Hydrostatics and Stability

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Module No. # 01
Lecture No. # 25
Trim Stability - I

In the last class we stopped in you come here no so I am just starting so in the last class we stopped at

We are trying to show that the We came to the final result that the total - we can keep the total draft without changing provided we change the sinkage and the trim, such that, we can make the total equal to 0.

Now, we will continue with that. We will come to what we call as a mean draft. The meaning of a mean draft is - of course, provided the vessel has some initial trim - it is some trim in the aft and the forward side.

Suppose, we make it even keel or it is not that it is even keel; we talk about the trim at the midship. It is not really trim; you cannot call it trim, because it is not below some region or above another region. It is really just a draft, so that we call it - as a mean draft.

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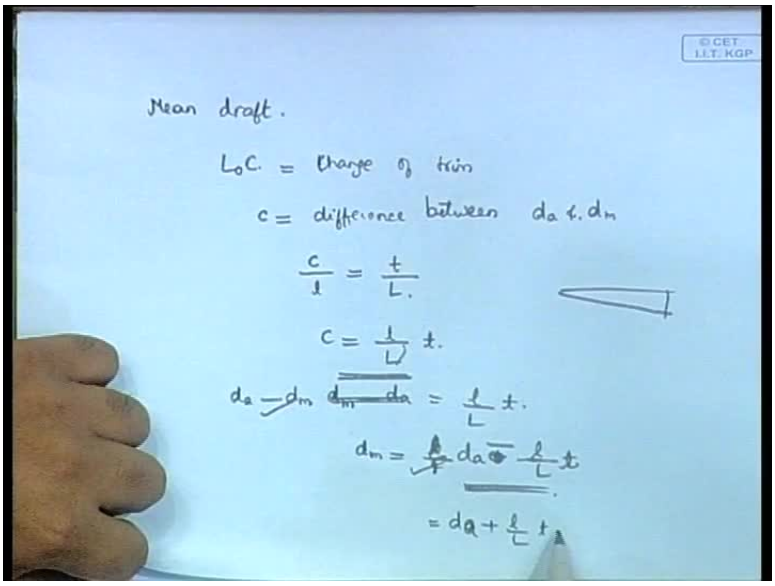

We call that as the mean draft because it is not really trim in anyway, so we call that as a mean draft.

When you add a load to a vessel you know that if the vessel is trimmed to some level and if you add a load to it. Let us suppose if the vessel is trimmed like this and you add a load here; if the load is such that finally the vessel comes to even keel - even keel means like this - in a horizontal state.

The thing is, this even keel in this case will not be the average draft - this is called the mean draft. Mean draft is the draft at the midship; it will not be equal to the average draft. What I am talking about as average draft is - this draft plus this draft by 2, because this will sink also or go up.

So, the mean draft in general Average draft means, suppose, you have some draft here and some draft here and you add a load. You take the average of these two drafts and that is called as an average draft.

The mean draft becomes slightly different from the average draft because of parallel sinkage and rise; so that is one point.

We actually I will just assume that you remember this; that is - we defined - we got an expression for change of trim and all that as L 0 C. There was a figure - I do not think I will draw the figure again. It is just the same one figure which showed that L 0 C means - L 0 L 1 was there which was put as C.

Then, L 0 C is the we called it as the I think it is the change of trim. It became the change of trim of the vessel.

Let us define a small c as the difference between - When you write like this, the subscript itself will tell you what it is - d a is draft aft, d m is draft midship and d f is draft forward.

As the name itself suggests, it tells you what it is. Let us suppose that c is the difference between draft aft and draft mid ship.

Just a minute I think there is a minute one mistake

Actually, one small thing - it is not midship; it is actually the center of floatation, it is not midship. Though, it may be very close but you cannot - what is that - interchange the two; it cannot be said like that.

Mean draft is actually the draft - though they have put at as m - it is the draft exactly at the center of floatation, because the vessel always trims not about midship, it trims about the center of floatation; that is very important.

That midpoint which we are thinking of - you know - when there is an aft and there is a forward. Conceptually, we think of as the midpoint - where it is; that is, actually the center of floatation, it is not the midship. So, L 0 C is the change of trim. Let us define small c as d a minus d m.

If you look back to the old figure, you can see it very directly in the text. You will see that there are two similar triangles come in that. As a result of which, if t is the total change of trim and c is the difference between draft aft and draft in the center of floatation f, then if l is the distance between - it becomes two similar triangles like this - something like this, some two triangles come.

So, c by l will become equal to, l is the distance from the aft perpendicular to the center of flotation - small l, L is the length of the ship - capital L, t is the total change of trim and this is like the change of trim in one side between d a and d m. See, change of trim is always defined as the difference in draft - between aft and forward, c is that between aft and midship, not between aft and forward but between aft and midship.

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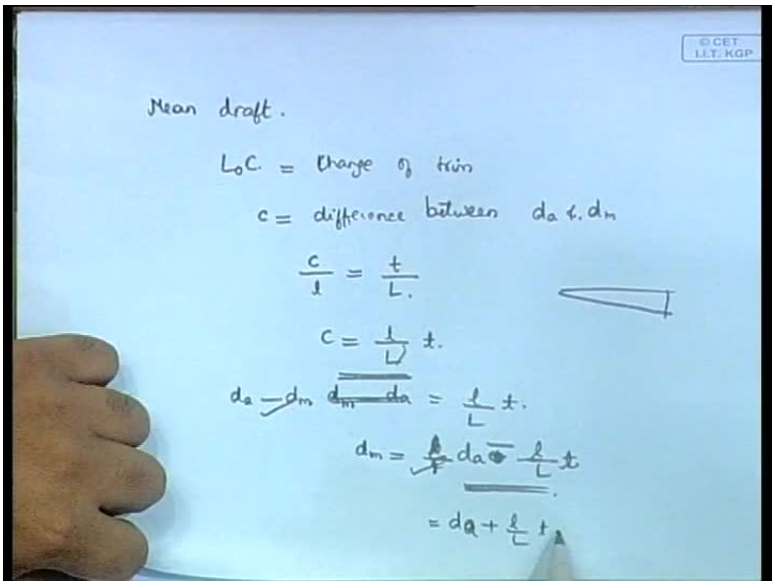

It is like one small triangle, half triangle and one big triangle. You are just saying they are similar and you are drawing this equation; so it automatically gives c is equal to l by L into t.

So, c is again d m minus d a is equal to l by L into t or, d m is equal to - l by - d a plus l by L into t.

Actually, it is not like that. There is a mistake. It will be d a minus d m because, otherwise it will be negative. midship will be actually If the draft is like this - then midship will be above; so d a minus d m will become like this. So, d - what will it become? d m will become d a minus l by L into t.

Actually, it just depends; I mean if it is like this - it will be the other way around. You just remember. This expression you can just look. We will do some problems. You will see you can - what you call - change according to that particular problem, but this is fixed - c is equal to - this is what should be added. This is the difference between the draft in the aft and the midpoint or the center of floatation - that we should be able to remember.

Why it is said means You might see a lot of the major part of this book - this chapter - always deals with trimming by aft, you means you v They have explicitly said - in the rare case of trimming by head - that means it is a very rare case; that means, a ship is never usually like this - it is always like this. If you look at any ship's picture, you will see that. When you see that next time, check carefully; not big ships - not like a oil tanker or anything, there you would not see anything it is too big.

When you see small boats, you check that - it will always be like this - it will never be like this. It is because the weight is mostly in the back side. Even for a small boat, you put the engine on the back side. You have seen that it is always at the back, so it will always be like this.

That is why it is always - in these, they have automatically assumed that the aft is always down, forward is up, so the middle will be somewhere in between - it is above the draft. That is why this definition will become d a minus d m. In the unusual case of vessel being trimmed by the head, it will be this - it will be d a plus l by L into t. That is very rare case but, in case, it happens there is the equation.

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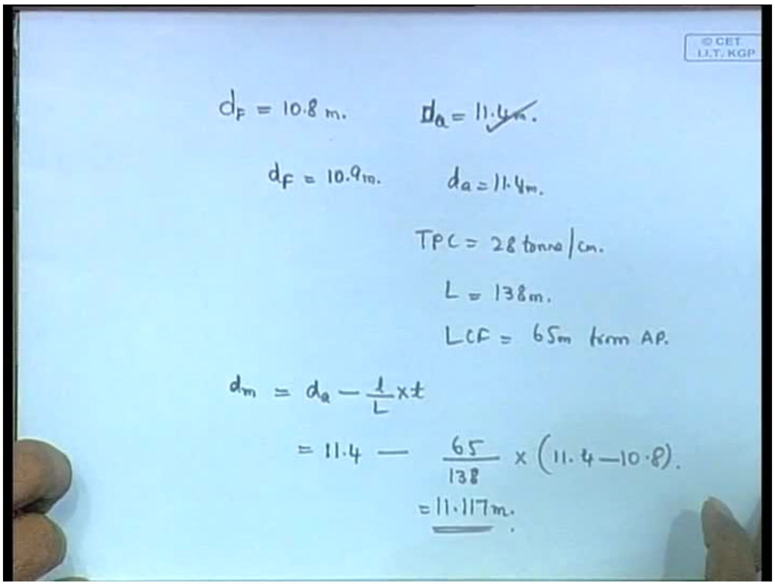

Then, one problem is there - we are told that there is a vessel which is floating at a draft forward equals 10.8, draft aft is equal to - actually, let us write it as small d - small d draft aft is equal to 11.4 and it is said that it is now going to load things in it. Final loading - after loading, it will have the drafts: draft forward equals 10.9 and draft aft 11.4 - it is the same thing - aft is not changed, aft is still at 11.4. Then, T P C is something, the length of the vessel is 138 meters and L C F is 65 meters from AP.

You are asked to find the total load or the cargo that has to load. You are given the initial drafts, final drafts and all these things. You have to find the amount of weight load it has to - amount of cargo it has to load so that this initial and final condition holds true.

We can proceed like this: first of all, let us find the as you can see, aft is below - aft is 11.4 and the other one is 10.9. It is like this only - as the usual case - so, d m - just by applying the previous formula - it becomes t, where t is the total change total trim change in trim or the difference between the aft and forward. The only problem here is to know what each thing stands for. Draft aft is this - 11.4, we are talking about the initial case, so 11.4 minus l - you have to know each thing, that is, I guess the only thing in this - l is the distance of the center of flotation from the aft perpendicular so that is given here, l is the length of the ship and t - what is t here? It is - that 11.4 minus 10.8 - that is all. It is the difference between the two forward and aft; if you just take the difference, you will get that; it is 0.6.

So this will give you something - 11.117 meter; so, this is your mean draft or this is the draft at your center of flotation.

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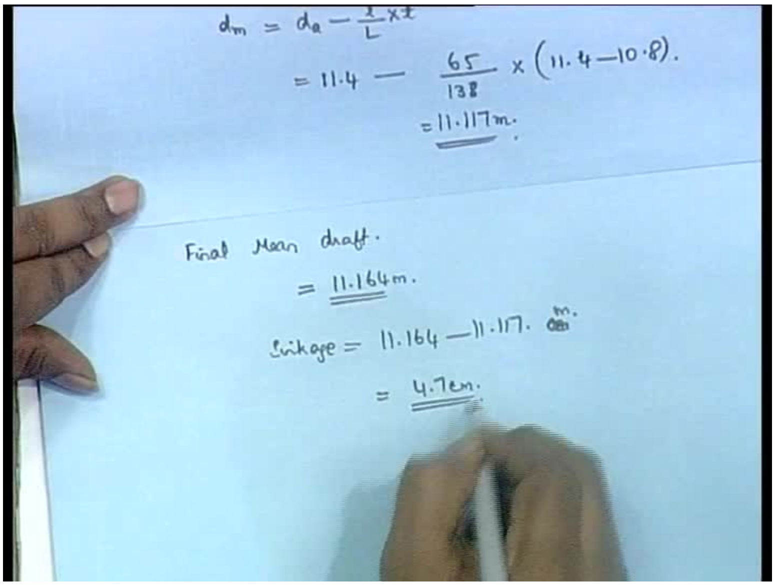

This is initially - before loading has happened. Now, loading is done and your final - same things you do - same set of – you are given all the data - same data for your final case also; so that you have to do it and you will get the final draft which is 11.164 meters.

We have the initial and final drafts. The difference between them will give you - what? that is what actually you have gone even further than the Actually, the difference between that will give you sinkage; so sinkage is equal to 11.164 minus 11.117 - this will give you the sinkage. That much meters becomes 4.7 centimeters when you convert to centimeters. This is your sinkage and as I said the next step is - we know that the sinkage is always given by - w by T P C.

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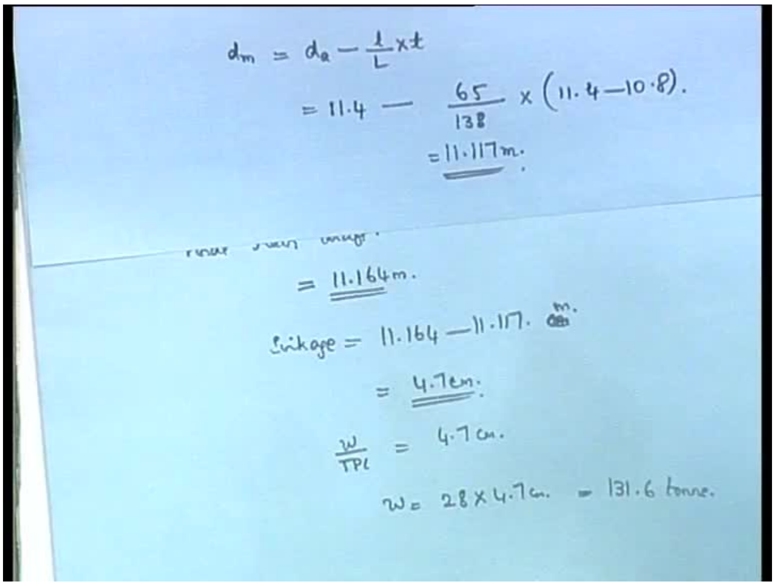

So, w by T P C is equal to this - that means w is equal to T P C into this. T P C is given as 28 something into 4.7 centimeters, so that much will give you in tonnes.

Actually, note these small things, when you are doing w by T P C you have to write your draft in centimeters and not in meters; otherwise, you will get divided by 100 - something like that; so the difference will come. w by T P C is equal to 4.7 because, T P C is always given for centimeters. One of those - One of its unit is like tonnes; what is it T P C is given as tonnes per centimeter, so 131.6 tonnes.

As you can see, you can check one thing. If you just take an average draft - we have taken the mean draft which is the draft at the center of flotation - if you take an average draft; actually, you will get a difference - very small difference, but still a difference in the answer.

It is a very small difference, it actually will give you an answer of 131 and that will give you some 140 - some difference in answer. You have to always take the mean draft, because that will give you the exact - that it will include the sinking and everything; so you have to take that.

Always take the mean draft and not the average; do not just take aft plus forward by 2; you just use the formulas that are given here.

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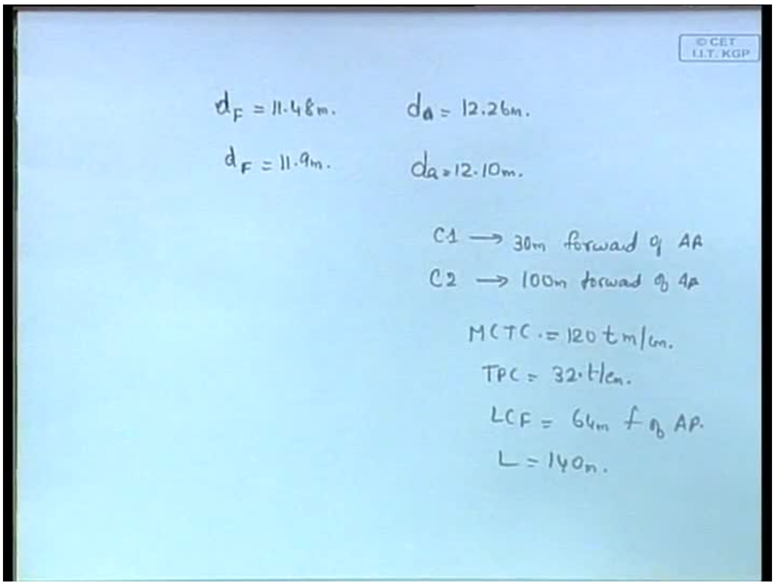

Another problem is - it is told that a vessel is floating at draft forward equals 11.48 and draft aft equals 12.26. Again, actually this is almost the same problem, but slightly different; that is in this it said that finally some loading is done and final drafts are: draft forward is equal to 11.9 meters and draft aft is equal to 12.1 meters.

The difference here is: cargo is loaded in this fashion - it is loaded in a compartment number 5 which is 30 meters forward of A P, compartment 1 is 30 meters forward of A P and compartment number 2 is 100 meters forward of A P. That means are you given the total cargo. No. You are not given the cargo also. That means you have to find two things here.

You are given a couple of these things like: M C T C is given - 120 tonnes meter per centimeter, you are given the T P C - 32 tonnes per centimeter, L C F is said to be 64 meters forward of A P and the length of the ship is 140 meters.

Here, what you have to find is - first you have to find the cargo that is to be loaded and the total amount of weight that must be added. Number 2: you have to find how the cargo is to be distributed between the two loads, such that, you get these final drafts. It is slightly more complicated than the previous problem.

Now, same thing, note that when you are doing parallel sinkage in all these trim problems; when you are doing the parallel sinkage - when you are trying to find the w by T P C, always find the w by T P C is equal to something - that is always equal to the value at midship - means it is a sinkage of the center of flotation and not midship. I keep- it is always the difference in the position of the ship at the center of flotation or the drafts at the center of flotation.

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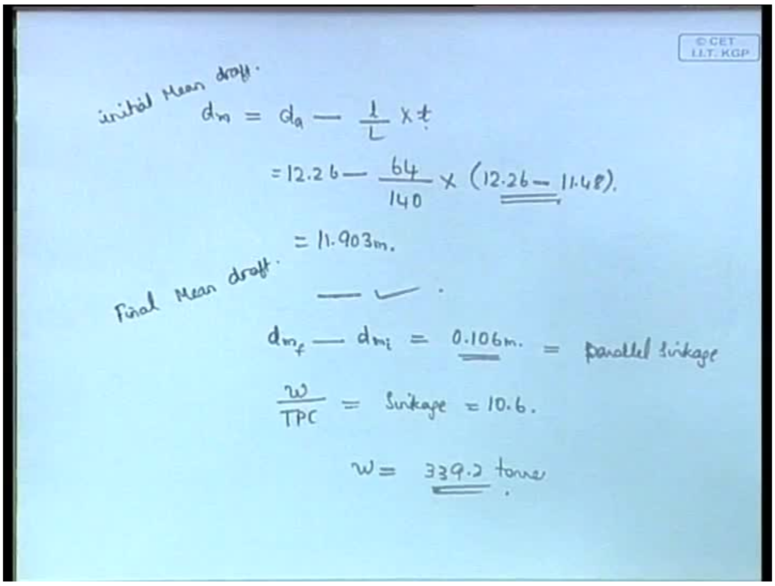

So, d m - so first the initially you have to find mean draft, which obviously means the draft at the center of flotation - d m is equal to d aft; this formula is anyway fixed, so you can do this.

Everything is given: draft aft we know, the distance of the L C F from the center of flotation from the aft perpendicular - that is given there, capital L is the length of the ship and t is the difference between the forward and aft or aft and forward aft minus forward. - this I guess is slightly confusing. The other things are fixed - l, L, d, a - are all given.

This you just know - what this t stands for – here, change in trim is forward draft minus backward draft - that is the change in trim.

You just do this - you will get something. Then, same thing, you have to find – this is the initial mean draft - similarly, you have to find the final mean draft; same process is applied for the final case. The final draft minus the initial draft - d m initial; so this final just do that, I am not doing it.

This draft minus this initial draft which comes, in this case, as 0.106 meter; so, this is your sinkage - parallel sinkage. Then, we use the formula - w by T P C is equal to this parallel sinkage. It is given in You have to write it here as 10.6 - that will give you your parallel sinkage. From this, we know T P C, we know the sinkage, we get w; w is equal to the weight that is to be added. In this case, it comes out to so many tonnes. This will give you the amount of weight that is to be added totally to the ship.

Now we need to In this, the additional thing is we need to figure out how much is to be put in one hold and in the other hold – two holds.

Let us consider the initial case. Once you add this w first usually we do not do means In the previous couple of sections, we did this problem in If you remember, in the previous couple of problems means, two - three classes back - we were doing problems related to: you are given the initial trim and some weight is added. What is the final trim or the final draft? We are finding the final drafts, in which, we added the trim and the sinkage and we got the final drafts - aft and forward; we have done that.

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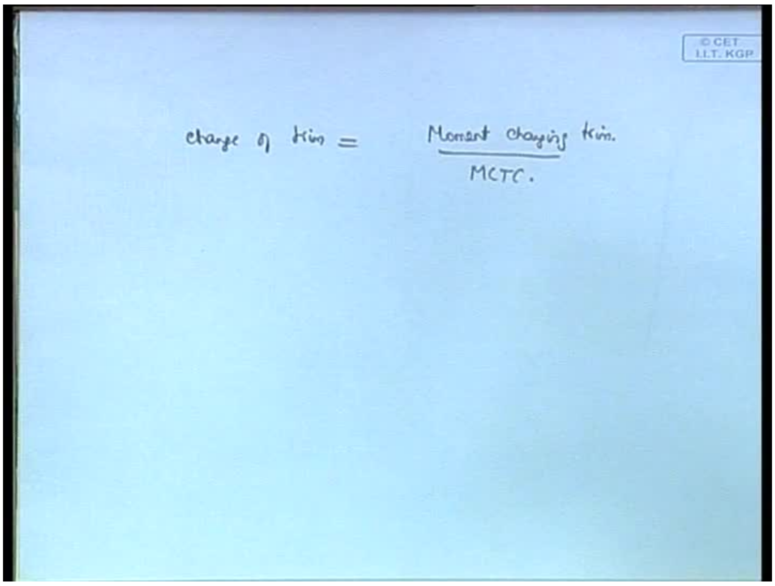

The same thing we are doing backwards. Here, let us see the change of trim - this formula has been used many times, so I will just write it - moment changing the trim divided by MCTC; this formula is there. How do you find the change of trim?

Actually this I think I confused it I did not I said change of trim for a couple of things probably let me see one minute

Here, I told something in a wrong way. I think, I will repeat this at least two times then, I have to make sure that you do not make this mistake in exam. What I told right now was that - in all these equations, there is a small t coming which is a trim. Actually, I told this in the beginning then, I made the same mistake myself. There is a something called as trim and there is something called as a change of trim.

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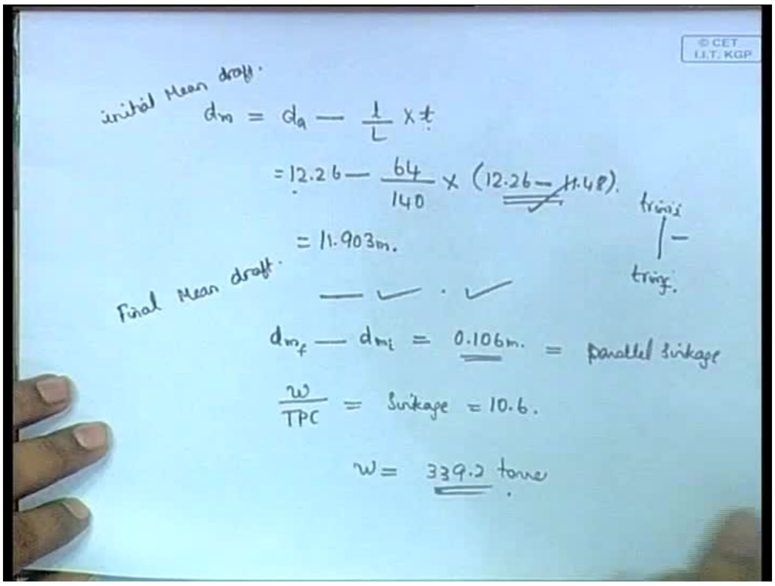

It is like this, that is, what is trim? See, in this expression we used here - we use a t - this is a trim. Trim is the difference between your forward and back and that is a trim; that is not a change of trim - that is just trim; so that is the first thing. This small t they are representing here is the trim itself and not the change of trim.

The trim initial minus trim final is what we call as change of trim. Actually, this itself I said as change of trim - I think I repeated that. At any case, this is the trim and not the change of trim. This is - trim and this is - trim 2.

Trim initial then load is added and you get trim final. The difference between the two - this minus this- will give you the change of trim. that I think that it can you I mean you can make a mistake, so that is why I am writing. Anywhere, t represents trim; there is no symbol or anything given for change of trim, it is written always as change of trim.

Just know what the difference is - trim is the difference between the forward and aft draft. Actually, there are a couple of things. First of all, there is the draft. Then, there is the draft then there is a draft in the forward and backward sides which are different- that is the second thing. I mean till now initially, we always talk about draft as one thing for a ship. Then, we see that the draft is different for the front and back of the ship - I mean the aft and forward of the ship - that is the first thing. The difference between these drafts is what we call as trim. When you add and remove cargoes from the ship, the trim itself changes and that produces a change of trim. That I think is the whole series of things.

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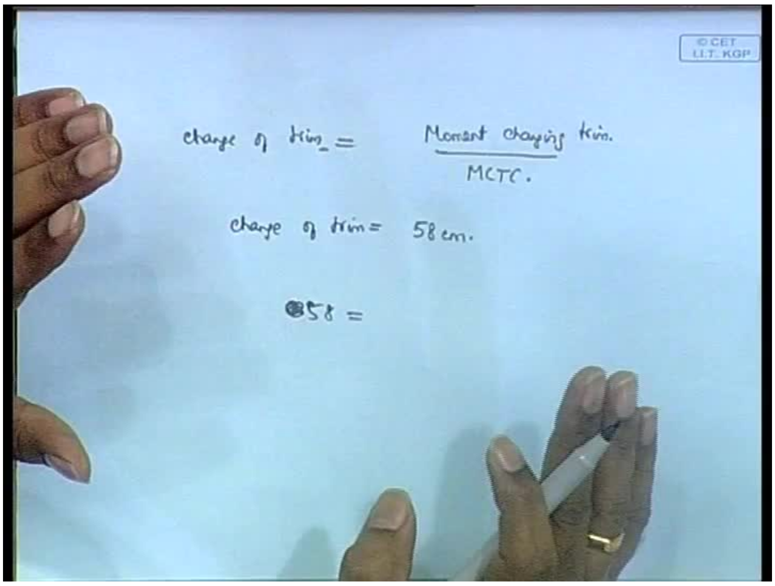

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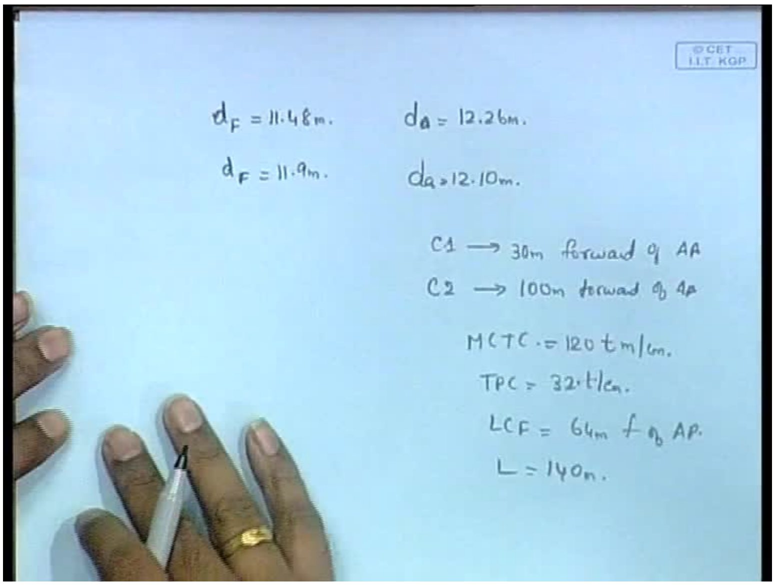

In this case, first - the change of trim can be calculated like this. I mean it is obvious, that is, we have here change of trim which is like this - 12.26 minus 11.48 will give you the initial trim, 12.1 minus 11.9 will give you the final trim. It will be 0.78 minus and this 0.2 that is 0.58 which is 58 centimeters; so 58 centimeters is the change of trim.

This formula - is for the change of trim. Change of trim which we can imagine itself; change of trim is equal to the moment changing the trim by MCTC.

What is the moment changing the trim? That is the only thing we need to - Like the left side we know - 0.58. wait Change of trim is also in centimeters, so 58 is equal to. What will be the moment changing the trim? That is, let us suppose that is what

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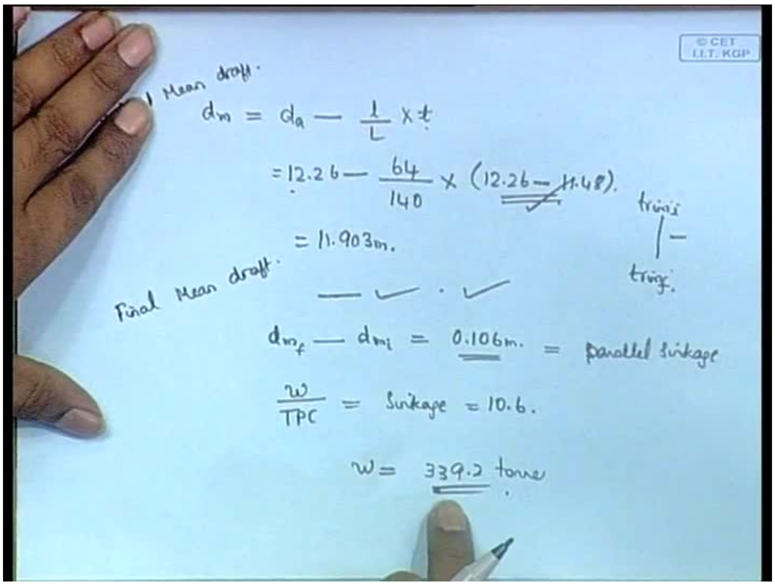

Let us suppose that w is the weight that you are putting in the hold 1.We know that a total weight of 339.2 tonnes has to be added; we have just calculated the total weight that needs to be added. That means let as suppose that w tonnes you are putting in hold 2; that means 339.2 minus w of weight we are putting in the hold 5 - the two holds. As a result of which, what will be the moment? That you have to calculate - that is, I guess the only thing you have to think of in this problem.

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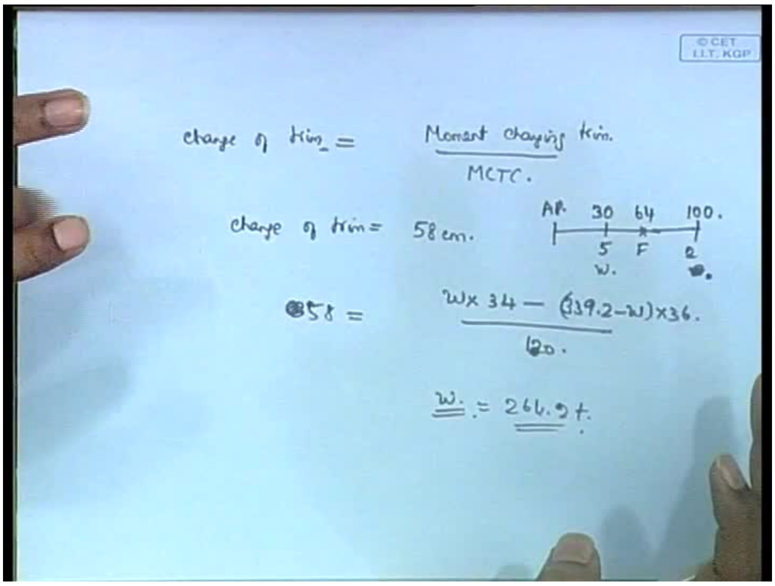

The two holds you are told: one is 30 meters forward of A P and one is 100 meters forward of A P. Another thing is when you are taking moments, do not take it about A P; It actually, you might get the answer, let me see. no You will get the answer, I think.

You will get You have it to take it about the center of floatation. I am wondering if you will you get the answer. I do not think you will get the answer if you take it about A P.

you have to take it about the center of floatation. right yeah which distance no I see that but what I was thinking is will you no it would not come you have to take it about the center of floatation only You see, you have to 58 so 58 is equal to let us say w is That is next thing, the only thing in this, so Every distance is given from A P in this case. You are told that your hold number 2 and hold number 5 is somewhere here- it is 30 meters hold number 5 is 30 meters forward of A P and hold number 2 is 100 meters forward of A P.

You are also told that the L C F is 64 meters - somewhere here, F is somewhere here - 64 meters; therefore, you have to take distances in a different fashion. It will be yes w into - one weight, let us say, if it is added here - w into they have that said here w into 34 minus or minus yes minus 339.2 minus w into 36 yes that is correct divided by 120; What is 120 divided by MCTC that is given MCTC is given 120, so this is all.

34 into one of them is positive one of them is negative so that is then soYou will get your w here, this will give you your w. You will get w is equal to - in this case 264.2 tonnes. That means you need to put 264.2 tonnes in the hold 2, I think. hold 2 which then It is just in the hold 2 and the rest of it which is some 75 tonnes you put it in hold 5. This is the way to distribute the problem I mean the distribute the cargo - which is the problem.

So I guess of course what I really we should do this problems This book you all have, so you need to do these problems before the exam definitely. If you have the concepts clear, I think you can do it. All these it is very sense sensibly only The only thing is you have to know what is change of trim, trim; you have to know all those things and these formulas of course. Definitely, you have to remember these formulas like - change of trim is equal to moment changing trim by MCTC - all these things. once you have it it is

Usually, for the exams also, I will take problems only from this, I am not going to devise my own problems. Even though, I asked the problems straight from the book this time, most of you seem to be as if you have never heard the problem at all. All of you seem to be, I mean reacted as if the problem was entirely new and you have never heard of the problem. Of course, nobody said that that 1.75 and what was it seven if you remember 0.5 0.275 that nobody has done

You kind of looked as if it is completely new. how that is what yeah you just did not do that is the thing Actually the second part, I mean the end semester is not like the first part. In the first part, I could ask questions like what is L C F and all those. like there are things like that Here is nothing like that its only problems so I think you will just have problems most likely you would not even have any theory nothing and even there is nothing to ask like what is statical stability nothing it is all just problems so I mean you just have to know the whole thing completely this time otherwise you will have so this time makes sure you do the and I would not ask anything outside this so just make sure you do these problems

So that means 50 marks 50 marks of problems you will have to that will be a lot of problems so then

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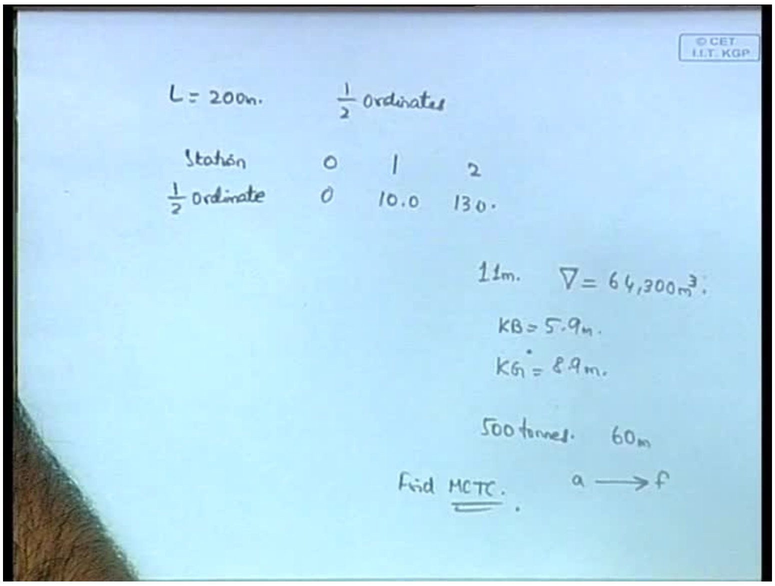

There is one more similar problem but it is slightly different. In this problem, you are told that there is a vessel of length 200 meters and you are given its half ordinates. You are given the half ordinates of the vessel like this: station, half ordinate - like this - you are given. You know what are half ordinates? when you are given the ship like this I mean If you are given the ship like this - this distance - is known as the half ordinate.

Like this - you have the half ordinate. Then, you are given a couple of hydrostatic data: you are given that up to 11 meters the underwater volume del that means I guess the draft is 11 meter problem we will see that up to a water plane of or water up to a water plane of 11 meters or water line of height of 11 meters, you are told that your underwater volume is something, that is, 64300 meter cube and you are given some hydrostatic data: KB and KG.

You are asked to find the change of trim. I guess this has a trim as it is standing also - it must be having a trim. You have to find the change of trim, if a weight of 500 tonnes is shifted 60 meters from aft to forward. so a weight of how much 500 tonnes is shifted from 60 meters from aft to forward. From aft to forward a weight of 500 tonnes is shifted a distance of 60 meters.

Moment changing trim - you know directly - 500 into 60 - that is the moment changing trim. MCTC is that is a question Find the MCTC - this is the question. What we should understand is looking at the problem itself, we can see that directly you are given the moment changing trim and you are asked the MCTC. What you will definitely need to find is your change of trim, so that is going to be what you are going to find. What we need to find is change of trim. Let us see change of trim. Actually, there are a lot of formulas; for change of trim. I let me see all the formula you have to just look back at all the formulas that you have for change of trim.

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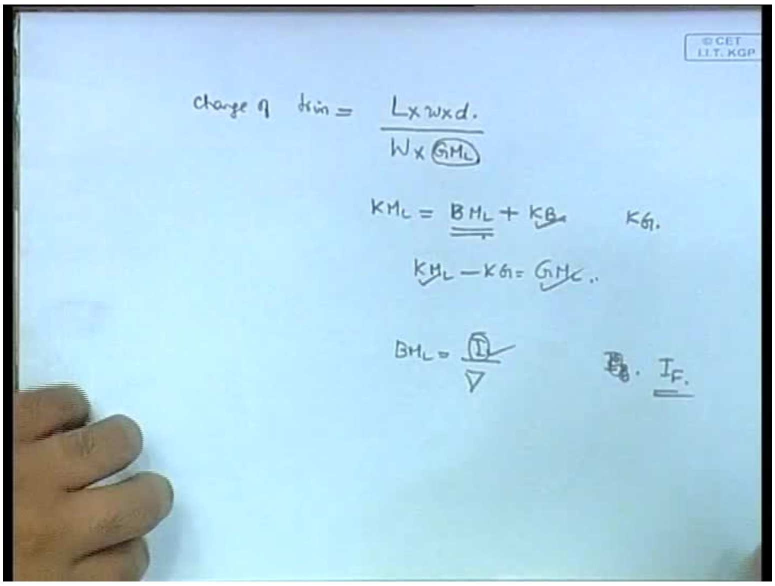

Actually, there are a couple of formulas - the one - I think the most common one that we have used is this; that is the change of trim there is a formula given like this.

We have done this. For change of trim one formula was given like this - where L - capital L is the length of the ship, w is the weight that is shifted - it is given here 500 tones, d is the distance through which it is shifted - 60 meters, capital W is the weight of the ship - total weight of the ship is the density of sea water into the volume under 11 meters - that is also given.

The problem comes down to finding GM L. 11 meter is not given as aft but I am going to assume it is aft; otherwise you cannot do it. so it is not it must be 11 meter must be the draft yes It is given actually - 11 meters is draft - 11 meters water plane is the draft.

The problem is to find GM L. To find GM L, what do we need? GM L We are given a couple of hydrostatic things like KB, KG; let us see - KM L is equal to BM L plus KB.

KG is given, therefore, KM L minus KG will give you GM L. Therefore, what we need to find is GM L; KG is given, therefore, we need to find KM L.

Now, KM L is BM L plus KB, KB is given; therefore, our problem comes down to finding BM L. BM L is I by del, therefore, del is known. Our problem comes down to finding I. Note one thing: this is BM L that means I is the center of is the moment of inertia about the transverse axis through the center of flotation which we call as barycentric axis, so I is about the barycentric axis. I thing those something what was the definition some symbol was given now for I through a barycentric I F probably I do not know I will call it I F now There is a symbol for I through the it is Here, it is given as I F, anyway we will put it as I F. I F is the transverse moment of inertia through the center of floatation - so this comes down this is what you have to find.

Let us start from the beginning. You are given the half ordinates of That is why you are given the half ordinates to find I I F.

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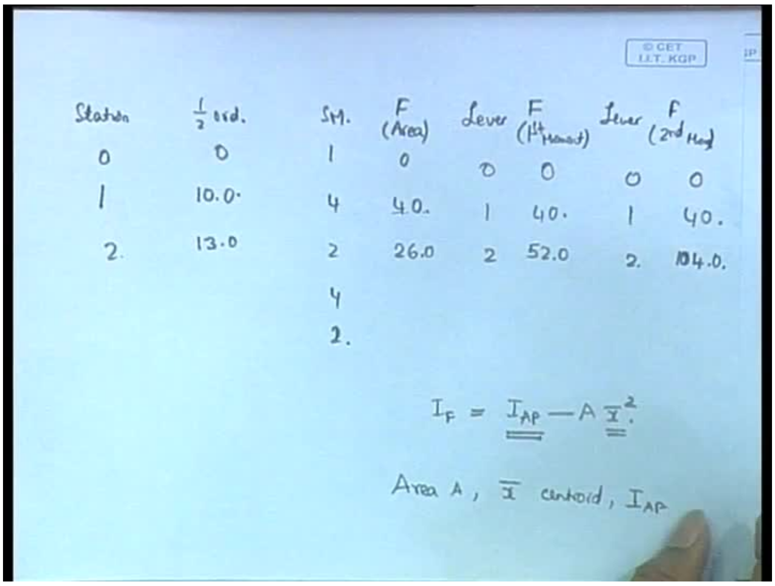

You are given the half ordinates and you are told That means it is like this - for different stations you are given the half ordinates, so we will make the table like this: station; half ordinate; Simpsons multiplier; then you will have a function of area; then we use a lever; then function of first moment; then another lever; then function of second moment - this is to find the this is to find the I F.

So station so First of all it is like this: one - you are given the half ordinates - 10, so let us do - 1, 4, 2, 4 - Simpsons multiplier 1, 4, 2, 4 - like this - like this you will go. Then, function of area - it is just y d x, so this into this.

This will become 40; this is 0, so this is 0; so 10 into 4 is 40 - like this. Now, lever you have to put - means you can put aft perpendicular as 0 and 1, 2, 3 - like that - each station you will put successive levers - 1, 2, 3. this is to find the wait we are finding the I F that is I about the yes

You need to find so no that is the thing you will have to do this see We do not know where the center of floatation is; therefore, you have to do a couple of things. First of all, we will use this formula - I F - this is what we have to find. This is the only way to do it, so I F - I through the center of floatation will be: I about the aft perpendicular minus A X bar square.

We need to find I about the aft perpendicular first, then we need to find x bar - a is the water plane area, x bar is the centroid of the water plane area which is your center of floatation; this will give you I about the center of floatation.

We will follow this - 4 - 40. We are going to take lever from the aft perpendicular only, so we will proceed like this. We will get - 0,1, so this will be 0 like this and this will become 40. Again, the same lever, so this will give you your second moment. Similarly, let me write the third one also - second will become 13.0, this becomes 26, you multiply with the lever it becomes 52, you multiply with the lever - again 104.

Like this the That means, in this, you need to find three things: A - the area; you need to find x bar - the centroid; and three, you need to find I AP - I about the aft perpendicular; these three things we need to find and, as a result of which, we can get I F.

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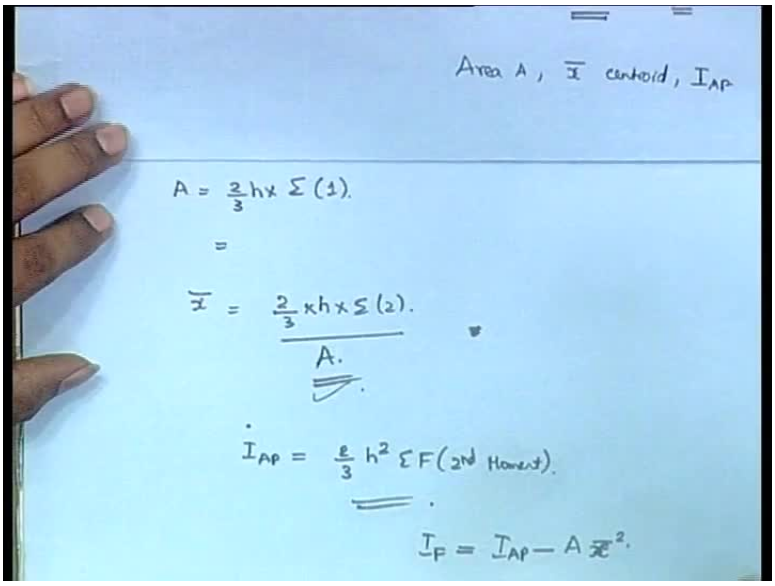

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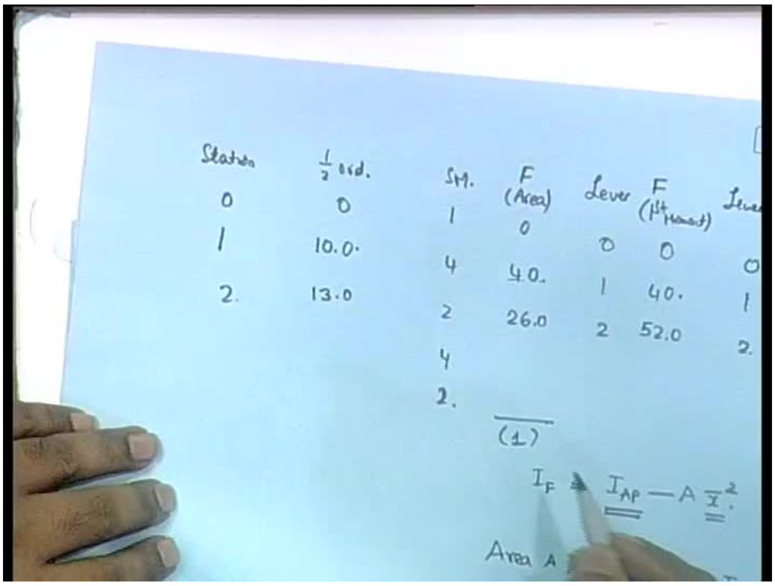

The next is very straight forward, once we know this. So, A will be 2 by 3 h into sigma; this is only thing. A is - see here - we have the function of area, so from that - you can from this total, we can get the - let us call this 1 - this total into sigma of 1 will give you this one. This will give you the total area; whatever they get. Then, x bar - the centroid will be the first moment divided by the area; so that is the next thing.

x bar is the next step, it is equal to 2 so this 2 by 3 into h into sigma. Let us call this second sum - this sum let us call it as 2, and this sum let us call it as 3. This sum of 2 sum of 2 divided by this area that we got which actually becomes 2 by 3 h into - wait centroid will be that will give you the first moment first moment by is it by area or is it by function of area one minute no here they have actually sigma area they have a function of area not the total area

That seems total moment divided by total area that is fixed any way so total moment is this divided by the total area what they have is 2 by 3 h I think it is a mistake it must be but they have done it actually they have I think it must be a mistake because they have a they do not have 2 by 3 h they just have Simpson I mean it any way even dimensionally it would not be correct h function of area this is correct no

That is correct so this It should be A only - means in the previous section - here we have actually found the area, so it should be like this only. This 2 by h into sigma of 1 should come the whole thing should come at the bottom. Here, you will have 2 by 3 h, so that means in the book there is a mistake. its they have taken only that

This will give you the x bar. then I - what was the expression for I? We actually derived some expression - second moment h square or h cube is it x square what we derived long back here it is given h cube h square is given

So that will be square dimension is linked to the power 4 h square area into lever they have h cube here see there are that is what when you are doing this be careful there are mistakes in this book it is not like the other book the brains book it that is very good there is but this has lot of mistake I do not yeah I think it is h square otherwise dimensionally it is not correct so this is h

We will write it as is it 2 by 3 2 by 3 h square into sigma F of second moment, so 2 by 3 h square into sigma if so this will give you I AP. Therefore, our problem becomes I F is equal to just I AP minus A x bar squared, so this will give you your I F.

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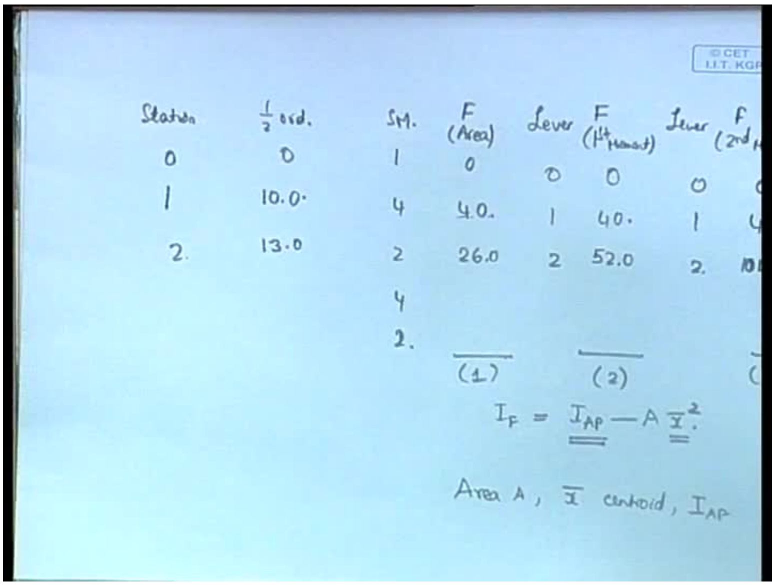

You just go back - once, you have I F; you will get your GM L - you have to find GM L. From GM L, you find the from the change of you find finally find the change of trim. I think your question is to find MCTC.

We already have the change of trim. No once, you have G 0 moment actually I forgot change of trim m c w MCTC is equal to weight we have GM L we have

Now, MCTC is equal to w into G 0 M L by I think there is are they using another formula there w into G 0 M L by L is MCTC right have you used a formula like this I am trying to see change of moment changing trim by MCTC is equal to change of trim yeah that you can do w into G 0 M L where is at 100 coming w into G 0 M L by L will give you in meter so you have to divide by 100.

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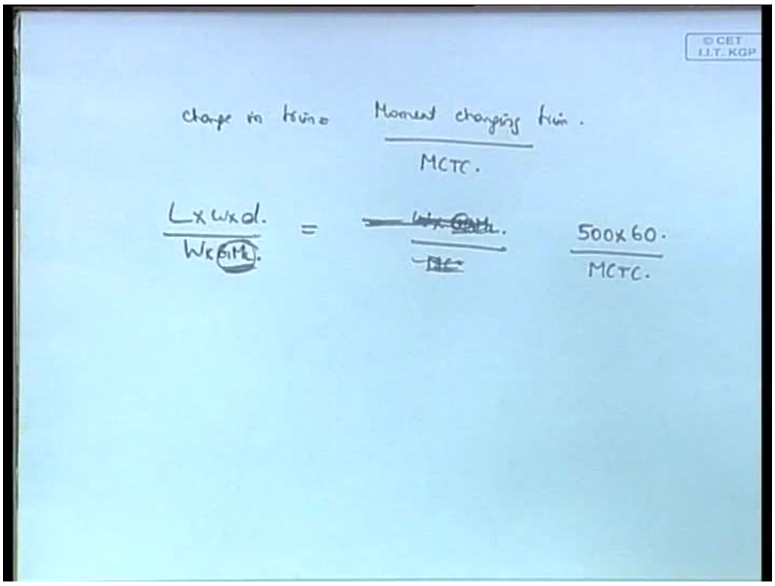

You just do the same thing, that is, change in trim is equal to moment changing trim divided by yeah that is a good change in trim is equal to moment changing trim divided by MCTC.

It is very straight forward; you can calculate the moment changing trim. What did I write? We have already calculated the change in trim as w into d, right? Have you calculated it no this problem is different this very straight forward.

This is a very simple problem; I mean this part is simple. You are told that 500 tonnes is shifted 60 meters from aft to forward - it is already given, so there is nothing. The moment changing trim is already given, so moment changing trim is just that 500 into that 60; this will give you the moment change in trim divided by MCTC, which we do not know. is equal to BM L. GM L we got. GM L what is this 500 divided by MCTC is equal to change in trim w is equal to yes L into w into d divided by w into GM L - that is what.

This will give you your result, so I guess the only thing to do here is to find GM L. The only thing to do here is finding the GM L in that elaborate fashion - that is the only part of this problem. There are actually lots of formulas in this - too many formulas in fact.

Change in trim, moment change in trim - you have to keep a track of when you are doing the exam. I think the best thing is you definitely have to do these problems. It is not possible to really to all this without you can do it but You definitely should do these problems. I think I will stop here.

Thank you.