Hydrostatics and Stability
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Module No. # 01
Lecture No. # 23
Trim Calculations - I

Today, we will go into…till now we have been talking about heeling, mostly - this chapter is on trimming; we are going to talk about trimming this time. As you know, trimming is defined as the longitudinal - let me call it - the longitudinal heeling of the ship, like this; if the ship is initially like this and if the ship goes either in this fashion or in this fashion we call it as trimming; this process is called trimming, similar to heeling in the transverse direction.

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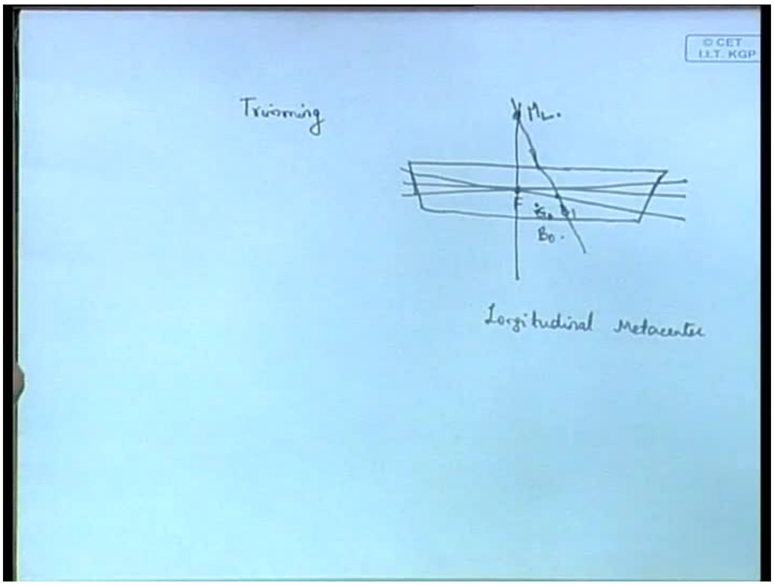

Couple of important points we need to note about this - first of all, trimming…in this case - in trimming - we always consider that trimming occurs about the centre of flotation; you definitely remember what is the centre of flotation is. It is this point where about which it is trimming; if a ship is like this, if it trims like this or like this at any case the point about which it trims - that centre point about which trims - is always the centre of flotation.

To repeat, a centre of flotation is the centroid of the water plane area; therefore, what you see in general is when a ship trims a little, some volume will come out here - or go in, depending on how it is; let us say a ship is initially like this and it trims by aft - by aft means like this - aft is going in; that is the meaning of trimming by aft, trimming by forward means forward is going in.

Trimming by…let us suppose it trims by aft like this; some volume goes in here - that goes into the water here - and some volume comes out of water here, since we are assuming that the ship is trimming about the centre of flotation the volume that is gone in here will be equal to the volume that has come out here. It is same as our heeling concept - there also we said whatever wedge is going in the volume is equal to wedge coming out; the two volumes are the same. Same concept here is that whatever is going in, the volume is equal to whatever is coming out; that is trimming.

Then we talk about…in trim we talk about everything in terms of a longitudinal - same thing, here we have the the initial vertical, then initially let us say G is somewhere - in the other case we usually draw G at the centre, in this case it might not be at the centre of flotation - G usually is not at the centre of flotation so let us assume G is somewhere here; then G, because of its trimming - it trimmed in some direction as a result of it its G will shift to another point G - G will not shift, sorry, B will shift to another - let us say this is G and this is B - B is somewhere just below it - it is on the stream somewhere it is a B…let us called G 0 B 0.

Then it shifts to B 1; its B will change and same way as you draw the heeling diagrams you draw a vertical like this - something like…and it hits the this at M L, we call it the longitudinal metacenter; this is the longitudinal metacenter - it is the metacenter, same as before, but we are looking at from a longitudinal direction - from a profile view, from the front; what you see you call it as a M L meta longitudinal metacenter.

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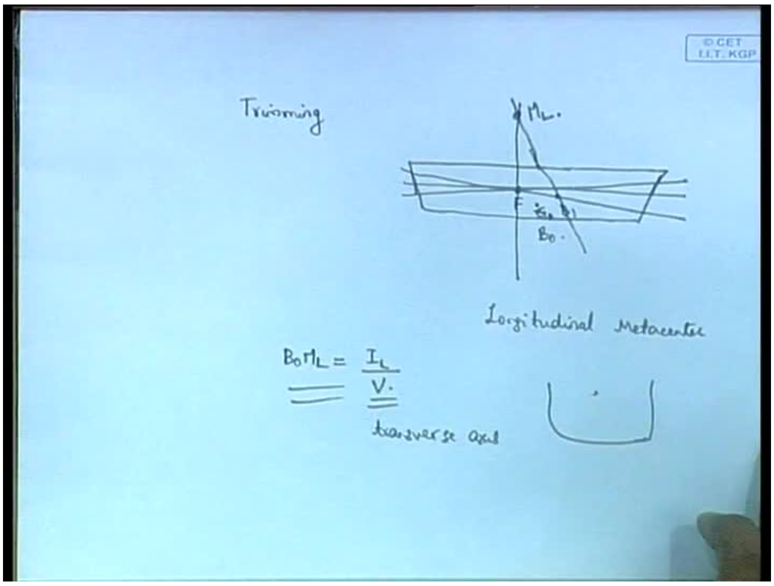

Here everything is written as M small l - it is not M 1, it looks like M 1 but it is actually M L longitudinal metacenter; of course, you will you can write this formula - lot of the formulas are exactly the same; for example, we had a B 0 M - if you remember, a B 0 M is the metacentric radius which is defined as I by del or I by V so it is the same - M 0 M L, M L means longitudinal; here we are talking about trim, just by seeing that L subscript you can decide that it is about the trim; you can look at the problem also when you see a problem and you see that the problem says something to do with B 0 M L, G 0 M L like that you immediately know that the problem is about trimming it is not about heeling at all; that is the only difference between M L and M.

So, B 0 M L can be written as I L by V where I L - remember, the other time we wrote it as I T or just I - here it is I L, it is the I about a transverse axis; I T was I about a longitudinal axis, though the names look confusing it is not like that; I in case of a…in the previous case when we were doing heeling - this direction - it is I about this axis - longitudinal axis - the axis going vertically along the length of the ship; if this is the length of the ship and if the ship is heeling - I am talking about heeling - if the ship is heeling like this we take I about this line; in this case, it is the other way I mean if you have the ship like this - like this, the ship is like this - and if it is trimming we take I about this axis - the I transverse, it is at about a transverse axis; but, it is written as I L it is called the longitudinal moment of inertia about a transverse axis that is why it is written as I L; that is a little confusing but it is what it is how it is defined it is the longitudinal moment of inertia about a transverse axis; you can define B 0 M L in this fashion where V is the total underwater volume of the ship below the draft - I mean below the waterline.

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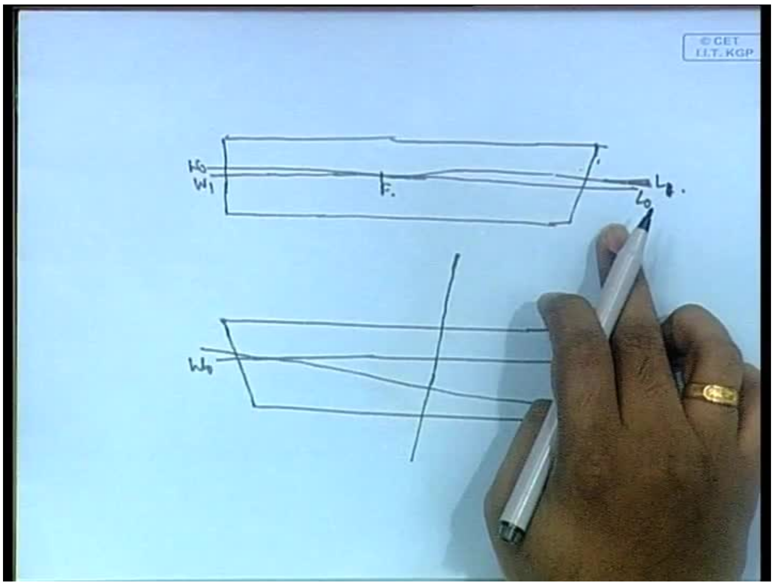

If you look at the figure - if you look at the text - it draws in a…what…I also probably found it slightly confusing initially - let us suppose, this is the ship - they always draw it like this in this figure; previously in the upright condition you called it a W 0 L 0 here also W 0 L 0 represents the upright condition but it is drawn like this - it is not… the figure does not look like that but I will draw in.

Let us suppose, that this is the ship it is not this slanted, please note that, but I am just drawing it so that it becomes clear; they usually draw W 0 L 0 like this and the final trimmed condition they make it horizontal - understand what I am saying? But, it is not here…this is highly slanted - it is not highly slanted like this - just a bit slanted like this. This is slanted in this direction and their horizontal is like this and the two intersect at this longitudinal centre of flotation like this - this is like this.

This is the centre of flotation F; they draw their W 0 L 0 like this and W 1 L 1 like this; so, your W 1 L 1 is finally written in a horizontal…it looks horizontal and not…though what they mean is that in the upright condition W 0 L 0 is horizontal; but, the figure does not really look like that so do not get confused when you look at the figure that is why I am explaining it specifically.

W 0 L 0 in the figure represents the upright condition, but it is drawn in a slanted fashion; it is just to make it simple and just for some purpose that is because their final W 1 L 1 they want to do some geometry with that - just for simplicity purposes they have done that; anyway, finally initial centre of buoyancy will be B 0 and your final centre of buoyancy will always be B 1, just like the previous - everything is the same.

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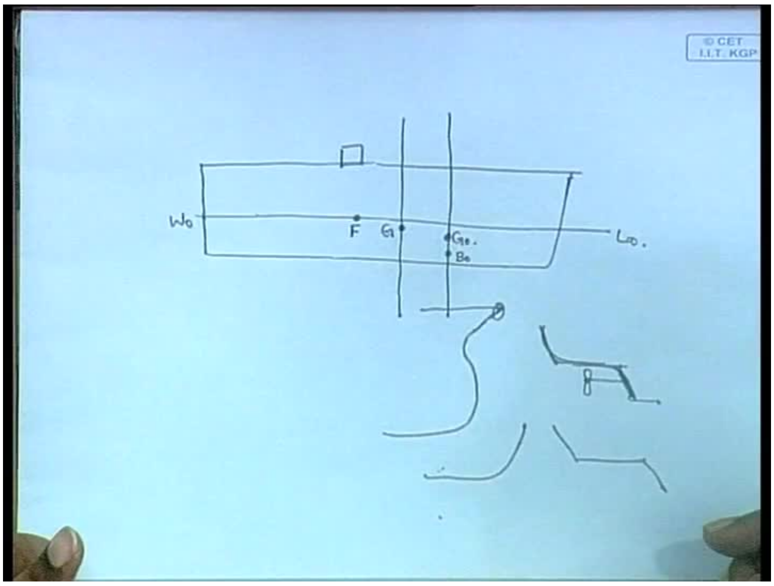

Let us look at some formulas regarding trim; first of all, let us consider this…actually I hope that when you look at this - when you look at a ship - you are able to figure out which is the aft and forward just by looking at the shape; it is like this, just by looking you should know that if a ship…something looks like this - this is an aft because usually this means usually here you put a propeller like this - it is always like that - a propeller is always put there; of course, slight modifications might be possible in the shape but in general this will be the shape of your aft or it can be like this it - does not matter - like this. At any rate, this kind of shape you should know is the aft and the forward usually looks either like this trait or it can look like this also…it does not matter.

This actually means a bulbous bow - it is like this; you will see this kind of a shape, this is more important - this will tell you it is the bow, because sometimes looking here you might wonder if you do not know this you will wonder which is aft and… so you know which is trimming by aft; trimming by aft always means aft goes down if trimming by forward the forward goes down.

Let us consider a vessel - in this case they have drawn like this, W 0 L 0 - the ship is initially at this waterline W 0 L 0 and let us say that this is the centre of flotation and at the centre of flotation suppose I add a weight W - this is the centre of flotation and at this point you will have G the centre of gravity G 0… G let us call it like this.

This is the centre of gravity of the ship initially - G 0; let us call this is the centre of buoyancy of the ship - B 0; as you know they will be in the same straight line because if they are not in the same straight line immediately a trim will act; because, if B and G are different, at G a weight is acting down - W at B a weight is acting up again - W; if two weights are acting up and down it will create a moment and any moment will cause the ship to trim; the ship will always be in a state such that the G and B are in the same vertical line - it will come to try to come to such a state so that will be stable.

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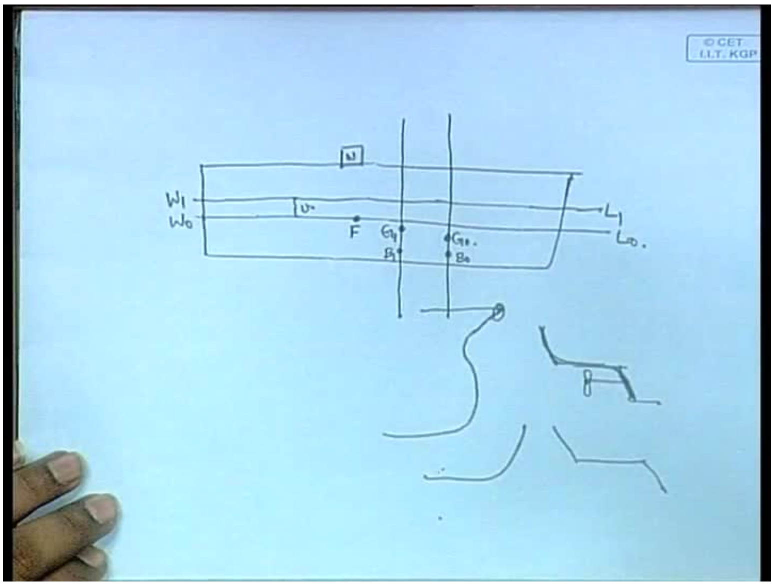

Here you have G 0 B 0 are the initial states and now I am adding a small weight W at the F - at the centre of flotation; the weight - that is very important here - a weight W is added exactly at the centre of flotation - means, at the top of course - in the same vertical line as the centre of flotation; that is what this means - it is exactly there; as a result of it you know that G will shift here to some new point G 1 and B will also shift to a new point B 1, because a new weight has been added.

Because F has been added at the centre of flotation the ship would not trim as such, it will just sink - directly sink, straight sinking, directly going down; it will go up down like this such that this will become W 1 L 1; that means a new weight - new volume - small v has sunk - this one; this will produce a small volume v that much volume has now sunk because the new weight has been added on top of F.

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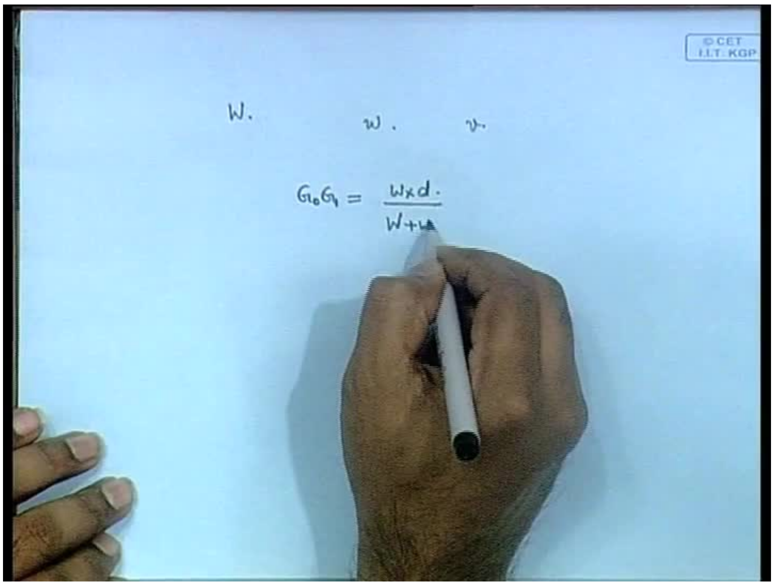

Let us look at some mathematics of this; weight of the ship - the total ship - is W, the vessel displacement is W, a small weight small w has been added at exactly on top of F or directly above F.

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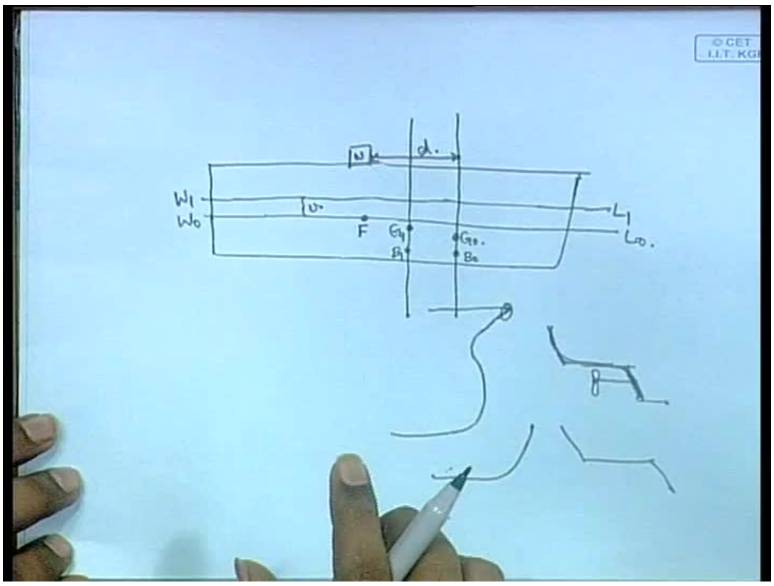

The vessel has now sunk or the vessel sinks from water line W 0 L 0 to a water line W 1 L 1 as a result of which a new volume small v has been added - because, it sank down. The shift in the centre of gravity of the ship will be given by (Refer Slide Time: 15:00) where d is the distance of this point from the centre of gravity; a new weight W has been added - so, W into d divided by… difference between the previous thing is that this time the weight of the ship is without the weight of the body.

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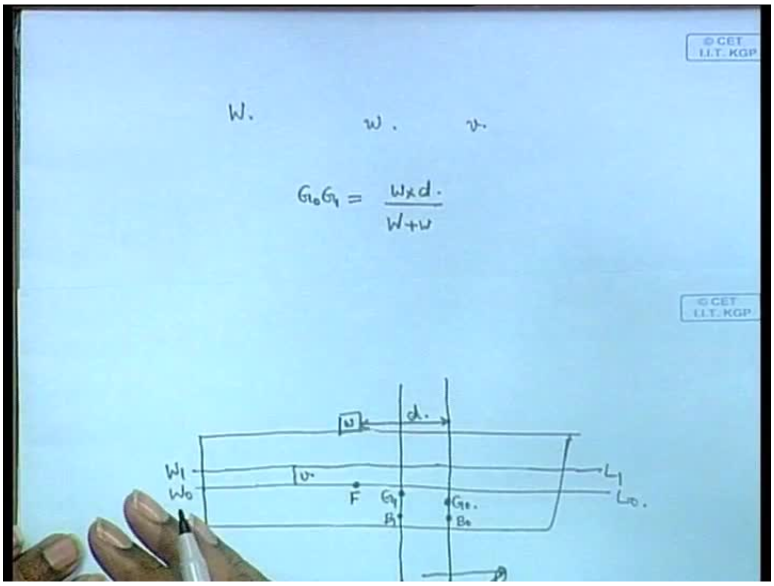

This is W plus w - in the previous derivations we did…if you remember same things we have done, many similar things we have done; in all those cases, the weight inside the ship is shifted that means the total weight of the ship plus weight is W; this time it is slightly different so it is W plus small w.

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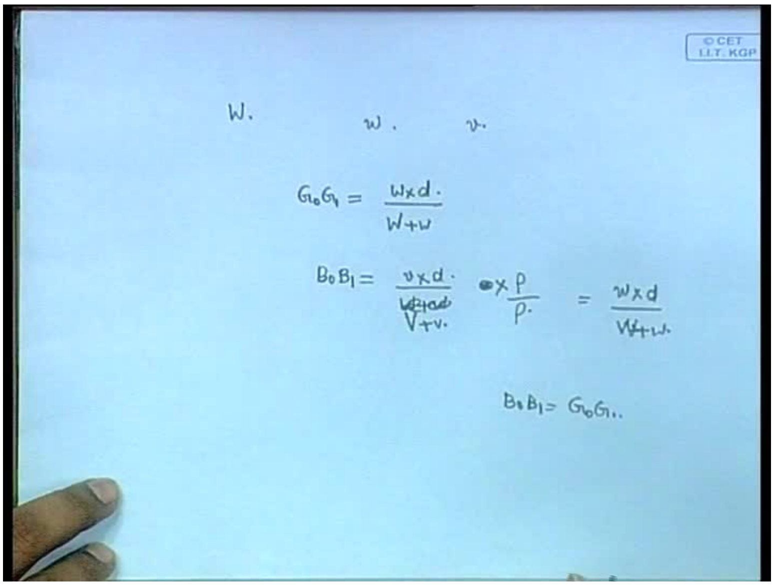

The shift in the centre of volume is exactly like the shift in the weight just that instead of weight it is the volume; it will be v into d divided by W plus w it will be…let me do one thing let me multiply both with numerator and… no not W plus w V plus v, is it okay? Because, B 0 B 1 is the shift in the centre of buoyancy; buoyancy is about volume therefore it is the shift in the volume, so V - small v - is the small volume added v into d divided by V plus v; but, you can see that v into rho is equal to small w - small v is the volume increase in volume; again, by Archimedes principle the weight added is equal to the volume - the weight of the volume weight of the water displaced; w into d by v plus V this again becomes W plus small w; what you are seeing here is that B 0 B 1 will be equal to G 0 G 1 - it does not directly come from looking at it G 0 G 1 we know, because a weight is added there G 0 G 1 has to shift directly you do not need to think so much to do that; know that the centre of gravity will shift in the direction of the weight we know that directly, we know that from our experience.

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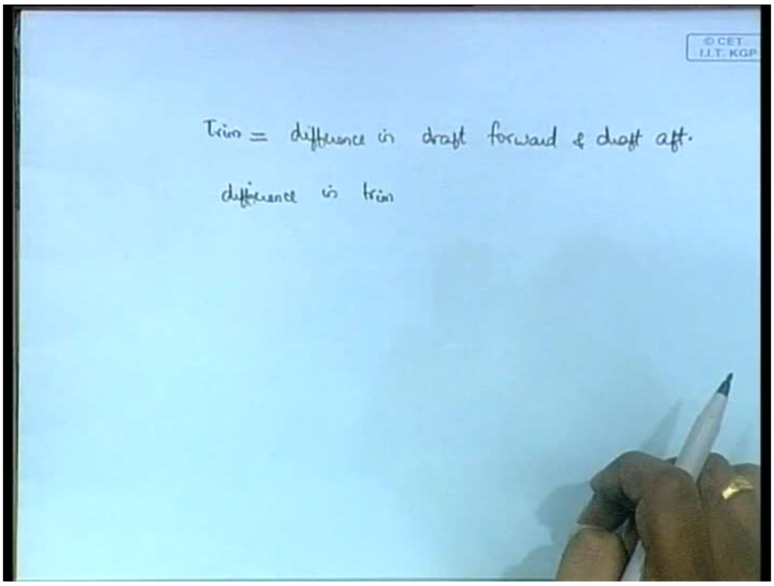

But, what we see here is that B 0 B 1 also shifts in the same direction, in the same magnitude it just come from mathematics it does not directly come from intuition; anyway, this is not the important part the next one is…this is just one simple derivation, but next one we need to do. First of all, I did not define this - the word trim is actually defined as the difference in draft forward and draft aft; that is how the trim is defined. You take the draft aft minus draft forward or draft forward minus draft aft will give you the trim that is the definition of trim, that is the first thing; now, which line B 0 and B 1 will be in the same horizontal line (18:45) (( ))

I understand what you are saying B 0…because, the volume has gone up - I mean volume has come at the top therefore you are saying B 0 should go up. Actually, their argument is that… see, actually I am trying to see if it is correct; V - see there is a new volume V added, that volume is added at the centre of flotation - you can think of it like that right? A new volume V is added at the centre of flotation when… so what will happen if it is added to the…it is just the same as weight - a new weight is added somewhere to the left of the origin; if you look at the figure a weight is added here, therefore obviously G shifts like this; a volume v - small volume - is added at the centre of flotation just like that the B shifts here; see, now your argument is that volume has been added at the top so B should go up; it will go horizontally from this argument I think it will go up also; because, volume (20:38)(( )) but it will go towards the centre of flotation definitely - that moment to the left is there - I am thinking about the moment to… the you are thinking it will go in a diagonal direction?

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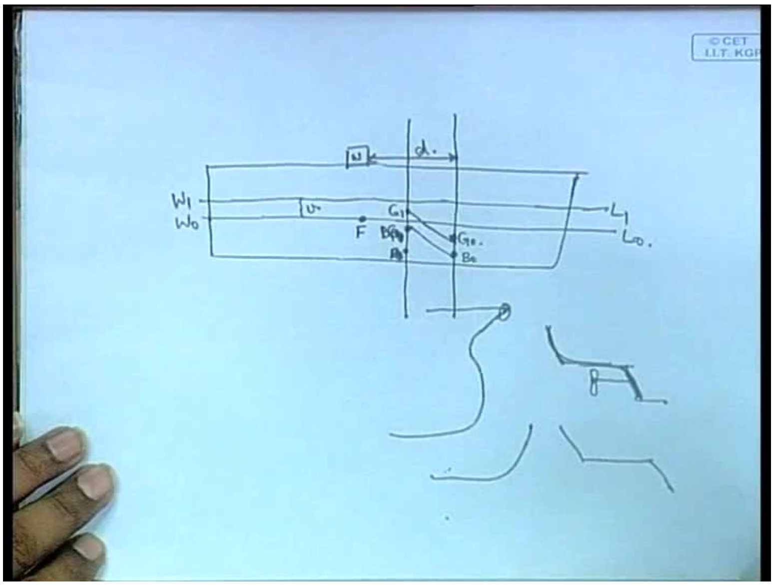

G does not go like that, right? G goes exactly horizontally only because there is no…no G also shifts up, ok…then this figure…. I yeah G also shifts up then this might be…I think it is like that only; it should be going up it is not here actually - G 1…G also will shift up - G will shift up B will also shift up it should go up like this - both of them…]it should be go up like that, correct.

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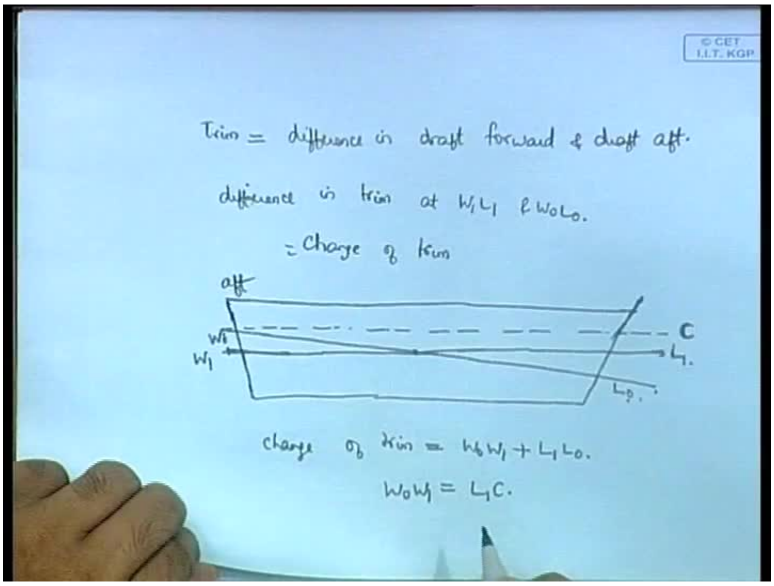

Then…actually they have drawn it exactly horizontal here that is not correct - it should go up; this is the first…what was I doing then? Difference in trim between…first of all trim is the difference in draft between the forward and the aft side - trim is the difference in draft; some trim might be there at W 0 L 0 it does not have to be even keel; even keel means exactly horizontal - the word is even keel; W 0 L 0 there will be some trim that is the difference between them.

At W 1 L 1 there will be some trim, the difference between those two trims…because of the trimming of the ship itself the water line has gone from W 0 L 0 to W 1 L 1 and at W 0 L 0 also there is some trim value at W 1 L 1 there will be a new trim value and the difference between those trim values is known as the change of trim; there is a slight difference between trim - as it is used - and change of trim; each time a ship trims you are going to have a change of trim and not really a trim - I hope it did not confuse you. Difference in trim at W 1 L 1 and W 0 L 0 - this is actually called a change of trim - if you want I can just repeat this - initially you have the ship at even keel, let us say, then some trim is there.

We define trim - that word is used in many ways, I use it as a noun now - trim or it can be used as a verb means the ship trimmed; they are different in meaning; ship trimmed is just a verb meaning that the ship moved like this there is no other meaning to it; but, trim itself as a noun has some meanings - first is trim, which means the difference in draft between the forward and aft - that is the meaning of trim.

Let us say, that as a verb the ship trims further; what happens is that initially there is a trim finally there is a trim the difference in trim is known as the change in trim; that is the… it is a bit vague but it is called a change in trim; it is like this, initially…this is just their way of drawing it - let us say that W 0 L 0 is like this and then you have W 1 L 1 W 1 L 1 is drawn horizontally.

Let us…W 1 L 1 - this is correct…W 1 L 1…now, the ship has… note initially W 0 L 0 - it might be with or without trim it does not matter then it becomes W 1 L 1; in all these problems I am not going to…I might…some places it comes; but, mainly we will be dealing about change of trim note, though there might be trim also - trim word also we will; note that we are mainly going to talk about about change of trim, that is, the difference in trim between the final case and initial case. We have W 0 W 1 L 0 L 1; let me do one more thing at this W 0 let me draw a line parallel to this line - like this - it will be like this, let us call this point C.

The change of trim is equal to…you can look at this, if it is according to this figure - do not draw your figure and try to derive it - look at this figure, this is horizontal; the real trim we are talking about is this distance between this W 0 and this L 0; forget this line for time this W 0 is its initial position here L 0 is the final position here and this is L 1 and W 1; the real distance we are talking about is really this W 0 to L 0 this whole distance from here to here.

This is actually equal to W 0 W 1 which will give you the height up to L 1 plus L 1 L 0; so, W 0… so, L 1 L 0 is this much plus there is some distance more on the aft side - this is the aft side; note, we can see that this W 0 C line has been drawn parallel to this L 1, therefore we want this W 0 W 1 - what will be it equal to? It is L 1 C; therefore, change of trim is equal to L 0 L 1 plus L 1 C is equal to L 0 C - it is just equal to L 0 C - this is your change in trim; it is difficult to…I mean very difficult to look at the figure itself and really visualize it, but you have W 0 initially L 0…but it is really equal to…L 0 C comes from mathematics you can see it is equal to L 0 C this L 0 C is known as the change in trim.

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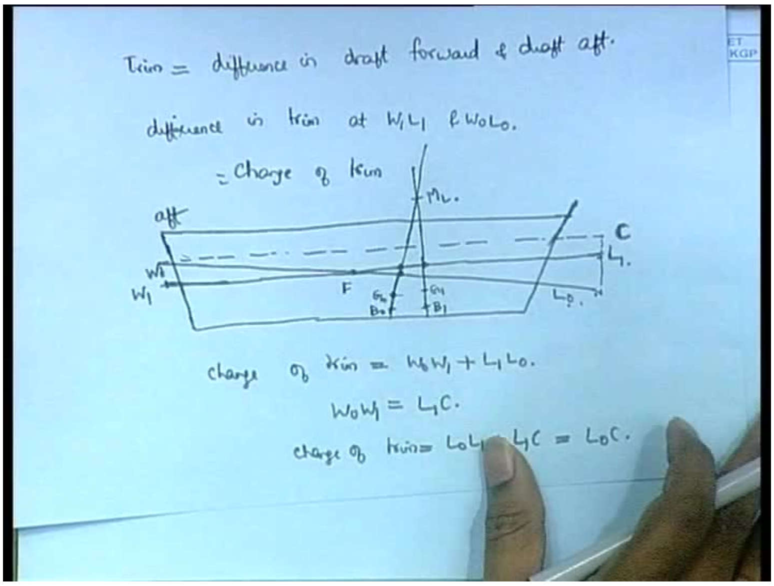

You can imagine that is the difference in trim between the initial and final conditions. Then, we have to draw these lines - this is F - let us draw that somewhere here; to this we draw a vertical - initial vertical - let us assume that it is somewhere on this line, you have the initial G 0 B 0 below that so G 0 and then here B 0 initial; this is vertical G 0 B 0 are on the same vertical; note, W 0 L 0 is initially horizontal - in this figure it is drawn in this fashion it is the same as heeling - in one figure you are drawing two things both of them actually representing a horizontal line; same thing, W 0 L 0 is also horizontal, this G 0 B 0 this line is a vertical line - that is the first position of…that is only the confusing thing.

Actually, this W 0 L 0 is the first position which if you want you can think of as upright condition, but the figure draws it in a slanted fashion it looks a little confusing but once you know that it is like this it is okay; G 0 B 0 and then finally the ship trims from this initial condition W 0 L 0 - the ship trims and let us say it is goes here; as you can see, it will be perpendicular to this line now - which is W 1? This is L 1 W 1 will be perpendicular to this line the new position - like this it is perpendicular to this; this will be your G 1 and this will be your B 1 and the position where they combine together is known as M L - the longitudinal metacenter.

Now, it is just a matter of similarity of triangles, that is, W 0 L 0 C - W 0 L 0 if you draw a line like this W 0 L 0 C like this - suppose, you draw a triangle like this W 0 L 0 or here W 0 L 0 C - this one triangle is here and M L G 0 G 1 M L G, now G 0 G 1 is parallel to this line G 0 G 1.

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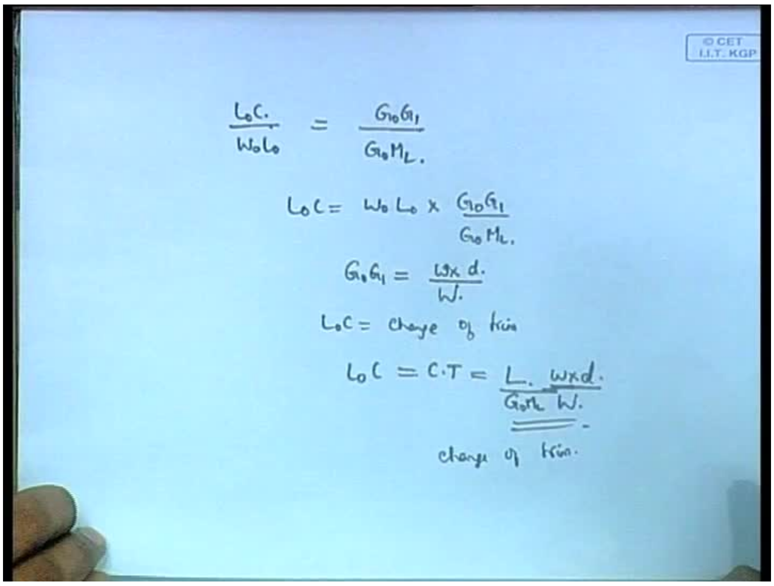

You will see that…actually there is no point…this comes I think you can just take…you can look at the figure you will know…from by W 0 L 0 equals G 0 G 1 by G 0 M L if you just look it comes from some similar triangles you will see there are two similar…how will? Actually, I forgot it - that is a good question; I did not tell you how the ship heels - a weight has been shifted here so here there is an initial weight - that is a good point - this is W 0 and the ship trimmed because this weight is shifted aft…W 0

The problem is this…main thing I forgot… you have initially a ship in the initial W 0 L 0 condition as a result of which…and next you are shifting a weight from some point in the forward to some point in the aft; the ship trims to W 1 L 1 and you have this set of conditions - G 0 G 1 by G 0 M L, then this becomes L 0 C is equal to therefore W 0 L 0 into G 0 G 1 by G 0 M L; then, this is the small w - small w into small d by capital W.

We have already seen that L 0 C is defined as the change of trim; it is therefore equal to - let us put it here - L 0 C the change of trim let us called it C T change of trim is equal to W 0 L 0; W 0 L 0 is roughly the length of the vessel - W 0 L 0 that length is the length of the vessel - so L into G 0 G 1 - which is w into small w into d by capital W - into G 0 M L; this is the formula for the change of trim this you just have to remember or by-heart; because, this is not very difficult to derive - this you can derive very easily; so, this is an expression for the change of trim; L is the length of the ship - you can take it as length between perpendiculars, w is the small weight that is shifted because of which the ship is trimming; d is the distance through which the weighted is shifted, capital W is the weight of the ship - the displacement of the ship - G 0 M L is the metacentric height - longitudinal metacentric height; this will give you your change of trim.

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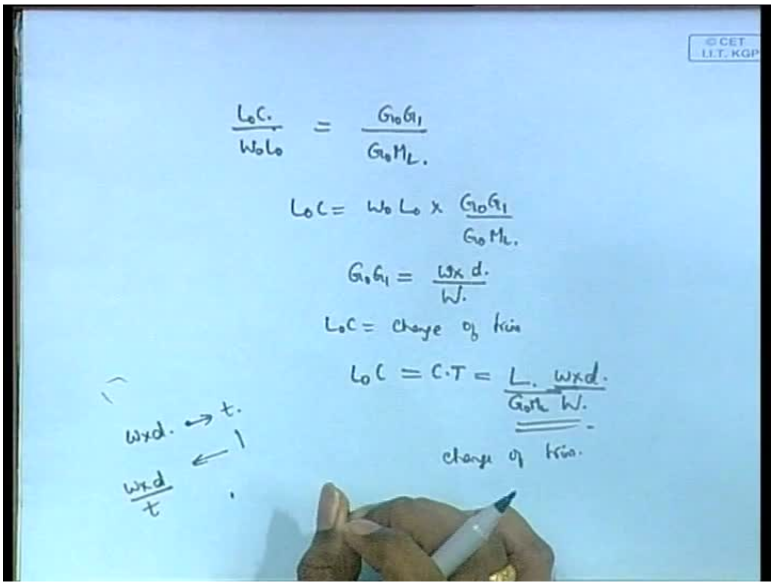

We can simplify these slightly; note that, w into d - small w into d - is the moment which causes, let us say, trimming by t meters - t centimeters - now, trimming by 1 centimeter is given by w into d by t - this is 1 centimeter, MCTC is moment change the trim by 1 centimeter; therefore, w into d by t - something is missing here; MCTC is the value of w into…so you can write w into d by t will give you the moment required to change the trim by 1 centimeter or MCTC, but they have written it as w into d - this I have to check anyway.

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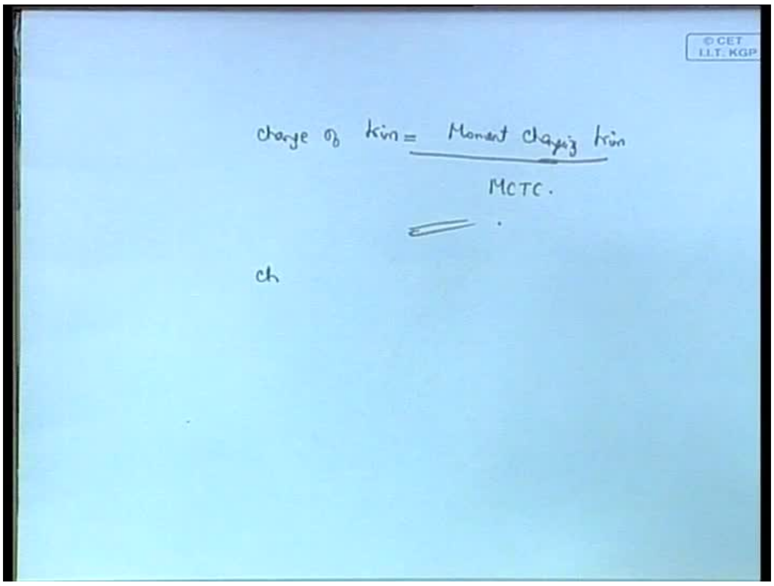

This is the thing, that is, change of trim is equal to moment changing trim - this formula you have to remember always - it is the basic formula - the definition of MCTC itself; MCTC means the moment to change the trim by 1 centimeter, so MCTC is equal to moment to change the… it is the change of trim - is moment to change the trim moment - which is changing the trim divided by MCTC will give you obviously the trim - the change in trim - first one is the moment which is changing the trim divided by MCTC is the trim…moment to change the trim by 1 centimeter, so when they are divided you get the trim right; this will you give the trim.

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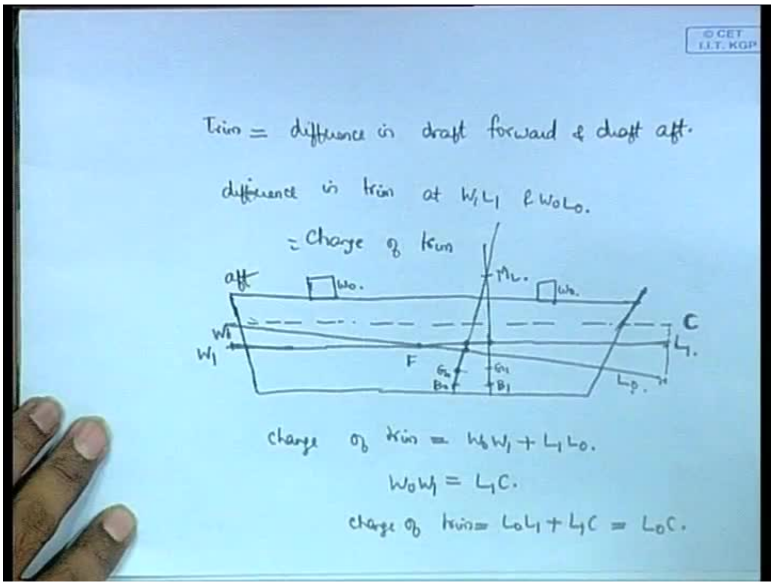

You get the change in trim by…this is the expression for the change in trim that also you need; once you have the total change in trim which is this - this is your L 0 C, we can find the change in trim forward and change in trim aft that is actually…let us suppose that…you can do one thing…that is very easy; see, if here you have a triangle from the aft you go up to the centre of flotation there is a triangle there and from this centre of flotation you go to the forward that is the another triangle there.

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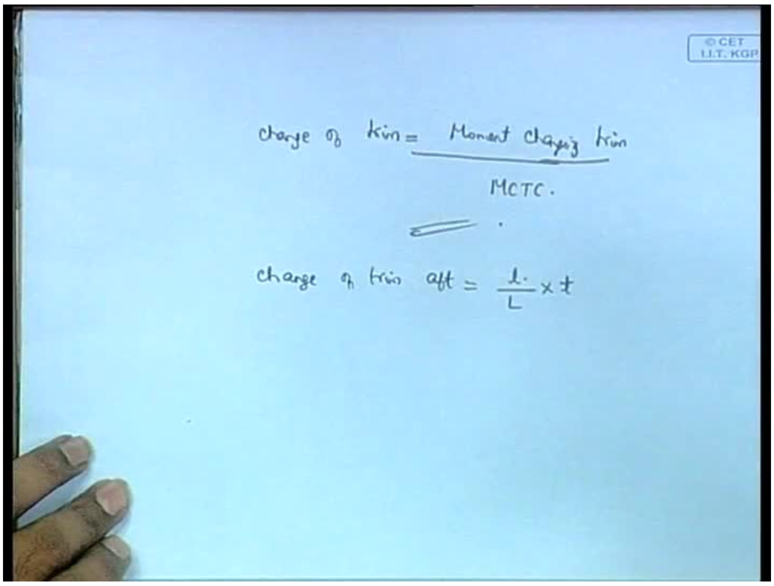

If you do, you can get the change of trim like this; let us suppose, is the l distance between the half most point and the centre of flotation and capital L is the length of the ship; so, l is the distance between the aft and centre of flotation and l minus l is the distance between these two lengths.

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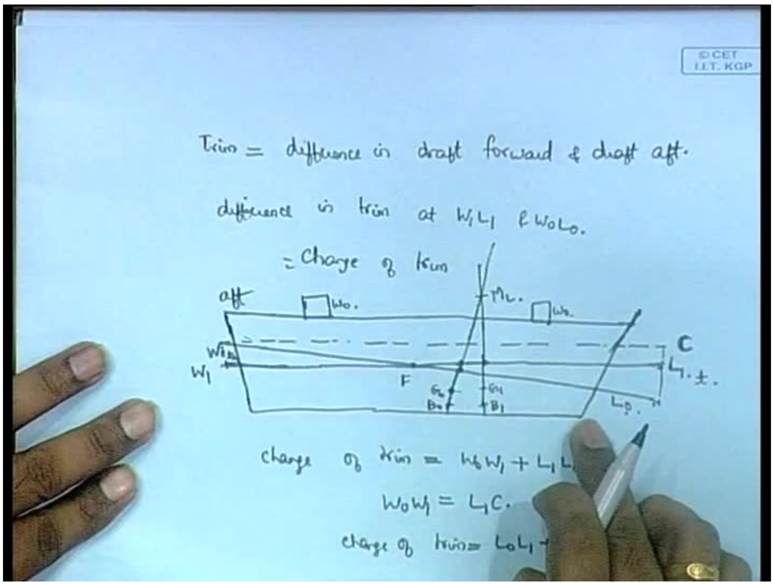

So, the change of trim in the aft side will become l by L into t it is just by similarity triangles where this t - is this ok? This t and this is t a - means, t aft and there is 1…no this is aft - t aft - and this is forward t forward.

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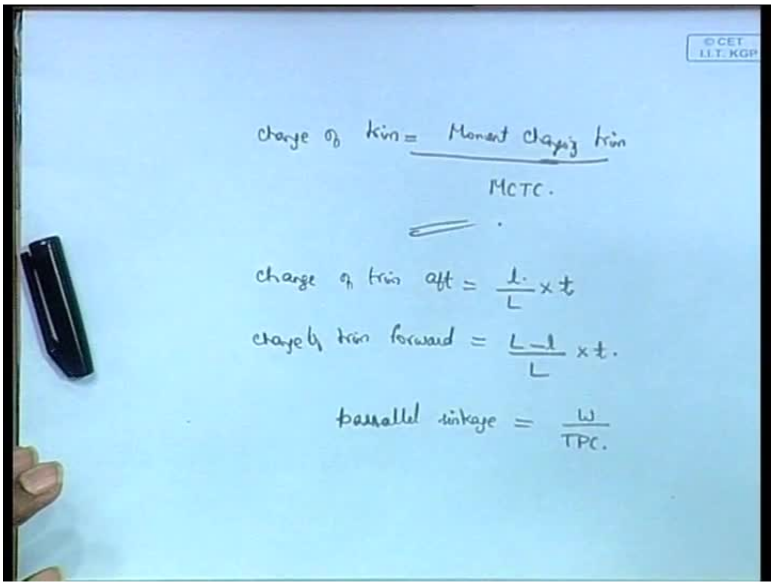

t minus this t aft will give you t forward; thus, you get the total t, therefore l by L into t will give you the change of trim aft and will give you minus L by l into t - this will give you the change forward; all we need to do, is sum them up - the change aft minus change forward will give you t itself - the total change in trim; so, the total change in trim is due to the change in trim aft plus change in trim forward it. From looking at the figure you will see there are two triangles and just by ratios you will get this - l by L into t and L minus l by L into t, this will give you the change in trim.

How do you find the total change in trim? From this formula - you need to find the moment that is changing the trim; in this case, for instance, in the case of a weight moving what is the moment changing the trim? It will be w into d - w into the distance for…you might have like different problems…you have…suppose the problem says that something like ballast is shifted from tank 1 to tank 10 - something like that - you have to know the weight of the water or the volume of the tank into the density of water and the distance between the tanks; once you have that, you know the distance through which the weight has been shifted or the ballast water has been shifted; that difference in that w into d will give you the total moment that is acting to change the trim; when you divide…MCTC should be given, I mean that is an a property of the ship itself so you cannot know that.

Once MCTC is given, moment change in the trim divided by MCTC will give you the change in trim; once you get the change in trim using this formula you can find how much is the change in trim aft and forward, and if you want you can think of it like this - you have the change in trim now, let us assume, that in the initial condition there was no trim, which means the ship was even keel - there was no trim; then, this change in trim that I am talking about is really your final trim, but it does not have to be; because, the initial trim might be there - if it is there then change in trim is not equal to final trim, but incase, just for simplicity you can do one thing - think of it as even keel initially and then the ship trims and you have found the final trim which is equal to the change in trim - change in trim is equal to the final trim because initial trim is 0 and from that you can find the change in trim aft and change in trim forward - from these expressions.

An additional thing that happens is if you add a weight to the ship - from outside if you take a weight and put on the ship there something called as a parallel sinkage - it just sinks - the word is parallel sinkage, that means if a load is… I mean, if a weight is loaded or discharged there is a parallel sinkage, which can be defined like this - w divided by TPC where w is the weight that is added and TPC is the tonnes per centimeter immersion; therefore, weight by tonnes per centimeter immersion will give you the total immersion; that is the amount by which the ship has gone down.

In all these problems related to trim you have the following things to take into account; first, parallel sinkage - incase the weight is added from outside you have to check if the weight is shifted inside, if there is no parallel sinkage there is nothing to worry there; if a weight is added from outside or if they say that weight is discharged or loaded - water is loaded, if some water is discharged like that - then you have to consider the parallel sinkage first, then you have to consider the trim; inside if you move the weights around there is a trim, and if you add a weight as such it will produces a sinkage; these two things once you know…and in all these calculations we have done trim in terms of centimeters so always trim is given in terms of centimeters, because it is that small; so, if you have ship length in meters - 200 meters - this will probably be 30 centimeters, like that, smaller value; it is usually given in centimeters.

You can use these TPCs without any problem - tonnes per centimeters immersion, moment to change the trim by 1 centimeter, all those things.

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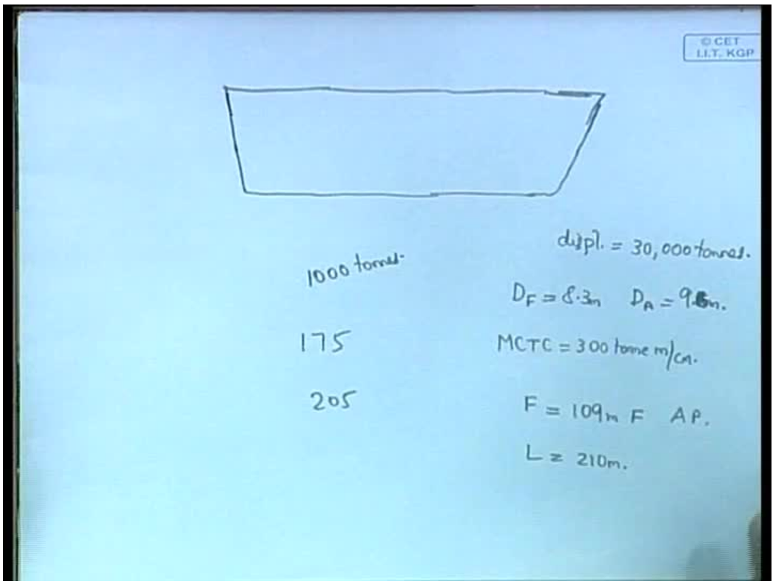

We will do one problem; there is a vessel, you are told that the vessel displaces 30000 tonnes - the meaning of which is that the displacement of the vessel is 30000 tonnes - so displacement is given to be 30000 tonnes - you are told that its draft forward is 8.3 meters, draft aft is 9.6 meters, then you are told that your MCTC is 300 ton meter per centimeter - that is how you measured MCTC - moment by centimeter; you are told that your centre of flotation F is at a distance of 109 meter to the forward of aft perpendicular and you are told that the length of the vessel is 210 meters. You are asked if 1000 tonnes of ballast are moved from a tank with the centre of gravity 175 meter forward of AP to a tank 175 meter to a tank 205 meter forward of AP.

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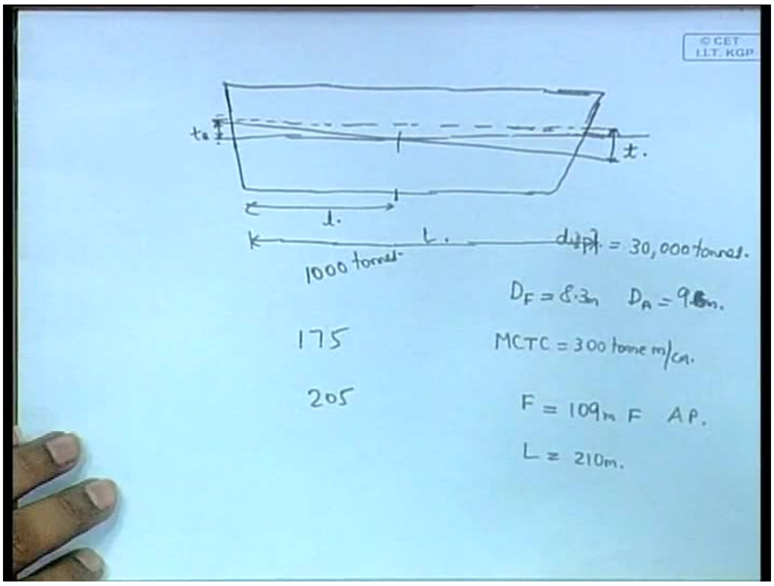

A ballast is moved from…1000 tonnes of ballast - 1000 tonnes of ballast is moved from a point 165 meter forward of AP to… basically there is a movement of weight in the forward direction, so the ship trims in that direction and you are asked to find the final draft. As you can see, in this case there is only a movement of internal weights, there is no parallel sinkage - you can let that go; it will be like this, initially…actually it is…you can just look at that figure they are all drawing it like this the initial position is like this then final position is horizontal.

We can draw this as well; I think, it will come like this somewhere; this is your t, which is the change in trim - same from our previous definition - and this will be your trim aft and the difference between these two will give you a trim forward; you are told that the centre of flotation - your position is given, this point the position is given at l and the total length of the ship is capital L; you are told this much, we know what is the weight that is shifted we know the distance that is shifted, so we know the change - the moment that is producing the trim change.

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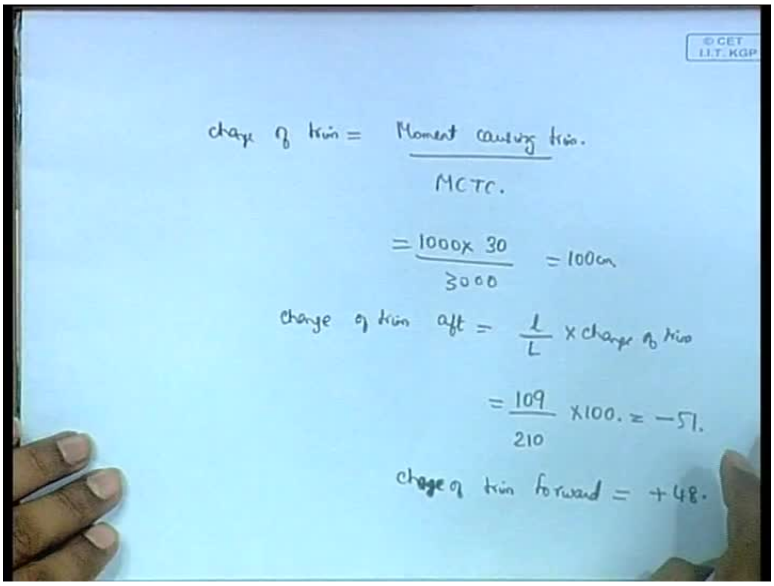

Therefore, the change of trim - we can directly calculate - change of trim will be the moment causing trim divided by MCTC is given - this is very straightforward; next is dividing it - change of trim aft, we have the total change of trim now change of trim aft is l by L into change of trim; so, this becomes 109 l - small l - is the distance from the aft perpendicular to the centre of flotation - that is small l and capital L is the length of the ship or the distance between the two perpendiculars; therefore, the change of trim aft is equal to l by this is 109 by this thing into 100 - change of trim is found here to be 100.

Here you have found the change of trim aft - that becomes minus; actually, that is a point - you have to see where the weight has shifted, in the case, 175 meter forward to 205 meter forward so it has shifted forward therefore it will go down; that you have to…you would not get it from the equations; because, change of trim…it just gives you the change of trim it does not give you the direction of the trim; you have to just see where the weight has shifted and do that; here you know that the weigh has shifted forward, obviously the aft is going up and the forward is going down so aft will become negative; note that, what is going out will become…when it is increasing it becomes positive that is how we are defining it

This will become minus whatever and change of trim forward will become…same way L minus l into l minus l by l into the total trim that will give you plus something.

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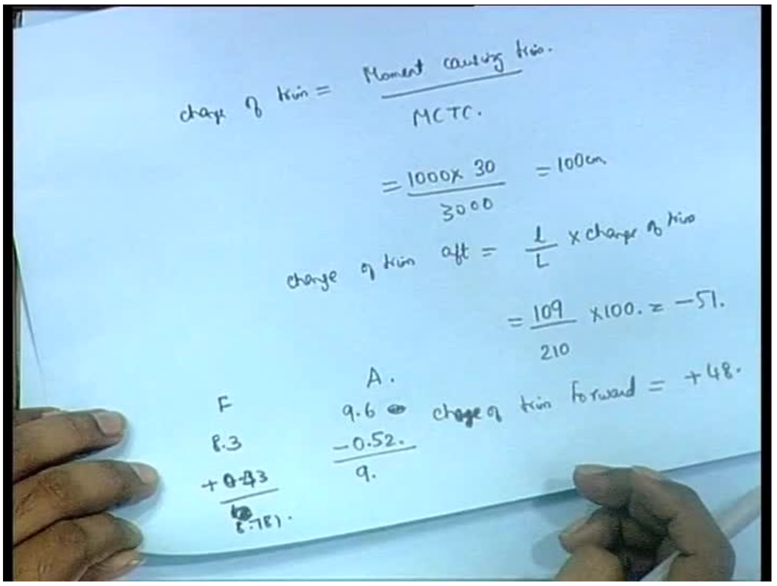

Your question is - what is your final draft forward and afterward? Like this you can put - you have given your initial drafts…you forward…you just add your final draft - final trimmed draft - you get your final draft now; what it is…0.43; actually, this is one check you can put on your problem, that is, you should not be getting trims like what I wrote first 4.3 - that is definitely wrong, 4.3 meters you will never get a trim of 4.3 meters - it is definitely wrong; 0.43 that is reasonable - 0.43 meters, so that is no, 48… 0.48 meters that is 43 centimeters; you should always get your trim between let us say about 20 centimeters to about 60 centimeters not more than that roughly in that range 20 to 60 definitely not more than that.

Similarly, you do in the aft side; in the aft you will have a minus that is the only difference, 9.6 and you have minus 0.52 this is like the maximum draft you can get; 9 point you will get something…this will give you your final drafts; most of the problem will be related to this that is - you have to find the final draft because of a shift in the some weight some ballast water some fuel or something.

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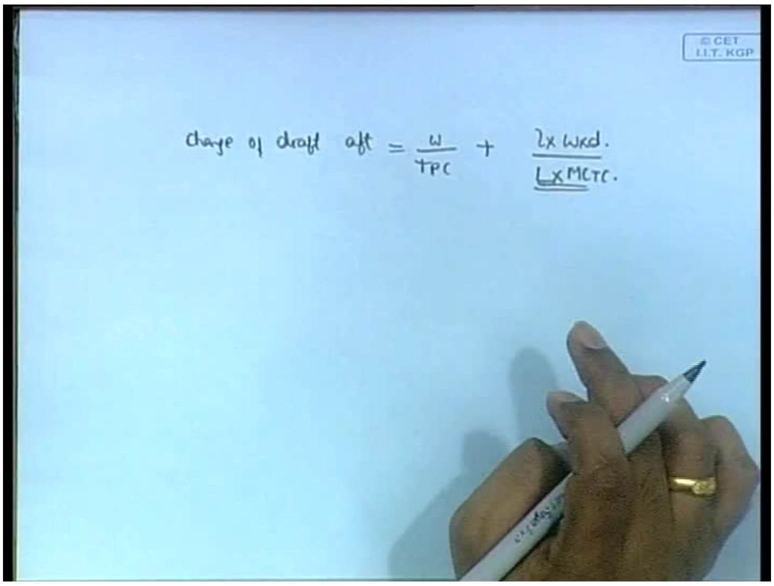

Then one more problem…the problem we will do….I will just do one thing and stop; what you need to remember is that in case you are shifting a weight in the aft direction this is how you have to do your problem - change of draft in the aft will always be equal to sum of two things - this formula I will derive it in the next class.

What it says is that your total change of draft in the aft or in the forward will be the sum of the parallel sinkage plus due to trim - this formula due to trim we will derive; the total draft or the total final draft is trim plus parallel sinkage; parallel sinkage is always directly given by w by TPC w is the weight added TPC is the tonnes per centimeter immersion and this is the…we have not derived the whole thing we will do it in the next class.

I think we will stop here. Thank you.