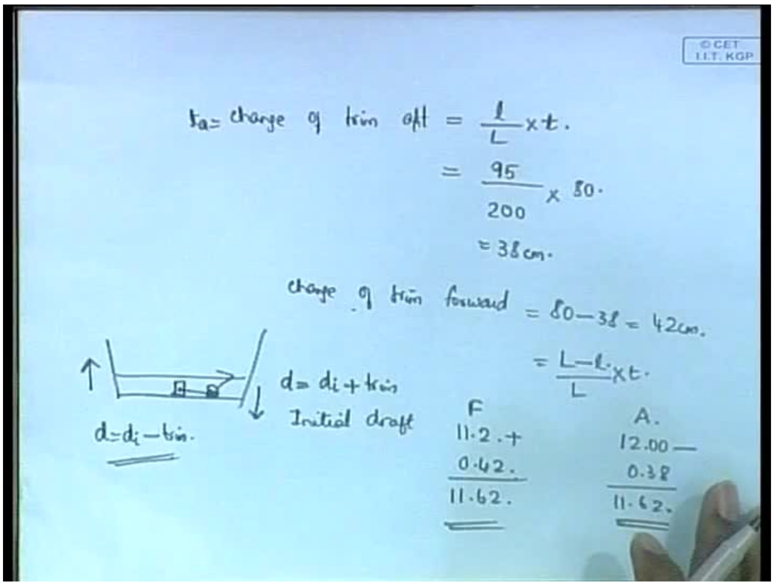

You have to see here. For example, see you are moving from 80 meters to 195 meters of AP, you are actually moving it forward, so the forward will go down. That will be positive, it will add up and the backward will - the aft side will go up, so it will become negative that you have to check each time. So, this is 0.38, this will also become 11.62.

Therefore, this will give you your final draft in the forward and aft section of the ship. As a result of shifting, the weight from here to here – forward, it is shifted here. As a result of the shifting of the weight to the forward side, the forward side of the ship will go down. Its draft will be initial draft plus trim on the aft side. Because of this going up, it will go up, therefore the final draft will be initial draft minus trim; not trim - change of trim actually.

Note that change of trim would not be the same forward and aft ward. It will be given by change of trim forward is this; that means, out of the total change of trim, some part of it will be due to the change of trim aft, some part of it is due to the change of trim forward. Thus, you can really - instead of when I say this probably. You cannot imagine it, why it is happening, but if you look at that figure, which says the trim aft and trim forward, then you can see that it is exactly correct.

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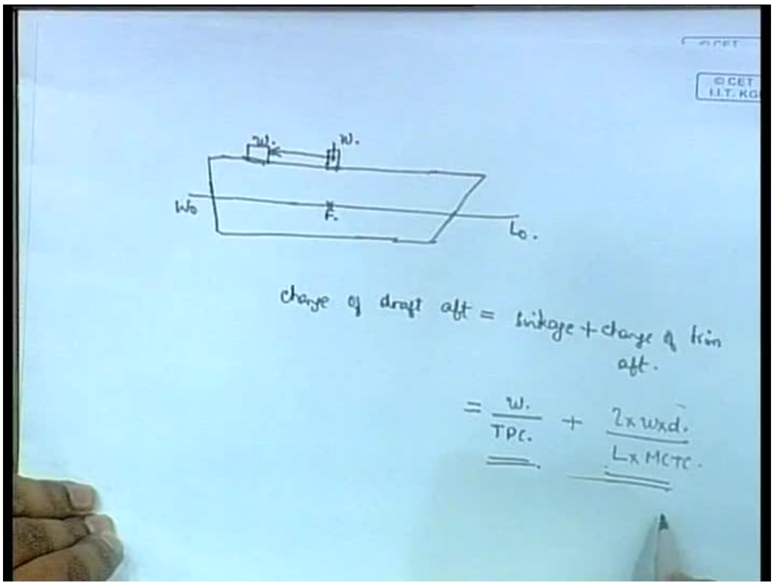

So, trim aft plus trim forward - change of trim aft plus change of trim forward, will give you the total change of trim. Depending on how the weight is moving, it will either be the sum or the difference; it will give you the draft - final draft. Suppose you have a ship, this is your initial water line W 0 L 0 and this is your center of flotation F. Suppose initially you add a weight here - exactly above F, some weight w is added - small w is added. Once you add the small weight w to exactly above the center of flotation, the ship will sink, it would not trim, but it will sink.

Once it sinks, suppose then you move this weight aft to some point here, now what will be the change of draft aft? It will be equal to the sinkage plus change of trim aft. These formulas you just have to memories, sinkage is always given by this formula - w divided by TPC; w is the weight added, TPC is tones per centimeter immersion. Therefore, you will get the sinkage in centimeters, not in meters plus change of trim aft, for that you have to remember this formula. I just derived it; well, somewhere I derived it, maybe yesterday. So, L into w into d divided by L - it is done, it is there somewhere; it is done no, so L into w into d by L into MCTC.

This formula - this is the change of trim aft and this is the sinkage. This will give you the final draft aft, so this formula is to be kept in mind. If it is the other way around means the signs can be different. For instance, if a weight w is removed from the center of flotation, this will become negative and this will also become negative, because if a weight is removed you say that a weight is removed in this - the removed weight is transferred in this direction. Which is like saying that a weight is removed - moved in this direction that will also be negative. That is, I mean, once you know this formula, you just apply it. When it is removed, you make it negative and when it is added, it becomes - w becomes positive like that.

One problem on this formula you have to remember, it is a fairly important formula. Then, you are told that a vessel is about to enter a river port over a bar. Means, over some - it basically - I will read the question. Where the maximum depth at high water is at 9.2 meters, she must have a minimum clearance of 0.5 meters and at present the draft forward eight point. See it is like this; that is, you are told that a ship has to enter port, you are told that the depth at the port region, whatever is given - 9.2 meters at high water, means that is the maximum draft - maximum depth.

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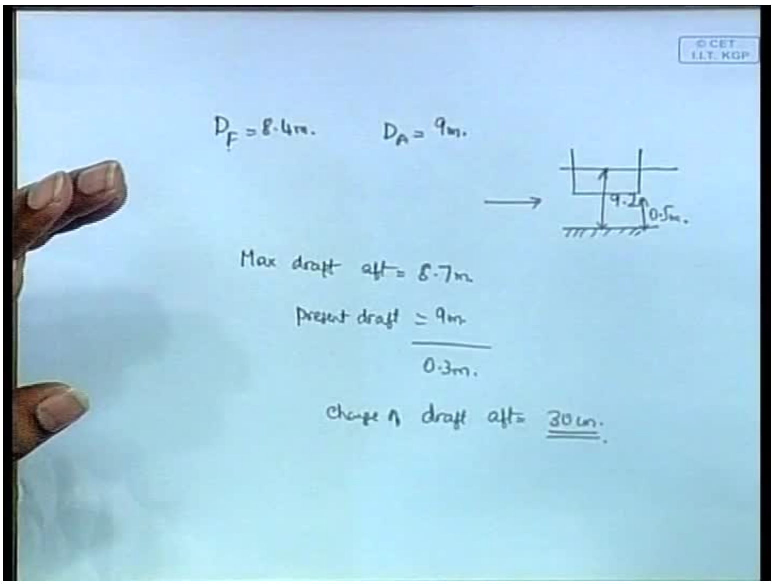

You are told that you are supposed to have a minimum clearance, it is like this. That is, the ship is entering a port - this is a port, let us say this is the water bed, from here water is up to this height. So, you are told that whatever it is, let says at high water, general meaning is that - this is about 9.2. You should have a clearance of about 0.5; the meaning is that when a ship enters here, first of all the ship has to be able to enter here. That means ship can at the most be 9.2 meters - that is the meaning of draft - the draft of the ship can at the most be 9.2 meters; that is the first meaning of this problem. If you are told that it should have a clearance of 0.5 meters, it means that this should at least be 0.5 meters.

That means, the ship cannot be 9.2 meters, it can only be 8.7 meters that is all; that is the meaning of this problem. So, a vessel is about to enter a port, over a bar, where the minimum depth is maximum depth is 9.2 meters. She must have a minimum clearance of 0.5 meters; that means the ship can have a maximum draft of only 8.7 meters; that is a meaning of that.

Now, it is told that the draft forward is equal to 8.4; draft aft is equal to 9 meters. As you can see, this is definitely exceeding your 8.7, this cannot enter; as in this format the ship cannot enter this port. So, some kind of trimming is required or going up - something has to happen that draft has to change.

Now, the question is how much water must be discharged? Obviously it has to - it is going up; that means, they are going to discharge water. The word discharge means, it is taken out of the ship, it is not shifting inside the ship. Then, they will say water is to be relocated or something, you will understand discharge word means it is going out of the ship. That means, the ship will go up as such, not just trim, it just parallel, not sinkage, the opposite of the parallel, floating - going up.

Now, how much water must be discharged from an after peak tank, with an LCG of 7 meters forward of AP? We will do the problem, it will be clear now. From the statement of the problem itself, as I said before, the maximum draft you can have - draft forward is only 8.4 that is ok - the maximum draft that aft can have, we have seen is only 8.7. 9.2 minus 0.5 clearance, so 8.7 meters only it can have. But, the present draft is 9 meters, it is given the aft, let us forget the forward side, its less than 8.7.

Therefore, the present draft is 9 meters; that means about 0.3 meters it has to go up - the aft side; that means this should be the change of draft aft, should be about 30 centimeters. This is another thing you should take care; that is, you need to figure out the problem, finally comes down to find what is the weight transferred or weight discharged and what the distance is. Two things - that is there can be two possibilities. First, you are discharging a weight, means the weight is removed from the ship itself; that is not moving inside the ship, it is just removed from the ship itself.

When you do that also, you will need to find out the position at which that weight is taken out. You will need the LCG for that that is definite. We will see why it is required, but you need that to find some moments. Number two is, in case the ship is transferred, I mean the water is transferred inside the - that is suppose that you say from a forward tank to a backward tank you need to find the distance over which it is transferred; that is also important.

So, two distances become important; one is the position of that LCG and other is the distance through which. In this problem, we are not actually shifting water inside, we are just discharging it. You need to find the position where the water is discharged, because then only you can find the moment lost. See some weight is lost at some point, means some moment is lost at that point. To find that moment, you need to find the distance where the weight is removed. Now, another thing is you need the distance where the weight is removed. The distance from the LCG that is center of gravity, we will look at this problem. This will become clear; that is, let us look at the plan view like this, of the ship.

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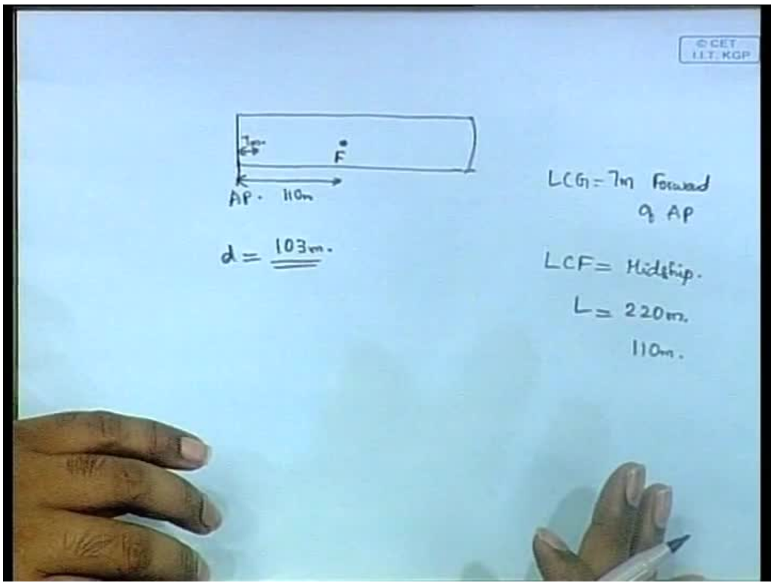

Therefore, somewhere here you have the center of flotation, then depending on this center of flotation - we have always say that the ship trims or moves, everything we have done about trimming, whether it is trimming aft or forward or parallel sinkage, everything is about the center of flotation, not about any other center, not even the LCG of the ship, it is about the center of flotation of the ship. That is mainly because, it is how it trims and it is because, volume aft becomes - the volume equal to volume forward; that is because of the reason why it trims about the center of flotation.

So, every measurement we do here, we do it about the center of flotation. This weight that we are removing in this problem, we need to find where it is being removed; Let us look at that. It is said that you are told that the water is discharged from a tank 7 meter forward of AP. This we will consider as AP, so 7 meter forward of AP, here - water is discharged. But, note we do not want distance from AP; we want the distance from F that is W. I mean that w into d or any d that we are using moment - we are always taking moments about the center of flotation not moments about the AP. So, we need the distance from this that means we need the distance of the center of flotation.

You are told that LCF is mid ship - exactly mid ship; that means you need the length of the ship. Now, the length of the ship is given to be 220 meters, therefore mid ship is 110 meters from aft perpendicular. So, this is 110 meters, therefore the distance between F and this position where the weight is discharged is 103 meters. This you have to find, this is your d - the position where the weight is discharged.

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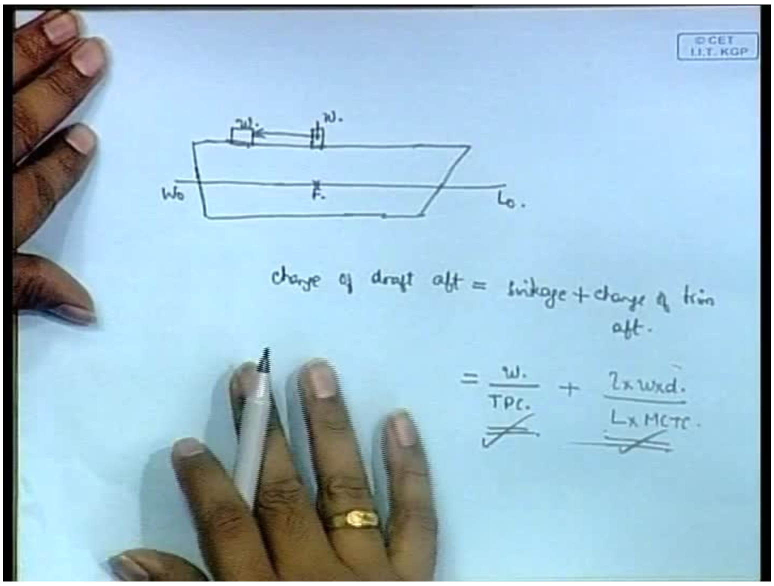

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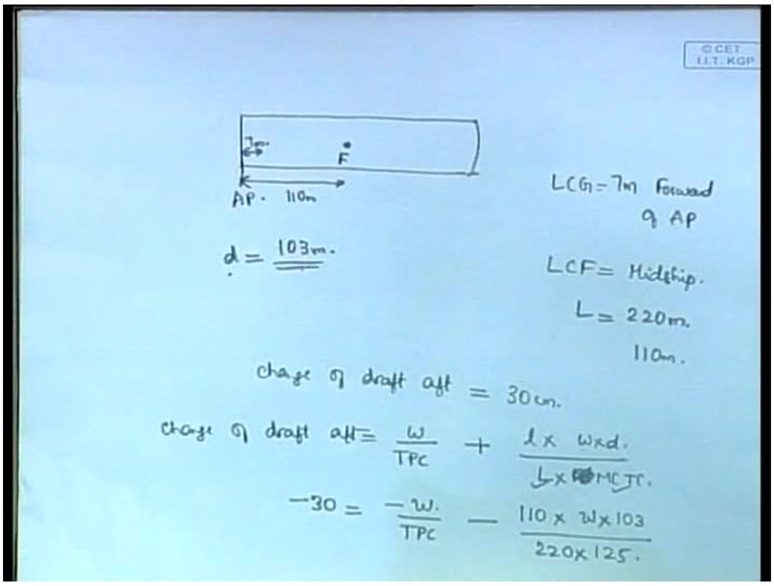

We have derived a formula here - this formula; that is the change of draft is equal to sinkage plus change of trim; it is w by TPC plus this. Now, this formula is what we are going to use here. It comes to be - from our previous part, we see that the draft has to change by 30 centimeters. If the ship has to cross that port or it has to enter the port, its draft aft - in the aft side, the draft should be reduced by 30 centimeters. Otherwise, the ship cannot enter, we have seen that (Refer Slide Time: 27:40).

Therefore, the change of draft aft - we are doing the minimum, we can of course make it lesser, but there is no point in that. Change of draft aft is 30 centimeter, we use the formula change of draft aft is equal to w by TPC plus l into w into d by L into MCTC, this formula you have to use. Now, note that in this case, everything will become negative, because it is a discharging of weight.

Therefore, it is a decreasing of draft, so it will be minus 30. Minus 30 will become minus w by TPC, minus l is the distance of the center of flotation - you have to know what each of these terms is that that is very important one. I will repeat, l is the distance of the center of flotation from the aft perpendicular; that is small l, w is the weight of the water or the weight that is discharged or added; D is the distance of the point where the weight is discharged or added from the center of flotation; that is very important, it is the distance from the center of flotation.

You will see that if you look at the derivation, otherwise of course you cannot know. If you remember, do the derivation you will see that d is the distance from the center of flotation, L is the length of the ship, then MCTC is the moment to change the trim by 1 centimeter. This has to be written in centimeters, because see w divided by TPC will give you the sinkage in centimeters, not in meters, because TPC is tons per centimeter immersion that is how TPC is defined, so w by TPC.

Similarly, l into w into d by this will also give you trim in centimeters; you put 30 centimeters minus this thing. Here, the center of - LCF is mid ship is given, whose total length is 220, so mid ship is at 110, LCF is 110 (Refer Slide Time: 30:00). Weight that is to be added or removed - so we calculated it, I think or it is given - that is what you require to find out. So, w into the distance where the weight is to be removed is here - this thing 103 - distance from the center of flotation 103 – 103 meters divided by l is the length of the ship - 220 meters and MCTC is given for this problem – 125. So, you just solve this equation for w.

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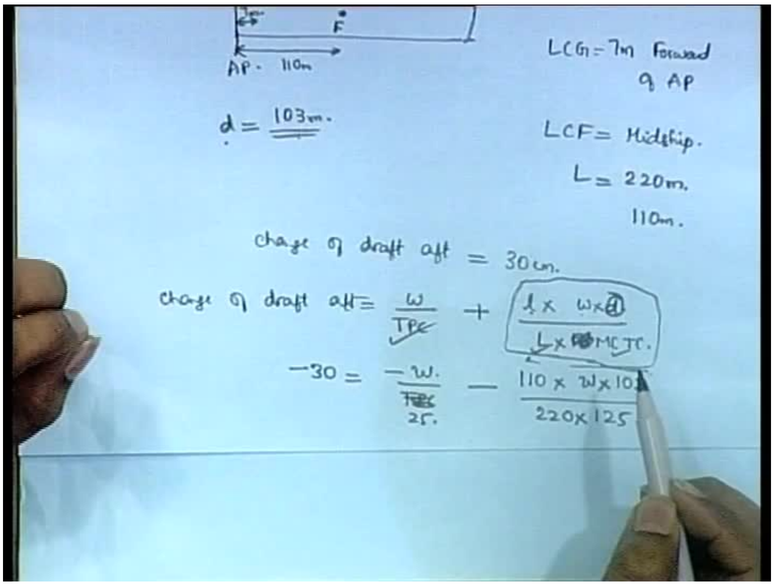

Only w is the unknown, so TPC is also given - 25 tons per centimeter; that is all. So, everything is known in this problem, you just need to remember this formula that is the total change. Just need to know, it is very logical only, total change of draft will be the change of draft due to parallel sinkage plus the change of draft due to trimming, whether plus or negative you just check. These equations - the change of trim equation this is very straightforward, very simple.

This I do not think you derive as such, so this you might have to remember. I mean you can derive it of course, but better you memorize it. I think, you have to know exactly what each term stands for l, w. This d for instance - it is not the distance from the aft perpendicular, d is defined to be the distance from the center of flotation; that is very important, otherwise the answer will be wrong. Then, in this problem, you just solve for w, it becomes 66.4 tones (Refer Slide Time: 32:15).

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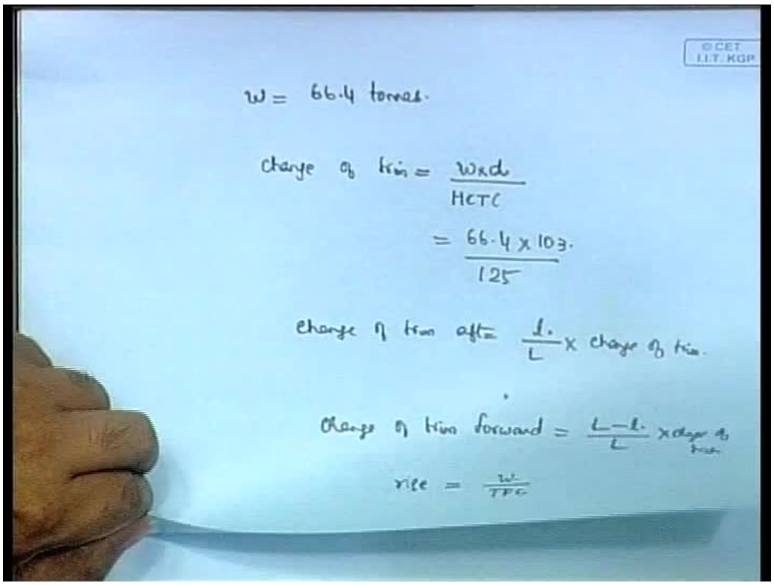

This is the amount of water that needs to be discharged at that point. Then, you can also find the final values of trim; I mean the final values of draft that this procedure is exactly the same. The change of trim is given by w into d divided by MCTC, there is no difference to this step, it is always done like this; change of trim is equal to w into d by MCTC.

So, w we have just calculated - 66.4 tones into d is the distance through which it has moved - it is done from the center of flotation divided by MCTC 125; so, you get that. Then, you need to find the change of trim in the aft side, this formula also you just have to remember, l by L into change of trim. Once you have a total change of trim, you need to do l by L into change of trim, will give you the change of trim aft. I think you can do that.

Similarly, you have to find the change of trim forward, that will give same thing and it will be like this, L minus l by L into change of trim that you can find. So, this gives you the change of trim, note that there is always two things change of trim and parallel sinkage or parallel rise.

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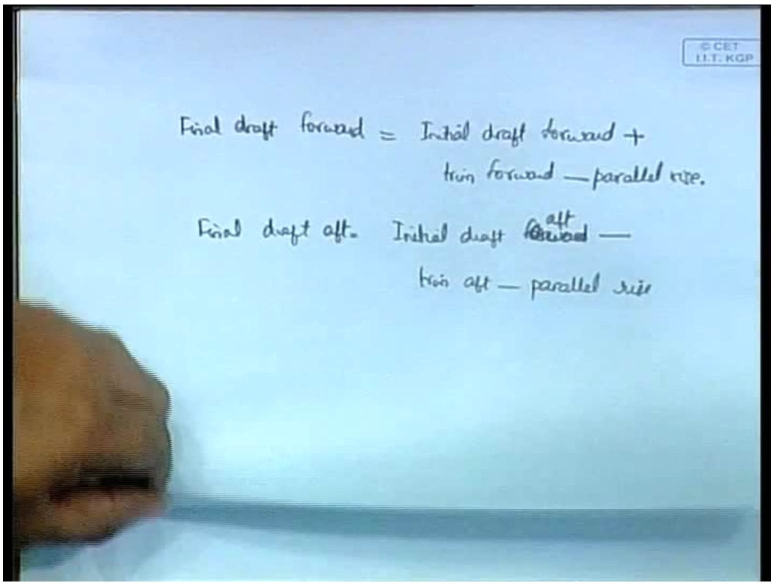

There is also a rise because of the discharge, so that rise will be given by w by TPC; that you just do and that will give your parallel rise. Therefore, your final draft is always like this - the final draft forward in this case – you have to see, in this case, in the aft side, a weight is removed, therefore forward will go down, forward is plus and aft is minus.

So, final draft forward will be initial draft forward - whatever is given - initial draft forward plus the trim forward minus parallel rise, this will give you your final draft forward. Your final draft aft will be your initial draft forward minus trim, not a forward aft. So, final draft aft will be initial draft aft minus trim aft minus parallel rise. So, this will give your final drafts, it becomes 8.64 and 8.7.

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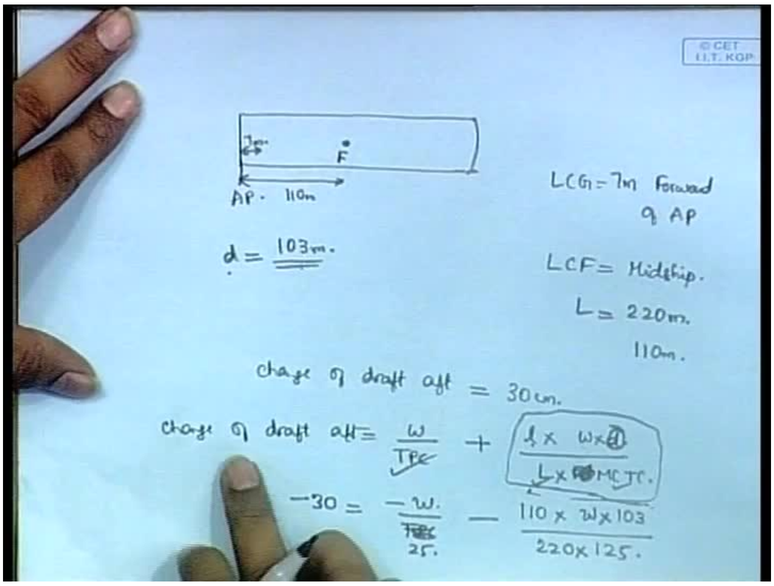

Now, one special case that is possible is that in this equation - in this, i do not think, where is it? Yeah, in this, suppose you have a change of draft aft given by this formula - this plus this (Refer Slide Time: 36:40). Now, it is possible that in a particular case, you can have such that the change of draft is zero, but these two still exist. That means, you can - for instance, this can go down, it can sink and this can trim up, such that the two things can cancel out or this can rise and this can trim down. So, that is a special case that is possible when your change of draft is zero, but still there is sinkage and trim.

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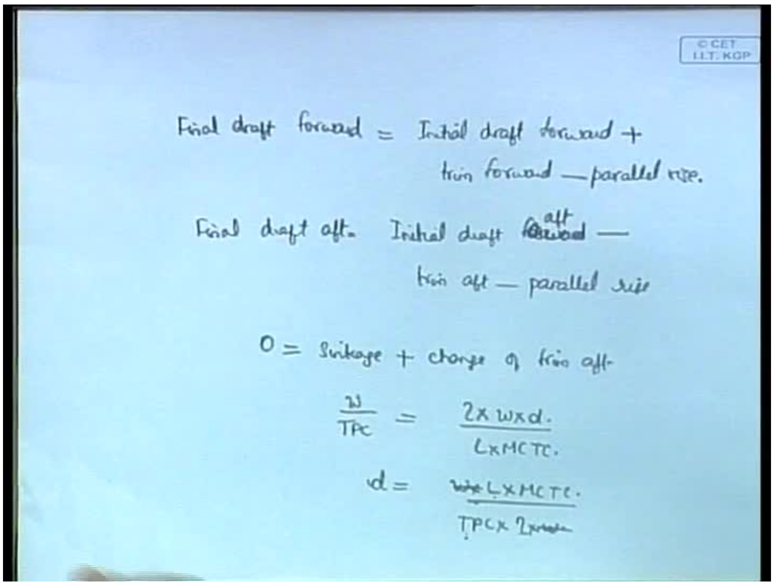

In such a particular case, what you are saying is that 0 is equal to sinkage plus change of trim aft. You will have sinkage is equal to minus change of trim, so you will have w by TPC will become equal to L into w into d divided by L into MCTC, this formula. It is just a particular case.

Suppose you are adding a weight in this particular case, the position at which you add the weight, you will get like this, w into L into MCTC divided by TPC into L into w, w will cancel out. In this particular case, you see that it does not depend upon how much weight you are adding, provided you add weight at this position - d in such a fashion. Means, if you design your d to be this, it does not matter what weight you are adding, how much weight you are adding, your draft will always be constant, draft aft will not change.

At that particular point, where d is defined by L into this divided by TPC into l - small distance, if in the ship at that point, there is a one particular point such that at that particular point if you add whatever be the weight, your draft would not change in the aft side and in the forward side also. That forward side it might or might not be same, it can change, it will change most of the case. What you say, it is possible; that is what I am also saying, it is possible, they can cancel out. Now, that is why I said it can happen also, draft will be - that will always be of opposite sign.

Sinkage will be same for both the sides, yes. If one is negative the other will be positive always, I think that is correct. So, it is not that it can be, I guess, it will always be there that there will always be a trim in the forward side though the trim in the aft side is always 0. I mean, it can be 0, if it is 0, there will always be trim in the forward side 1.

What is reverse no that is a different case, I am saying that in case the draft backward in the aft is 0, can the aft forward also – not the aft. If the draft in the aft side is 0, can the draft in the forward side also be 0 that is what I am saying. That is not possible, but draft in the forward side can be 0, the draft in the aft is not 0; that is also a possibility, but that is not what we are talking about here.

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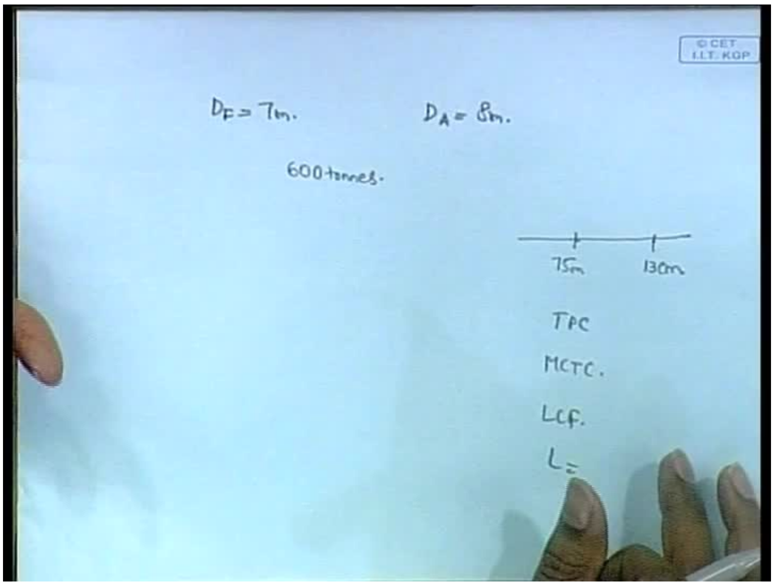

There is one problem on this we will do this. Now, you are told that a vessel is floating at a draft forward of 7 meter, draft aft equals 8 meter, you are told distribute 600 tons of cargo between compartment 1 which is at a LCG of 75 meter forward of AP to a compartment 2, which has an LCG of 130 meter forward of AP so as to maintain the draft aft constant.

You are going to transfer 600 tons of cargo and it is to be transferred between like if this is a ship at 1.75 meter forward 135, so 75 meter forward to a region which is 130 meter forward from here to here you are shifting a weight, so you are told how much distance it is shifted that is also told. You are told that the draft aft should remain constant it does not change, you are asked to find the final draft forward. You are given the TPC, MCTC, then LCF means position of the longitudinal center of floatation and you are told that the length of the ship is so much.

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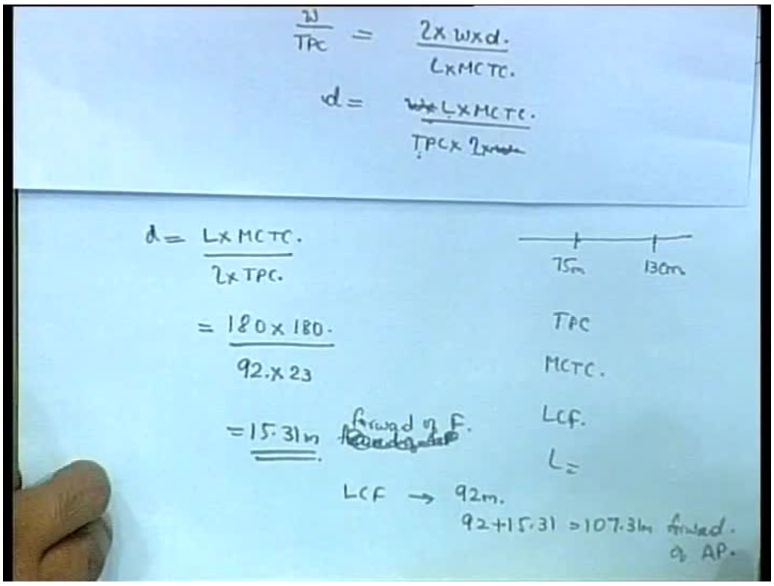

Now, straightaway we can use this formula there is nothing much to do actually; so d is the distance through which the weight has to be shifted, it is equal to L into MCTC by TPC into L. If we just put this formula distance through which it has to be shifted is equal to L into MCTC divided by small l into TPC. This is given 180 is your length of the ship MCTC is again given to be 180; only problem here is to know exactly what each of these small l capital L all those things is small w d etc everything you should know.

You are told that the LCF is at a distance 92 meters forward of AP and TPC is given to be 23 tones per centimeter, so this will give you 15.31 meters forward of AP, d is the distance from the center of floatation forward of you have to direct it is from the center of floatation. Actually it is written as like this forward of F forward of the center of floatation not AP forward of F 15.31 meters forward of center of floatation.

Now, you are told that 15.31 meters forward of center of floatation, then you are told that LCF is at a distance of 92 meters from the aft perpendicular, now the weight has to be moved from 15.31 meters forward of F which means 92 plus 15.31 which is 107.31 meters forward of AP forward of aft perpendicular, we are just writing it like that one that is the distance from AP.

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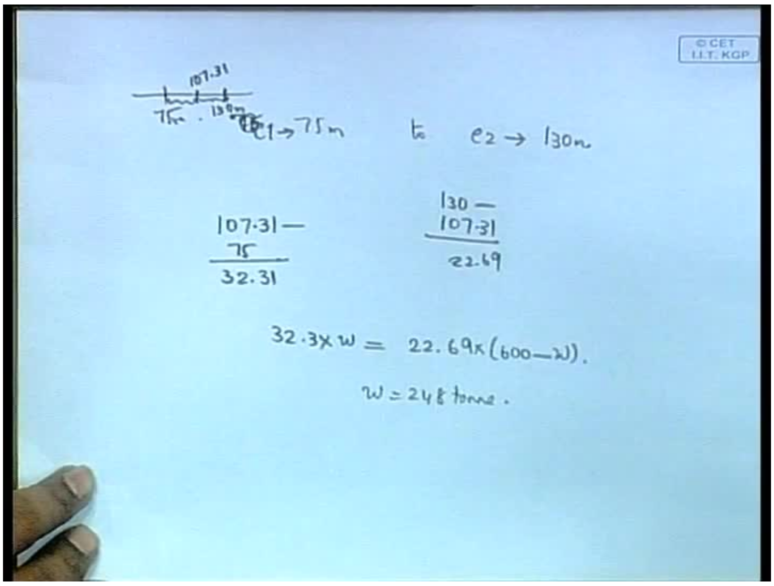

You are told that compartment 1 that is the movement of weight is from like this from 75 meters forward of AP to 130 meters forward of AP, so 75 meters to this is compartment 1 to compartment 2 which is 130 meters forward of AP. Now, 1 minute that is the G of 1 G of 2 30 G from aft perpendicular 600 tones is added no it is not like that its actually told distribute 600 tones means exactly some of that weight is added at 75 meters and some of that weight is added at 130 meters center of mass will be 15.31 from center of floatation that is what they have done and therefore if w therefore there are two things at 75 so this thing this 15.31 or forget that.

We take this 1 distance from AP because everything is given as distance from AP this 15.31 meter forward of F is actually 107.3 meters forward of AP. Let us take that 107.3 meters somewhere around here you have the G means, let us say that w amount of weight is added at 75, 600 minus w amount of weight is added at the other point at 130 as a result of which your center of gravity becomes at 107.31 that is a problem.

So, what you do? You say that moment like this distance it is 107.31 minus 75 that will give you 32.31 that is this distance, at this distance is 130 minus 107.31 the first distance 32.31. Let us assume that w weight is added on that side if you had a doubt I will just this is 22.69 into 600 minus w. All we have done here is the problem says that there are 2 tanks there is a compartment 1, compartment 2 there are 2 tanks in that compartment 1 I am adding w weight another tank I am adding w 2 weight such that w 1 plus w 2 is equal to 600 tones that is given; but we do not know how much is added in each of them.

From our first part we saw that the net center of gravity of the weight added is at this point 107.31, now we just find out the center of gravity that is all so this 32 point I think this is very obvious it gives you 248 tons. Therefore, what we are saying is that a w of 248 tones of weight is added on first compartment the remaining whatever 352 tones of weight is added in second compartment and when you add it like this it will produce a center of gravity at some point.

I mean it is like the total amount of weight of 600 tones is added at the center of gravity when you are adding something here and something here it is like adding the total weight at the center of gravity. When you are adding at the center of gravity this formula holds that d equal to L into MCTC only thing you have to take care is that d is the distance from the center of flotation and not from the aft perpendicular that conversion you have to do.

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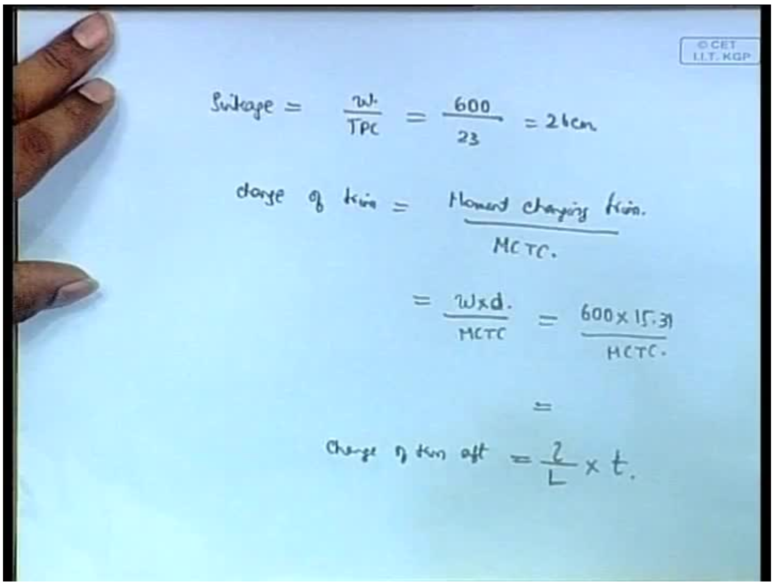

This is the problem as such then this is the main part of the problem of course, you are also asked to find. Once, this weight is added in this fashion what is your final position of draft that is the same thing we have to done many times. You do this that is first you find the sinkage; here we are adding some weight in one point and point so total weight added this is very straightforward. You are told that the weight added is 600 tones is added by 23 is equal to whatever 26 centimeter, this much of sinkage you get. These two formulas I think just use the same thing always.

This formula should be used all the time change of trim is equal to moment changing the trim divided by MCTC, here slightly tricky thing again moment changing trim what is the moment changing trim? It is w into d, but what is that d? d is 15.31 because d is the distance from the center of flotation again not from the AP it is only for the doing the problem that we take from AP, because it is slightly easier to think w into d by MCTC which will be in this case weight is 600 tones is added and d is 15.31 divided by your MCTC that will give your total change of trim.

Then you need to find the change of trim aft which is using this formula total change of trim, then change of trim forward which is total change of trim minus change of trim aft. Therefore, you get your change of trim forward and then your final draft is initial that again you have to check. In this case weight is added on 2 sides, so you have to see which side goes down and which side goes up. In this case, 248 tones is added in the backside and aft side and 352 tones is added in the forward side, more weight is added on the forward side so the forward side will go down that will be plus this will be minus aft will be minus that you have to check.

Therefore, the final draft forward will be initial draft forward plus the trim is it sinking or its weight is added, it is sinking plus sinking that will give you the final draft forward. The final draft aft will be initial draft aft minus the trim plus the sinkage change of trim aft is that what we are try to do change of trim aft is 0. Let us see actually the change of trim of they are cancelling out each other. So, the change of trim aft is not 0 change of trim aft plus the sinkage is 0; change of draft aft is 0 change of trim aft is still there. Two things are there change of trim and there is a sinkage, they sum up to produce a change of draft where change of draft is 0.

Yes, change of draft is 0 in this case they are cancelling out each other, this will give you your initial draft, final draft in the backward and forward side that is this problem. This is one type of problem that you can expect of course, these thing you can derive very quickly but lot of things you have to may be memorizing also lot of these formulas.

Some of the important things are, first is the expression for change of trim that definitely has to be remembered. Once, you have the total change of trim of ship you need to be able to find out the change of trim in the aft direction aft side and the change of trim in the forward side. Then you need to know what the parallel sinkage expression for that; that is more or less enough; other things are just applying it. You are saying that the draft 0 you said that equal to 0 that you can derive, so once you have this I think you can do it. I think we will stop here. Thank you.