**Hydrostatics and Stability**

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**Module No # 01**
**Lecture No # 26**
**Trim Stability – II**

Before I start, you know that we have split the marks into 50 marks for end semester, 30 marks for mid semester and there are 20 marks left. In that I usually give an assignment something that requires little bit of work, so maybe not tomorrow the class after that, I will give you the assignment, may be within one week or two weeks, you submit it.

It will be actually a big problem which will combine a lot of things. Most likely you will have to do computer programming all that and do because last time for instance, what I gave was like M curve. I give some vessel, you have to draw the M curve that means, you will have to first calculate it. It is much easier to do using a computer, you put those equations on a program, you can just get it at least an excel sheet, so that is easiest way to do it.

So, I will give you the problem in two classes, you submit it within two weeks and that will be for 20 marks.

That and all I do not care, you must know something, know FORTRAN or C or something.

Nothing like that, it is not that I except you to program using … I am not bother about programming but, to draw a very nice looking graph it is better to do it in a computer always instead of… that is all, whatever method. Some people did it in mat lab last year, some people did it in java and all, and it is up to you, whatever you know you use that, just do it using whatever is most comfortable, but a problem needs to be solved that is all.

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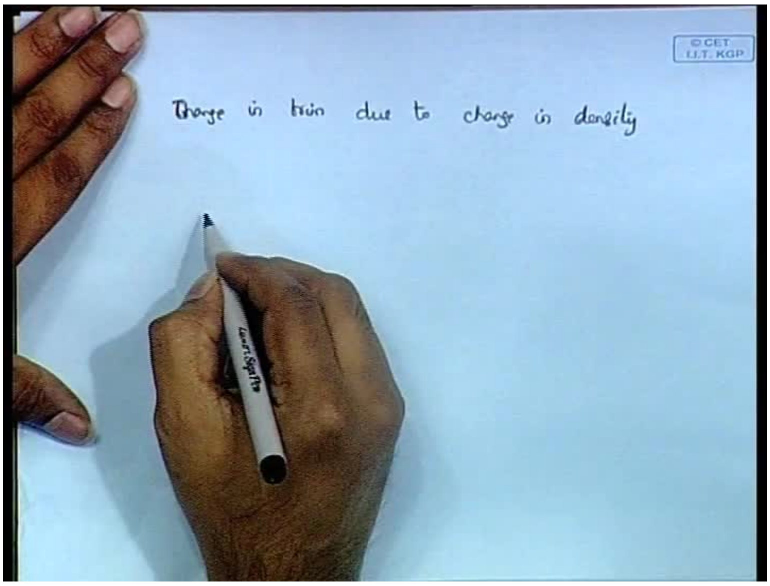


Now, let us look at the next one. Suppose that a vessel moves from a water of density rho 0 and it moves into another water of density rho 1, for instance a ship that is travelling moves from, what is it is called, it is called some kind of lake before it reaches a sea and then it moves into the ocean, for instance something like that.

So, it produces sharp changes in density and when such a change in density occurs, what will happen? First of all, a parallel sinkage will occur you know that, because the upward force or the buoyancy force is given by a rho into del, del is the underwater volume, rho is the density. If the density changes for instance, if the density increases obviously the buoyancy increases, therefore draft increases.

Another thing happens parallelly, when the density changes, one more thing that will happen is that because of the sinkage of the ship, you know that a small amount of volume is added at the top. Now, we can assume that this amount of volume is added at the center of floatation, center of floatation is the centroid of the water plane area really but, it can be assume to be centroid of that volume that is come at the top; so you can assume that this much of volume, new volume has been added at the center of floatation.

In general, you will have B, the initial B the center of buoyancy somewhere to the right or to the left, most likely to the right of the center of floatation. Now here, a new volume is added, now what will happen? It will trim, so just because of a change in density it will trim.

Of course, directly by intuition you will see that when there is a change in density, there is a sinkage, there is sinkage or raise that is directly coming from intuition but, if you know the mathematics you can also see that there will be trim also. The ship will go down or up depending upon the – well, it will come down only, because most likely the center of floatation, in almost 75 percentage of the cases, center of buoyancy will be to the forward of the center of floatation it is always like that, it comes like that.

Obviously, volume is added at the center of floatation, of course it depends, whether that volume is added or subtracted that is the thing that depends upon whether the density is increased or decreased like it has moved from a lake to a sea or from sea to the lake that makes the difference. If volume is added, so obviously volume is added at the aft therefore, the center of buoyancy moves like this (Refer Slide Time: 05:10).

So, it sinks by the aft or trims by the aft, more volume at the back means it trims by the aft, so this is the process of change in trim due to change in density. Just to draw this, I will just try to make it clear.

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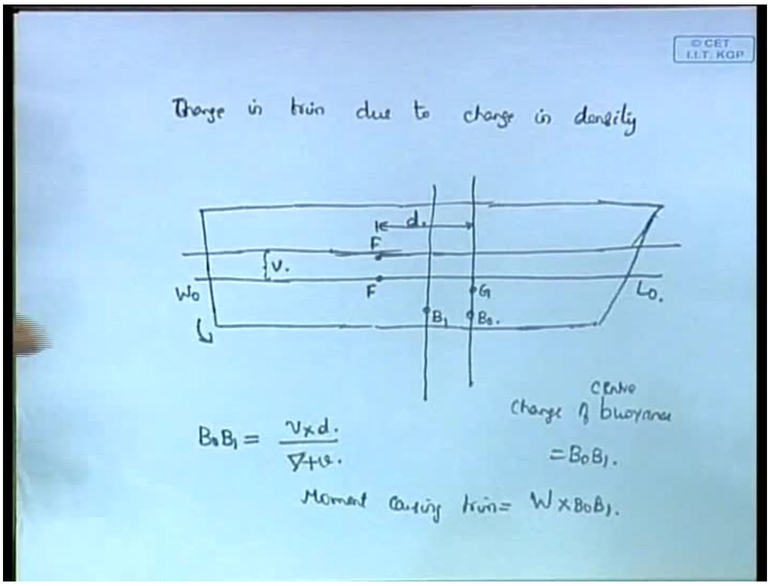


Now, initially there is a water line W 0 L 0, this is the initial water line and the ship has a center of floatation let us say it is here, this is the center of floatation initially it is here F, it is in this vertical line. Then let us say that initially it will always be in a condition such that G and B will be in same vertical line because, otherwise it will trim further. Let us suppose that this is the initial B, let me draw it here (Refer Slide Time: 06:15).

Let us suppose that this is the initial position B 0, then some G is not changing here, G and this is the initial state, the ship is initially that center of floatation F, B 0, G. Then it moves into water which has higher density as a result of which it is sinks further. If it is higher density means, higher buoyancy it will go up that is correct. If it is a lower density it will sink further, lower density it will sink further because the buoyancy will reduce.

This is the center of floatation at that point F and now the B moves to this - as you can imagine there is an increase of volume here, this is the increase of volume small v, so B 0 moves to B 1, G does not change its the center of gravity, so that itself we can see B and G there is different, so there is a trim; a trim has to occur in anyway.

Now, because of this addition of volume at the center of floatation, B has moved here and now the ship obviously trims. In this case, so the ship trims like this; this should go down because v has been added here, v has come this is moving right? It will trim like this, the ship will trim to the aft, it will trim like this, then same thing we can do let us say that the distance between this and center of buoyancy initially and the F is d. Therefore, we can see that the change of the center of buoyancy is B 0 B 1. Therefore, we see that a volume v has been added and a center of buoyancy has moved from B 0 to B 1, so there is a shift B 0 B 1 in the center of buoyancy. Now, with this data let us work (Refer Slide Time: 08:26).

Now, a small volume v has been added. The distance through which the center of buoyancy has moved B 0 B 1 will be equal to - let me see this one minute, means a small volume v is added at a distance d, it has moved a distance d a small volume. So, what we see here is that it is correct, a small volume v has been added a distance d from the center of buoyancy. As a result of which, the center of buoyancy moves B 0 B 1 is equal to - it just like the center of gravity - center of gravity has shifted from G 0 to G 1 by that same thing, del is initial displacement of the ship, so del plus v is the final displacement of the ship or the displacement volume of the ship. So, this will give you the shift in the center of buoyancy.

Therefore, the moment causing trim, we can write it as, W the weight of the ship into B 0 B 1. It is due to the change of volume that there is a shift in the trim, so the moment is produced due to this shift in B 0 B 1 because W into B 0 B 1 will give you the moment causing trim.

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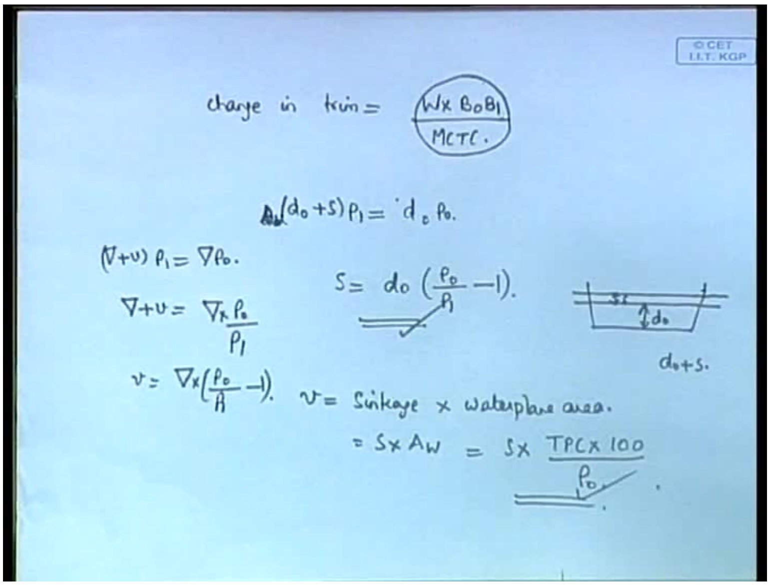


Therefore, change in trim becomes W into B 0 B 1 divided by MCTC. This is the direct formula, we say that the change in trim is equal to the moment producing the trim divided by MCTC, moment producing trim is W into B 0 B 1. Change in trim, this is change in trim, you are talking about change in draft, this is change in trim. Then, we can write one formula, we know that the initial weight is equal to the final weight that is the weight of the ship, so you can write like this.

Let us suppose that d 0 is the initial displacement of the ship initial draft of the ship and let us suppose that S draft has increased, it is increase in draft d 0 plus S into rho 1 will be equal to d 0 into rho 0. Here, we are just saying that W is equal to W, means initial W the weight of the ship is equal to the final weight of the ship or volume into displacement initially, you know that the weight of the ship is equal to weight of water displaced that is Archimedes principle.

Now, weight of water displaced is del into rho always, so just initial del into initial rho is equal to final del into final rho. Just do a little bit of manipulation, you will get S is equal to d 0 into rho 0 by rho 1 minus 1. So, S is the change in draft means ship is like this (Refer Slide Time: 13:03), initially its draft is d 0 and then the ship sinks further, its draft increases further by S and therefore, d 0 plus s is your final draft. Now, this increase in volume or the increment in volume can be found from v is equal to sinkage, this is your sinkage S is your sinkage, sinkage into actually what should it be? Sinkage into area obviously, it is the water plane area.

So, sinkage into water plane area will give you - so this is like S into let us write it as A W. In the beginning, we derived an expression for A W as you remember this that is an expression that water plane area is equal to TPC into 100 by rho 0; you did it for mid semester, so I think you should be remembering it. It is not at all difficult you say that you know if there is a unit change in draft, we did that TPC is due to a unit change in draft, so if there is a unit change in draft, what is the change in volume? So, equate the two you will get this expression, so S into TPC into 100 by rho 0 this gives you an expression for the increase in volume.

We have seen some methods till now, whereby you can find the increase in or you can find the sinkage, W by TPC is one of them, that is the main way of finding the sinkage. So, once you have that, you can use these expressions to find the increase in volume. No, no, TPC into 100 by rho naught is A W, the water plane area.

Now, this expression, this is exactly like this, see there is an A W also here (Refer Slide Time: 15:37). It is not exactly this but this I mean this should be A W plus the new A W which is but, it we are assuming it to be almost same, because water plane area does not change might because of change in draft of probably 10 centimeter or something it does not make any difference.

The real expression is like this, so del plus v is equal to del into rho 0 by rho 1 or v equals del into rho 0 by rho 1 minus 1. We are just having a couple of similar formulas for - so you know we have this expression, we will need this for the few problems, so this is needed, this is very important (Refer Slide Time: 15:55) W into B 0 B 1 by MCTC is the change in trim.

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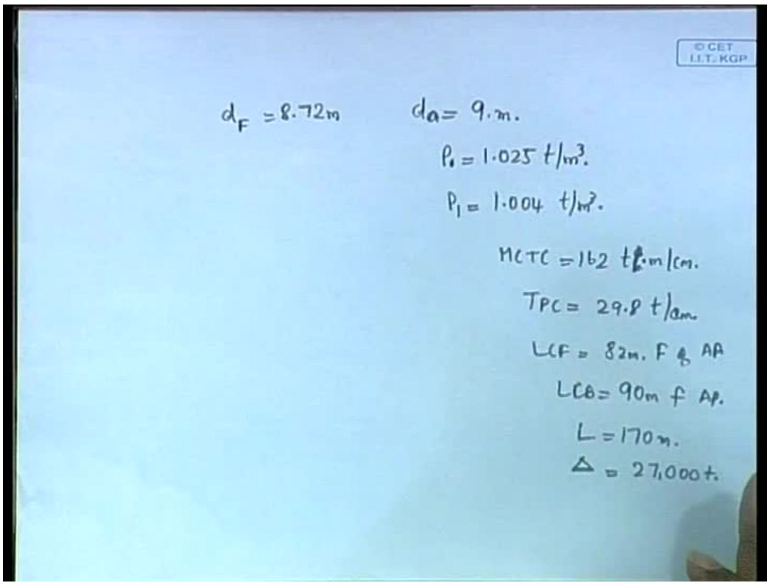


There is a problem. You have told that, a vessel has a draft forward equal to 8.72 meters, it has a draft aft given as 9 meters and it is in a water of density 1.025 tones per meter cube, this is the initial density of salt water. Now, it enters a dark water of density rho 1 equals 1.004 tones per meter cube. You are asked find the draft forward and aft, taking account for the change in trim due to the change in density. And you are told MCTC is equal to 162 tones meter per centimeter, TPC equals 29.8 tons per centimeter, LCF is equal to 82 meters forward of AP, LCB equals 90 meter forward of AP, length of the ship is equal to 170 meters and displacement of the ship is equal to 27000 tons.

With this data, you have to ask to find the change in trim and finally, the final drafts due to the ship moving from the salt water initially, at the density of 1.025 into ordinary water of density 1.004. Now, first of all, you need to find the amount by which it will sink, that is what I mean you have to find the amount by which the ship will sink, so you have to find the initial draft and the final draft.

Note, we always find the sinkage or the S in this case by taking the mean draft, we never took the aft forward or we usually take the mean draft and it is the draft at the center of flotation; so we say that, if the center of flotation as sunk by so much that is the parallel sinkage, that is what we call as parallel sinkage.

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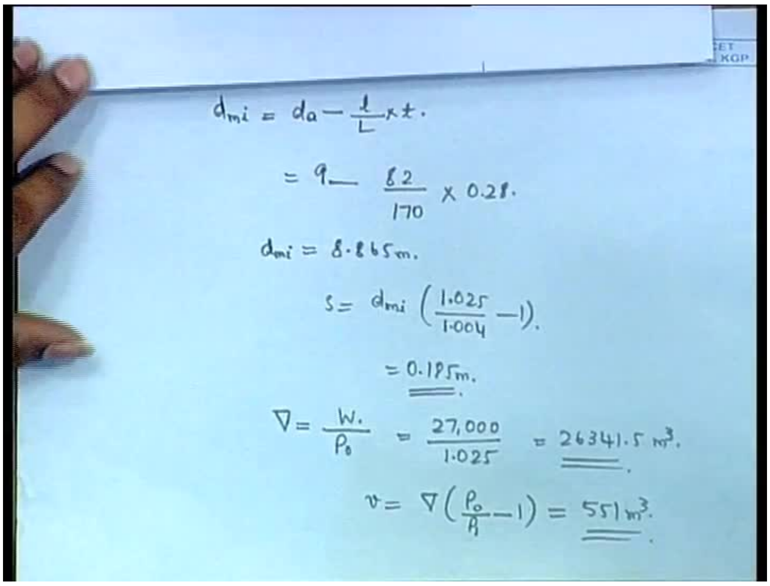


So, the mean draft initially is equal to this formula - I mean you just have to remember - t is the trim, I mean I will just repeat there are two things here, there is the trim and there is a change in trim. This is the trim, trim is the difference between the forward and aft drafts that is all and change in trim is the change in that trim or added, so d m i is equal to d a minus l by L into t.

The draft aft is given to be 9 minus L is the these things should be clear L is the distance of the LCF from the aft perpendicular it is given as 82 and L is the length of the ship 170 into t is the trim that will be the difference between the forward and aft drafts, 9 minus 8.72 is 0.28. So, this will give you the mean draft initially, it comes to 8.865 meter, so this is your initial draft, mean draft. Since you know the change in density means, since you know how much is the initial and final density, you can directly find this S from this you know d 0 initially.

Note that, this d 0 is the initial draft at the mean point, there is at the center of flotation that is what we just calculated. Now, we can directly calculate this as, so S is equal to just do this initial mean draft into 1.025 divided by 1.004 minus 1, therefore it becomes about 0.185 meters. So, this is the amount, 18 centimeters is the distance by which your ship will sink, the mean draft will sink because of this change in density, that is the first thing.

Then another thing is del, which is the initial volume of the ship is equal to W by rho 0, which you can directly calculate, W is given 27000 tons divided by rho 0 is 1.025 tons per meter cube, I will give you, so this is the initial volume of the ship. Again, from this formula, we can find the increase in volume, so v the increase in volume, just do this del into rho 0 by rho 1 minus 1, so this will give you something, so this much is the increase in volume due to the change in density.

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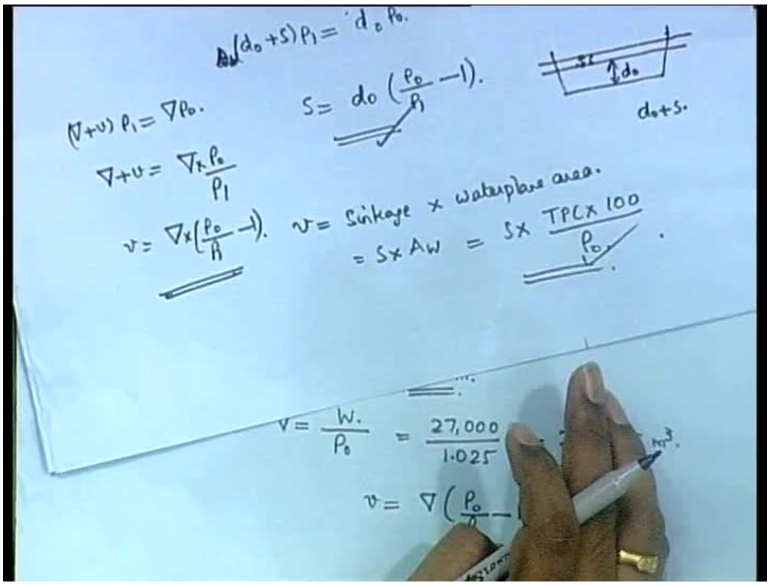


Now, the ship has this is parallel sinkage. There will be trimming, that is the next thing you have to calculate, two things you have to do, whenever in case of load added or in case of change of density both are exactly same, there is the change in the only difference is that in case load added, you say that the moment changing trim is equal to W into shift in G 0 G 1.

It means shift in the center of gravity or the distance through with the weight is shifted, W into d that is the distance through which the weight is shifted or the distance through which the center of gravity shifts divided by water and that will give you the moment changing trim. But in this case, when there is a change in density you do not use G, you use B, because volume is changing as a result, because of this change of volume there is a change in trim. Therefore, in loads you have G, in density you have B that is the only difference, everything else is exactly same.

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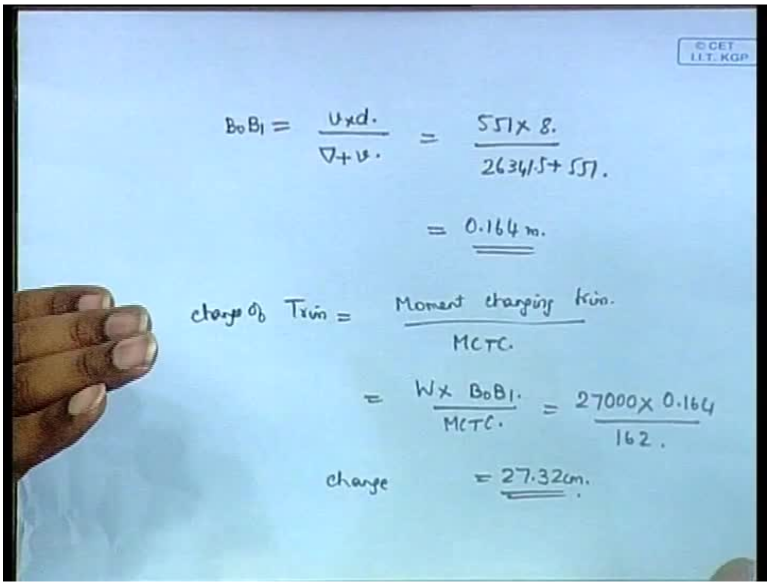


Now, this B 0 B 1 even though formula for B 0 B 1 and G 0 G 1 are more or less same, instead of volume you put the weight, that is only difference; v into d by del plus v is equal to - so v is given and we have to find B 0 B 1 the distance through which B has shifted. How much is that? LCB is given, that is initial LCB is 90 meter forward of AP, we need to find v into d, d is the distance between LCB and F, right? 90 minus 82, 8 correct, so this will give you the B 0 B 1 divided by this 26341.5 plus 551.

When you do this you will get your B 0 B 1, the distance through which the center of buoyancy has shifted 0.164 meter and then next is trim is equal to moment changing trim divided by MCTC, it is a moment changing trim by MCTC. The moment changing trim is equal to W into B 0 B 1 divided by MCTC, W is equal to the weight of the ship, 27000 tones into B 0 B 1 we just calculated divided by MCTC; MCTC is given, so this will give you the total trim and now we need this is the change of trim not trim sorry, this is the change of trim.

Now, we need to find the change of trim aft and the change of trim forward, I mean our purpose is to find the final draft forward and aft, so we need to find the trim forward and aft, we have found out the parallel sinkage S, we have already found. Now, we need to find the trim aft and trim forward added to parallel sinkage and you add to that the initial draft, you will get the final draft, so this is the change.

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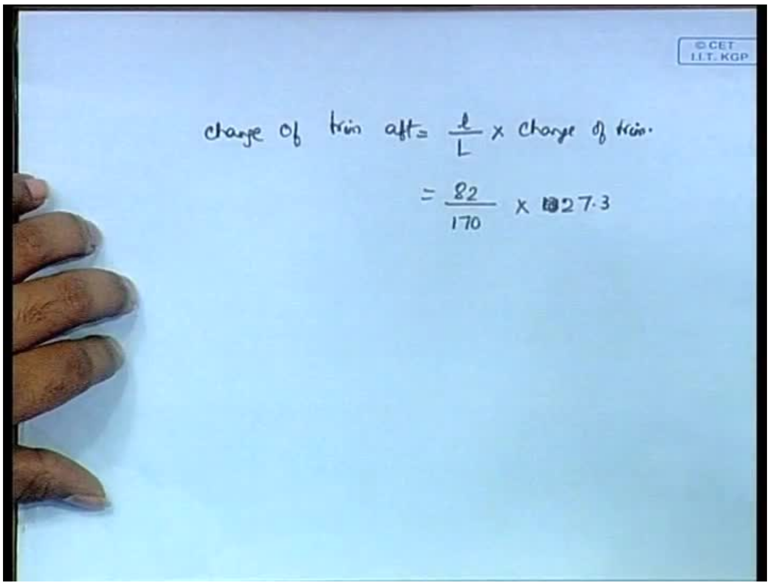


Then these formulas also we have used, so the change of trim aft is equal to l by L into change of trim 82 by 170 is the length of the ship into change of trim we just calculate it, correct sorry 27.3 we just calculated in the previous thing.

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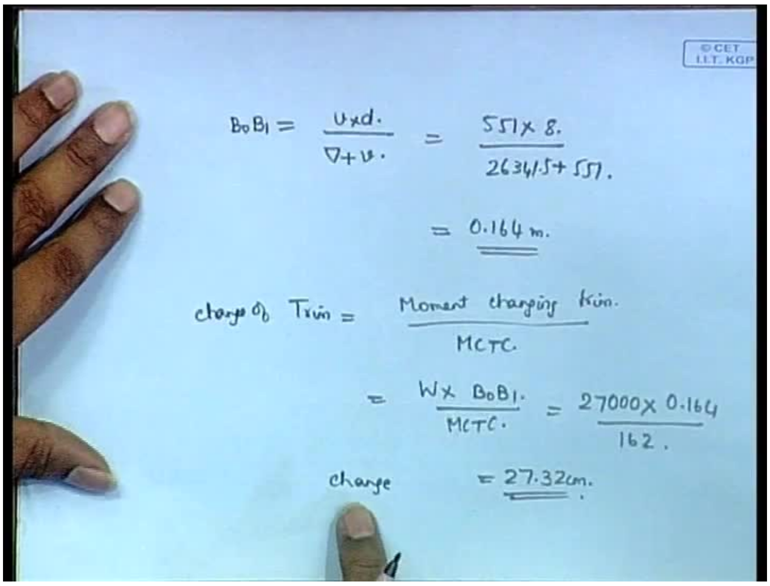


This is the total change of trim, so change of trim into l by L, where l is the distance of the center of floatation from aft perpendicular, capital L is the length of the ship, so you do this, you will get 13.2 centimeters.

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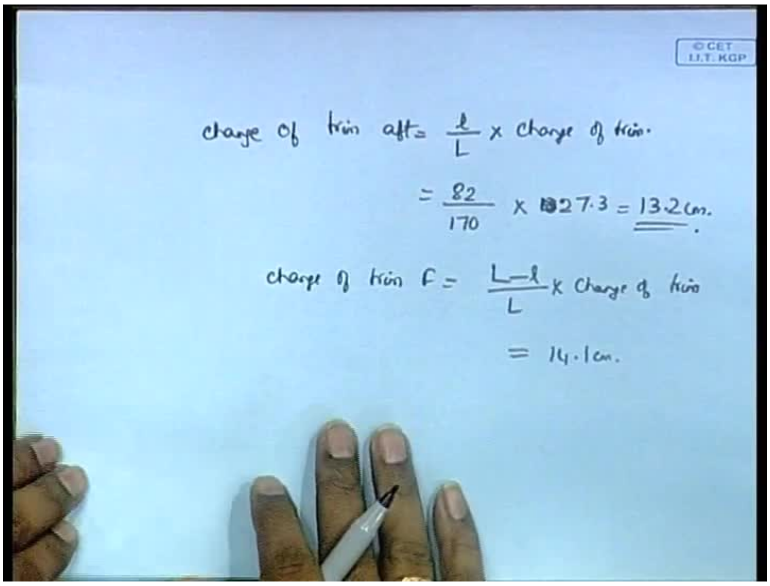


This will give you the change of trim aft and the change of trim forward will be L minus l by L into change of trim that will come to something 14.1 centimeter. Now, all you do is, if you add to the initial drafts you add the parallel sinkage, in this case parallel sinkage it is sinkage, because the density has decreased so it is sinkage, so that is increase in draft but, something which is slightly confusing here wait a minute, it is says that the ship has gone down at the forward.

Now, I have to see, why? That is aft is come up and the forward has gone down. Here, B has moved to the aft, how the ship is trimming forward. This I have to check, why it is so? It does not seem directly obvious, this I will check and tell you but, according to them they are saying that the ship trims by forward not by aft. Even though the center of buoyancy has moved backward in fact, let me check that, is it a mistake here or is it correct. Anyway, it was accordingly more volume is added at the aft, no nothing like that, there is no balance sink here.

This is just a case when the ship has moved from one density to another density and as a result of it, what we saw was that, the B center of buoyancy has shifted backward to the aft, if the center of buoyancy has shifted to the aft it seems to me like volume has added in the aft obviously, otherwise B would not shift there; if volume is added at the aft that is but, due to parallel sinkage, it will trim forward or backward.

Now that increase of buoyancy is due – no, no, its an increase of buoyancy, you can right see that increase there is an increase in volume at F because of parallel sinkage, not because of trim, because of the density changing it is first it is parallely sinking, then it is trimming, so because of this parallel sinkage a weight is added here, we can draw this and see.

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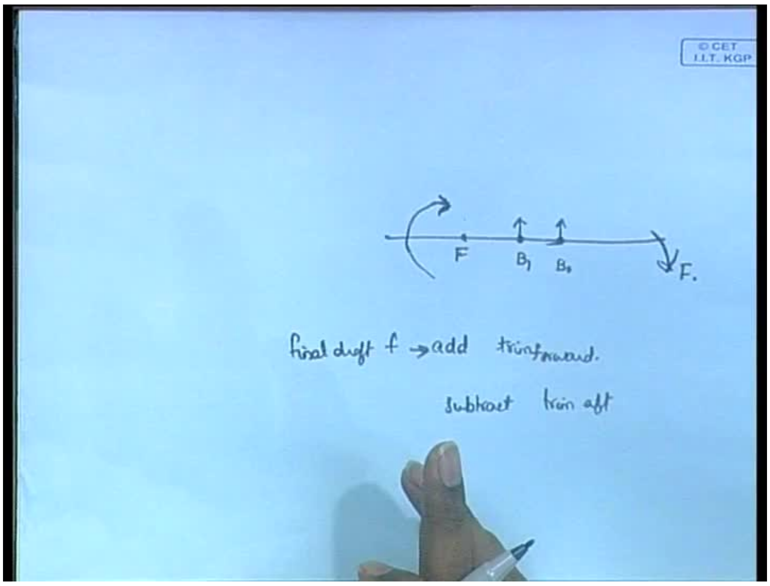


Let us see this for instance if this is F, if this is B 1 and if this is B 0, weight is added here, this is parallel sinkage. Now the question is by which direction does it trim? See, we can see one thing, the force acting is buoyancy into initially it is like this (Refer Slide Time: 32:29). Now it is like this, I think it will trim by forward, see this is correct.

Look at this figure, initially it says that F is the center of flotation initially, F it is obvious obviously, you have to take the moment about F because its trimming by F, so F into this distance F B 0 this is the initial it is higher, in this case its lesser. So, there is moment acting like this, means the moment is like this or rather the moment like this is decreased that is the better way to Prove. The moment is like this initially, the moment is lesser because the distance has decreased, so that means it is like reverse moment, acting like this, so this will go down little I have also forgotten (Refer Slide Time: 33:01).

Now it is like this sure, so I think in the initial also I have told you. The ship when it goes from higher density water to lower density water, first of all it will sink and it will actually trim forward it will always trim forward it is because of this. This is initially B

0, this is B 1 the weight has - that is what cross confusing - this is due to parallel sinkage that see because of the increase in volume at F, there is a parallel sinkage as a result of which B increases, that does not say anything about trim, it is just due to parallel sinkage that is a different thing.

Now, we have to find what is that direction of trim? That is like this, trim is occurring due to the buoyancy here, at B 0 it is like this, at B 1 it is like this; this distance is more, so the initial moment is more, the moment has decreased, whatever is the moment initially in salt water has decreased (Refer Slide Time: 34:06). So, the moment which made it trim like this has decreased, which makes the moment like this as come or negative is less that means positive is more same; by that concept the ship will trim like this.

You have to add trim forward and subtract the trim aft to get your final draft here, final draft, this is forward you have to add. Remember, whenever the ship goes in you are adding the trim to the draft, whenever the ship goes up you are subtracting - it is obviously like this, that is sinkage is when the ship comes down like this, that is plus always that is an increasing in draft, you can see it is an increase in draft.

Similarly, trim like this means here it is an increase in draft, here it is a decrease in a draft, here it is plus, here it is negative. In this particular case, the ship trims like this, so this you have to add, this is how you find the draft forward and aft at forward you add it and aft you subtract it (Refer Slide Time: 35:15).

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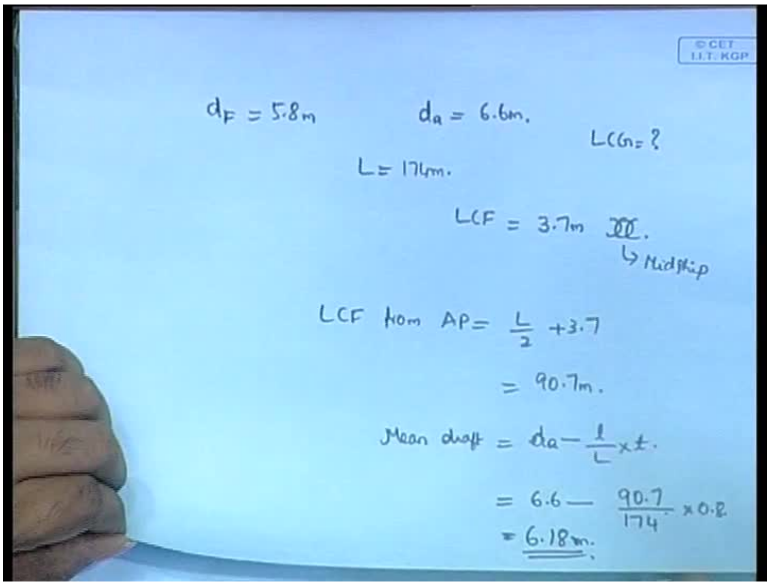


This is what happens when you have density change, there is one possibility. Using this formula, there is another problem that is you are told that a ship is floating at draft is floating at a draft forward equal to 5.8 meters, at a draft aft equals 6.6 meters. Now, you are asked to find the position of the longitudinal center of gravity means, find LCG. You are told that the length of the ship is 174 meter and some hydro static data are given like, you are told that LCF is 3.7 meter.

See there is a figure like this (Refer Slide Time: 36:50), you know what this means right? This means midship always, you can look at any figure, in ship drawings you will see this, in the drawing itself we will put this figure, it means midship. So, LCF is 3.7 meters from midship, so that is what that figure shows. Then we know what LCF is from midship, midship is obviously half the length of the ship, so total length of the ship is 174. If you want to we first let us find LCF from half perpendicular, it will be L by 2 plus this 3.7, so that will be 90.7 meter.

Now, let us find the mean draft. Note that, whenever you are doing anything with draft find the mean draft anyway, because whatever you do in most cases, you will have to find parallel sinkage or what else, in case you need to find the change in trim anything, you need to find the mean draft at all cause.

Do not take mean draft as average of that two drafts, use this formula. We derive the formula, so use this formula d a minus l by L into t, where t is the total trim. Trim is again defined as the draft forward minus draft aft. So, this is equal to draft aft is given, you are given the drafts in the aft and forward direction minus l is the distance of LCF, so that is given 90.7 divided by l 174 into this is 0.8. Again here, note that this small l is always the distance of LCF from the aft perpendicular. So, such a few things that just has to be by hearted, just memorize, so 6.6 minus this thing, so this gives you the mean draft.

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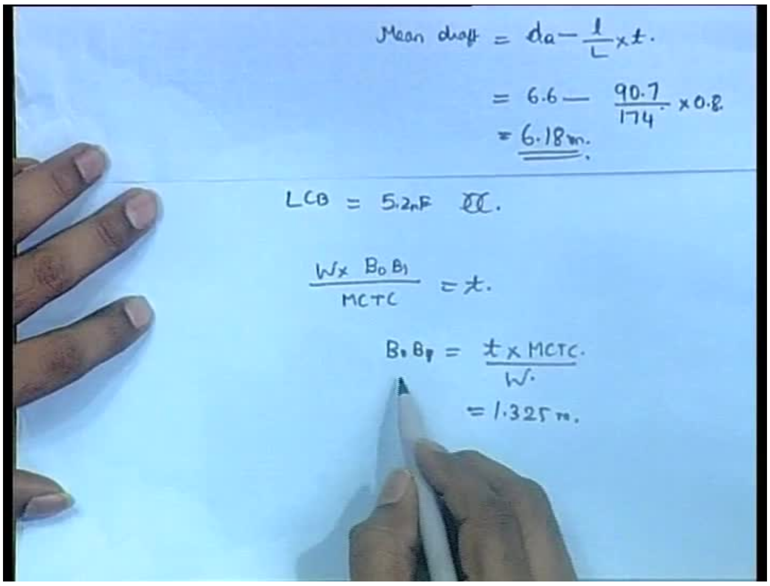


Now, once you have this, you are given - I did not write it there but MCTC is given. MCTC is 356 tons meter per centimeter and W is equal to 21500 tons, this is also given then, this is also given I did not write LCB is equal to 5.2 meters forward of same thing midship. We have told that LCB is 5.2 meters forward of midship. Now, we can use the formula the distance through which, means we have this formula anyway W into B 0 B 1 divided by MCTC is equal to trim. This formula we have, I will just change it around.

Therefore, B 0 B 1 is equal to trim into MCTC divided by capital W. So, this will give you the distance though which the center of buoyancy is shifted. No, it is not the change of trim, it is the trim. See, if it is at even keel you have something, like this you have a trim draft aft minus draft forward will give you the trim. In this formula - that is what please study this carefully, people lot make lot of mistakes in this, because as I said before there is one thing called draft, there is one thing called trim and there is one thing called change of trim, three things.

Draft is where the ship is or the depth or the final depth to which the ship is that underwater portion is that is called the draft and that has trim, which is the difference between the draft aft and draft forward. Then if something happens to the ship like loading have or something is loaded on the ship or it changes the density, then the initial trim will change to a final trim, that is a change in trim. Of course, then there is a parallel sinkage is the distance through which is the mean draft or the draft at the center of floatation comes down or goes up due to the loading.

Here, you have B 0 B 1 is equal to t into MCTC by W. In this case, there is no change in trim, we are not talking about any change in trim, and we just have a ship that is in some trimmed condition. It has some initial draft aft, initial draft forward, you are just asked to find its longitudinal center of gravity provided you are given some hydro static data like LCB, LCF etcetera.

So, B 0 B 1 is equal to trim into MCTC by W t is the trim, all these things we have therefore, this is comes here meter. Now, what we are seeing here is that see we have assume that of course, it goes without saying the ship is in stable condition otherwise, you cannot do this problem, that means some if it can still trim or go to some other given heal, it said different problem all together.

So, what we can say is that ship is initially it was design; it was put here on the sea with some loading and then it trim to some angle. Why did it trim into that angle? It trimmed because it is trying to bring it is G to the same point as B it will trim that much such that G and B are in the same point and once it becomes in the same straight line, there is no more any moment and its stable as far as rotation is concern.

Two things, actually when you put a ship on sea two things will happen. It will adjust itself such that its weight is equal to center of buoyancy first; therefore, it will design its draft as such it will design it is draft, it will go down so much such that its weight of its buoyancy is equal to the weight when you put the ship in the water. Initially after you design it, if you designed it properly, then it will come to it’s - we will when you are designing itself you actually design the draft, so when you properly design, to that design draft it will come and sink. At that stage you are buoyancy will be equal to your weight that is the first thing that will happen, then the ship - I mean nature will check if the LCB and the LCF, LCG are in the same position.

If it is not in the same position means, in your initial design you have made a mistake - I mean a ship should actually look like this in its load condition, a ship should at least in its design load condition the ship should look like this in an even keel. If it is not in that will happen, if its LCG and LCB are at the same vertical line but, if it is not let us see the LCG is forward, LCB some different then immediately the ship will - that difference in moment will act one force acting down and one force acting up separated by a distance producing a moment. So, it will trim; it will trim to such angle such that, these two come in the same straight line again at that angle it will be stable.

These things you have to check while you are designing the ship, so that the ship is initially at the design draft - I mean this is how you design it draft for instance, this is only way you put weight is equal to buoyancy, you will get this is a draft that the ship should be when it should go into this water of this density. So that is the same thing happening here, the ship is now come to some stable state, so we say that the distance through which B has shifted from its initial position I mean LCB. We can assume that this is the faulted design if you want such that, because of the design LCB and LCG did not come at the same place or maybe you added more load then the design itself says; design says that weight is so much, you added more load, whatever it happen LCG it did not become equal to LCB. As a result of which B shifted to reach G and so it moved this much distance.

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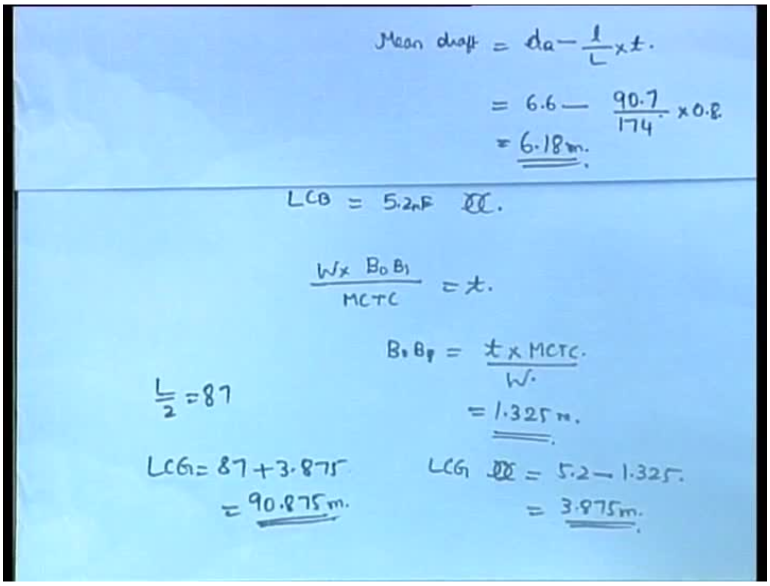

So, you can find that your LCG should be it has shifted this much, you have center of buoyancy shifted so much, which means this is the final position of your center of gravity meter. If you just add an L by 2 to it, you will get the distance from aft perpendicular this is the distance from midship, you see this figure. LCG you add 87 this thing to this 3.875, so you get your 90.875 meter. So, this gives your LCG, then one more problem that is yours.

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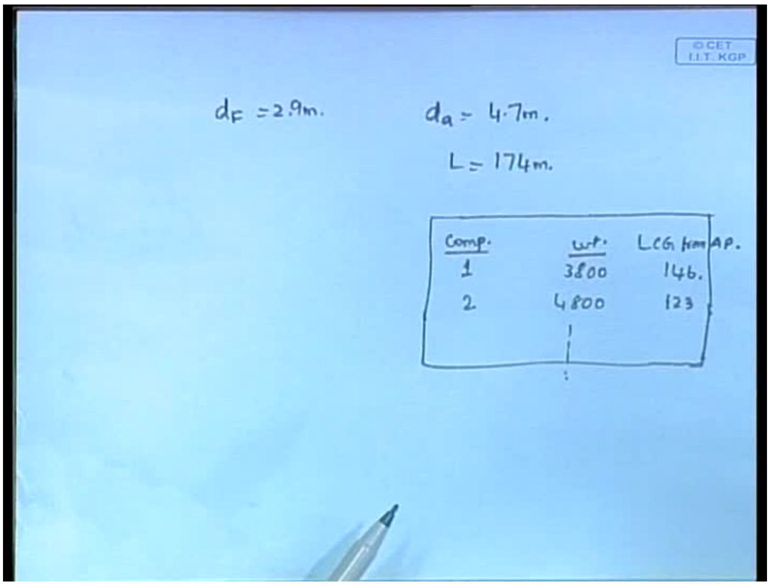


You are told that there is a vessel that is floating at draft forward equals 2.9 meters, draft aft equals 4.7 meters and the length of the ship is 174 meters. Then you are told that there is going to be a loading of cargo, I will just, I would not write the whole thing but, you are add loading some cargo. So, like this on your compartment 1, you are adding 3800 tons and its distance from the aft perpendicular is 146 meter, so like this you keep adding like this (Refer Slide Time: 47:48).

So, this you are told, so initially you have a ship in some trim and then you add a lot of weight. Now, you are asked the final draft on compartment, once loaded your whole thing, what will be the final draft. As we can guess, first we have to find the initial LCG, we can do one thing, let us assume that the ship - just this previous problem, so you have the ship, you have not put in these loads before that, you have the ship put it in sea. It is said that, when you are given a problem like this which says that, a ship is floating at the draft which means it is in a stable state.

It is said that the ship is floating in that draft, we are given the forward draft and the initial draft, that means you are given the trim, so you are given the initial conditions and when it is in this stable state, we can automatically assume its LCG should be equal to its LCB. First, we will see in even keel LCB when you are given will be the initial LCB - I will tell you - that is see you are given here, this probably will be given LCB, this is the hydrostatic data; hydrostatic data means it is the data when the ship is in an even keel that is when you are designing it. Hydrostatic data is always the data that you are given when you are designing a ship means for instance, ship we have design the ship you are always designing the ship for an even keel.

If you are told that from the hydrostatic data, the LCB is so and so, the meaning is that when the ship was in an even keel, its LCB was here that is the value given, but see this problem says that the ship has trimmed, it has trimmed; that means LCB is no longer at that value LCB has shifted, so that is very important. Though you are given the LCB is not the final LCB in the trimmed condition, it is just the LCB given by the hydrostatic data, which means LCB in an even keel, when it is designed.

A ship is always whether it is faulty or not they have designed it for an even keel, a ship is always designed for an even keel. So, you design it in that condition but, maybe because it is faulty, it trims and the LCB shifts now to some new point. That new point you do not get from the hydrostatic data that you get from some other value. The additional thing that you need to know is it has trimmed so much, such that its new B will be directly below or above G or may be at the point of G that is the important thing.

Two things, hydrostatic data means even keel that LCB that you are given from hydrostatic data do not take it as the position of the center of buoyancy, when the ship is in a trimmed condition that is wrong, it is not like that. The LCB given from the hydrostatic data is the LCB when the ship is in an even keel, then you are told that the ship is trimmed, that itself says that the buoyancy has shifted from that position, it has shifted to some other point and it has shifted so much so that finally, your B is directly above on or below the center of gravity. Therefore, you know how much where the center of gravity is from this, by working on this you will get what the center of gravity is.

I will just do the first part, we will complete. Now, we know the problem is, first you are given all these hydrostatic data, so first what you need to calculate is you need to find the distance through which the center of buoyancy has shifted, B 0 B 1 has shifted that you need to calculate. Next, from B 0 B 1 you find the final position of LCB or LC what you have is LCB 0 find LCB 1, final position of the center of buoyancy.

Now that L C B 1 will be equal to your LCG, so you have your initial position of the LCG. Initial means, after trimming you have the position of your LCG. Now, loads are added at different points on the ship, at different longitudinal position loads are added. As a result of which your LCG changes again, because of load adding the LCG will change, so LCG comes to a new position, now that will give you your new position of LCG.

Now, you go exactly backwards from the problem I mean, what we did initially from that LCG you find B 0 B 1, you find the distance through which it will you go backwards to find B 0 B 1, from B 0 B 1 you go backwards to find the trim and from trim you add and subtract to the trim to get the final drafts, so it is just going backwards. So, I will stop this here, I have somewhere between the problem but, I will stop this here.

Thank you.