Hydrostatics and Stability

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Module No. # 01

Lecture No. # 07

Problems in Stability-3

To continue from the last class, you are given a couple of conditions. First, I have explained two tables already. You are told that you are given the draft and the half areas in the first table. The second table gives you the stations and half ordinates.

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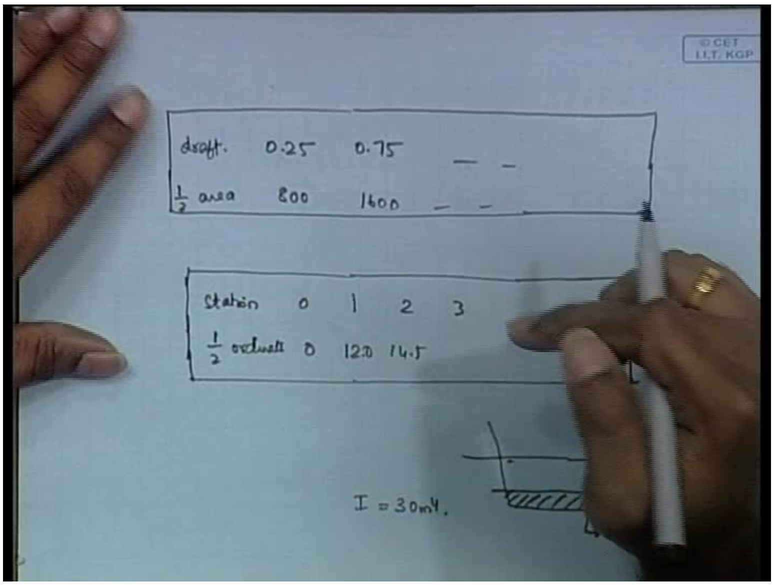

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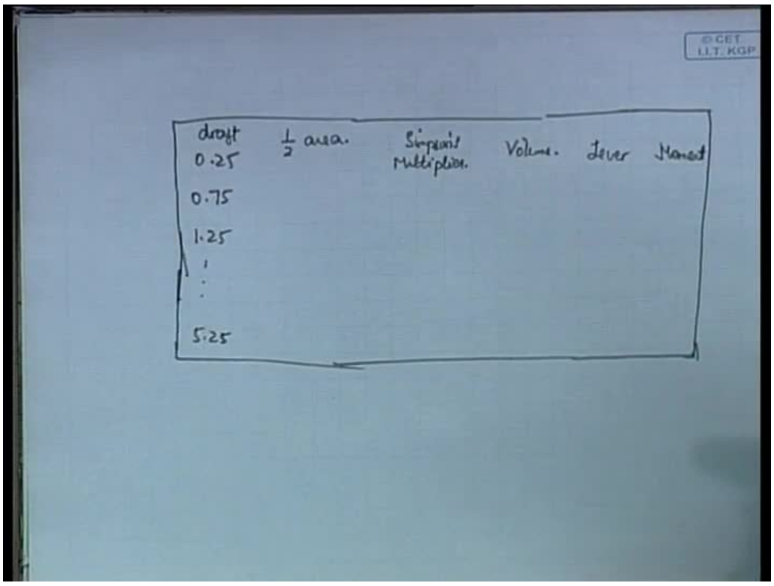

So, two tables we have already defined. Other than that you are given another table. That is, I mean, you will be just given this table, you will be asked to fill the rest of it, like half area. You have already given the half area, means you can fill from the half area for different drafts. You can fill it here; that means, you take this table, you take these distances 800, 1600, it comes here (Refer Slide Time: 01:05).

This is something I should - actually after we do this, we will spend a little more time. The Simpsons multiplier is actually little bit confusing. When you have stations like this 0.25, 0.75, then it becomes 1.25, then it becomes 2.25 - actually this I should write 3.25, 4.25. If you have 0, 1, 2, 3, 4, 5 there is no doubt, there is no confusion. It is 1, 4, 2, 4 that thing you have to write, but we will do this later. This will become little different when you do different kinds of stations, means 0.25, 0.75. You have other terms coming, we will do that.

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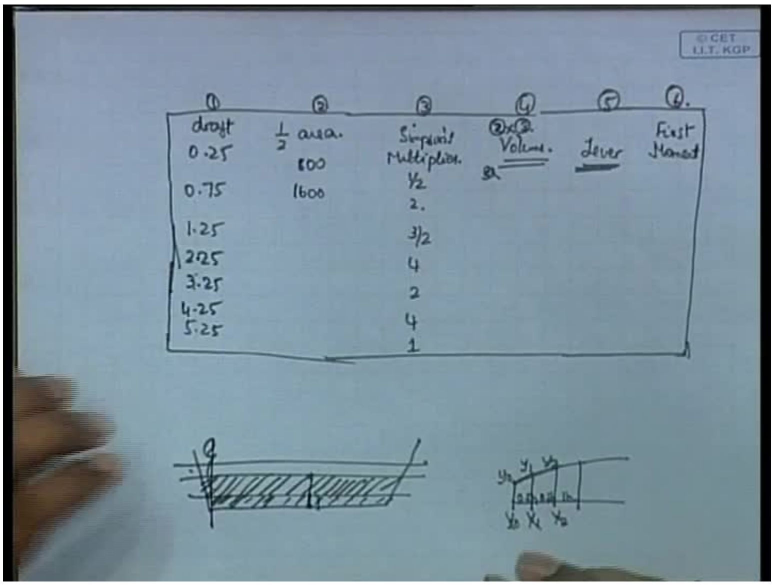

One simple thing you could do is you know how to derive this, right. You can derive this quickly if you want to. What should be the Simpsons multiplier? Means, you know how to derive that Simpsons multiplier that formula - that derivation. You have to remember, you have to know how to draw that like this. You will have a curve like this; you divide it into like Y 1, Y 2, Y 0. These are X 0, X 1, X 2 and these will be Y 0, Y 1, Y 2 (Refer Slide Time: 02:30).

Now, the best way is you take that Simpsons multiplier formula, you divide into some six stations - six points, I mean X 0, X 1, X 2, X 3, X 4, X 5. Then find the area - you take the total area under that section. You derive the area under that section assuming that this distance is - let us suppose, you assume the distance between 1 and 2 to be h. So, 0.25 and 0.75 the distance is 0.5 h. The distance between station 1 and 2, or between 0 and 1, if it is h, the distance between 0.25 and 0.75 is 0.5 h. Like that you take this to be 0.5 h; next one is 1 h that difference is coming because of the different type of stations. With that you re-derive that equation for the area (Refer Slide Time: 03:10). Actually, I will ask you to do that for some time, when you do that you can get the real value of the Simpsons multiplier for that particular case.

If you are having a problem like this, if I give for the exam, this will take at least 45 minutes to do, may be at least 35 or 40 minutes to do, I think. But, one thing about doing a problem like this is, if you are able to completely do one problem like this, it shows that you have kind of mastered Simpsons rule - Simpsons multiplier rule, also these things as half areas, what is volume, what is moment and i by del, all those things. So, you might end up with such one big problem. In this case, now I am not deriving it, but we will derive some special case in Simpsons rule after this.

Let us suppose that the Simpsons multiplier in this case, it really comes like this, actually – half, 2, 3 by 2, 4, 2, 4, 1, it will end up like this. For this particular, we will derive and see how it comes (Refer Slide Time: 04:50). You are told that there is something here after this volume, which we call as lever. Lever means, when you multiply the volume with some distance you will get a moment that distance is called as lever.

For example, if you have a ship like this, volumes in this case we are actually finding like this. (Refer Slide Time: 05:40). So, not stations, let us say that you have water lines, suppose you are finding the volume of this region, you multiply it with this distance, you will get one moment. Then, you take this whole volume, rather may be this volume alone - this region alone, then you multiply it with this distance, you will get another moment. Those distances are called as levers; that is why we have mentioned here as lever; that is the meaning of that lever.

This is the volume; this is actually giving you the Simpsons multiplier. This is 1, 2, 3, 4, 5 and 6; this is the first moment, then you have - this volume is actually your 2 into 3 (Refer Slide Time: 06:30). That would not give you really the volume; you have to multiply it with what? To get the volume - this distance, means the distance between each station. Here, you are multiplying, when you are multiplying with Simpsons multiplier, you are actually multiplying this - a kind of that fraction 0.25 to 0.75, will give you 0.5, that is a fraction. When you multiply with h - when you multiply it with h you will get the volume.

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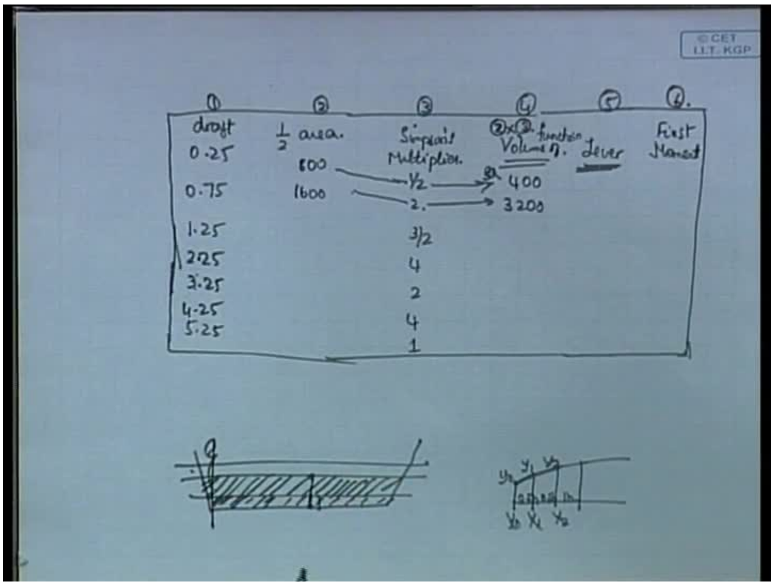

But, this will give you a function of volume. I would not write it as volume, this is a function of volume. So, this is given here by 2 into 3. This is the half area, so you are multiplying the half area with the length, with that fraction, when you multiplied it with length it gives you the volume. This is the half, this becomes 800 into half, this will become 400, 1600 into 2 3200, like that (Refer Slide Time: 07:40). So, this is this into this; this is this into this; this gives you this value. For the exam, for any assignment or anything, I am not going to give you what is the definition. You just have to know half area is this distance; it is the half area, it is not that distance; that half area is that section area, area into this distance will give you the volume inside. It is not the distance, I told; it is not the distance, what I mean is at each Y what is the sectional area? You are getting that area into that distance - this horizontal distance will give you the volume in that area - volume in that region (Refer Slide Time: 08:00).

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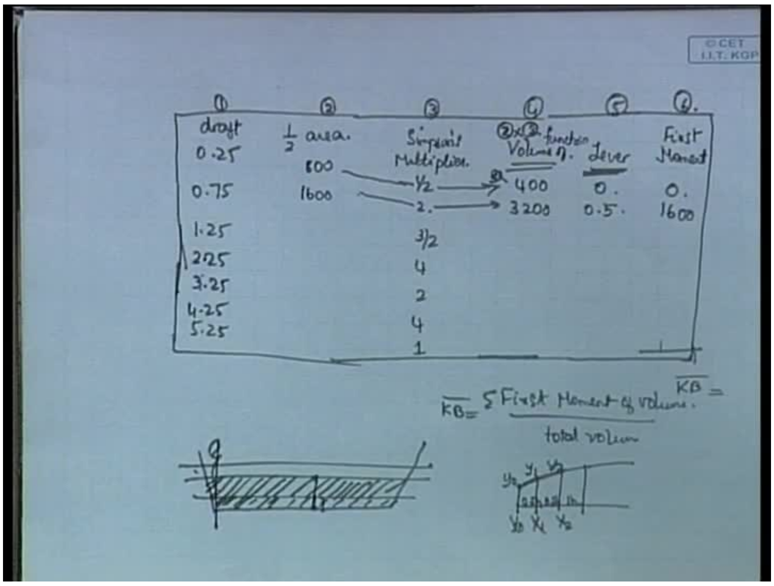

That is the way to calculate the volume. So, looking at this, even if this table is not given you should be able to generate this table that is what I am coming to. You are probably - you are just given these two tables, which will give you the half areas of water plane and half ordinates of water plane. Whatever you are given you should able to find the volume. Then, you need and how do you find the function of - these levers will be like this. First one is at 0; these are at different drafts not different stations, so 0, 0.5. I keep on saying stations 0.5 is this lever (Refer Slide Time: 09:10).

So, in case I have confused, it is not station, I myself thought of it, is not station, it is the water line; that is, it is like this, it is not like this, its areas not like this, it is like this, I told you wrongly (Refer Slide Time: 09:39). That is we are talking about volume like this, means you have it like this; that is, you have the area multiplied by this length, this length is giving you the volume; that is the volume not this distance (Refer Slide Time: 09:20).

In this case we will talk about volumes like this. The area multiplied by this length is giving you the volume that is the volume not this distance (Refer Slide Time: 10:00). So, this lever is actually this distance - distance from the bottom, when that volume is multiplied by that lever you get the moment that is called the first moment of that volume. In this case, 400 into 0 will give you the first moment 0, 3200 into 0.5 will give you 1600 - the first moment.

Now, what is the point of finding this first moment of volume, think of that and tell me, what will it give you? What is it to find? I mean to find what are we doing? KB that is what - the idea of this first moment is to find KB, which is given by KB is equal to the first moment of volume - the sum - the total first moment of volume divided by the total volume. Means, you calculate each of this, you find the sum - the total divided by the total volume here. Of course this has been multiplied with an h to get the total volume. Once you have that the sigma, first moment of volume divided by the total volume will give you the KB for that whole volume - means for a whole ship, in fact for that particular draft of 5.25 meter.

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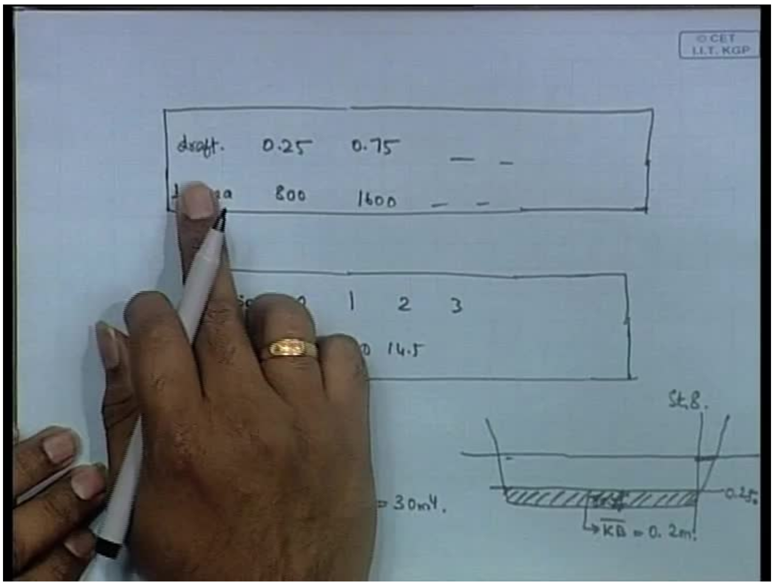

Now, just one thing to note here is, in this table, in the first table as well, see you are starting here with a draft of 0.25 meter; you are not starting from a draft of 0. Means you are not starting from the heel, you are starting from some 0.25. This is the first waterline that is given.

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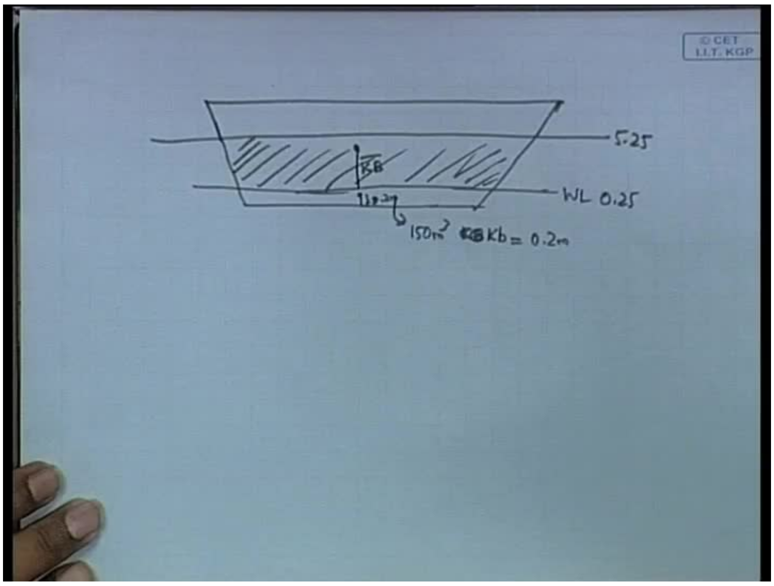

So, all your calculations whatever you do using this table that kb, what you get will be the kb of - I will draw this figure. This is water line 0.25, you will get the kb from this, this kb you will get or kb of - let us say - this is 5.25, this is given as a draft. You will get kb of this volume; you would not get anything about this. That is why they have said that below point 0.25 there is an appendage volume of 150 meter cube - we have said that this volume is 150 meter cube and that volume has a kb - let us call a small kb equal to 0.2 meter (Refer Slide Time: 11:50). The kb of this volume, this distance and this kb is 0.2 meter. So, the problem is not very simple, it means once you understand the different points of it, of course it is simple.

So, these are the things. First, from the table, you will get this whole volume, this shaded region that I have shaded here. You will get this volume; you will get the kb of this shaded region also. This you will get the volume and kb of this shaded region. By using the additional data given in the problem you can find – you know the kb of this, then you have to find kb 1 v 1 plus kb 2 divided by v 1 plus v 2, will give you the kb of this whole ship that is the first term. Next, is to calculate the I (Refer Slide Time: 12:50).

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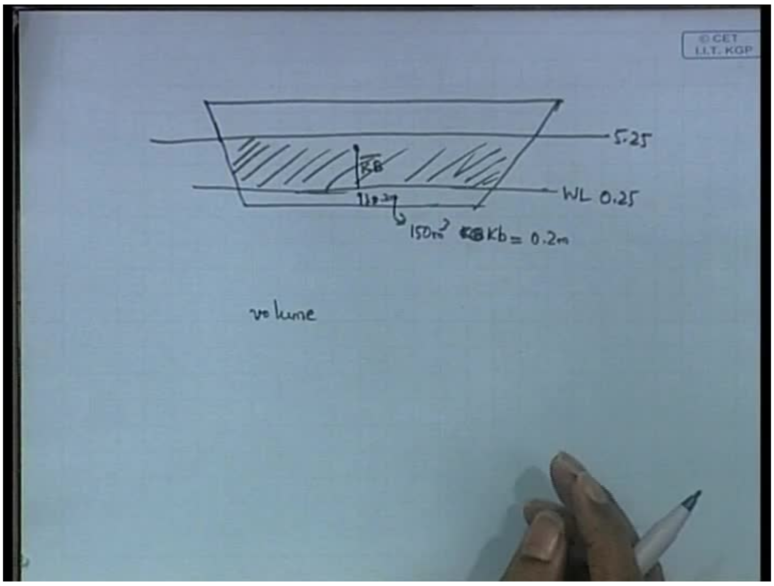

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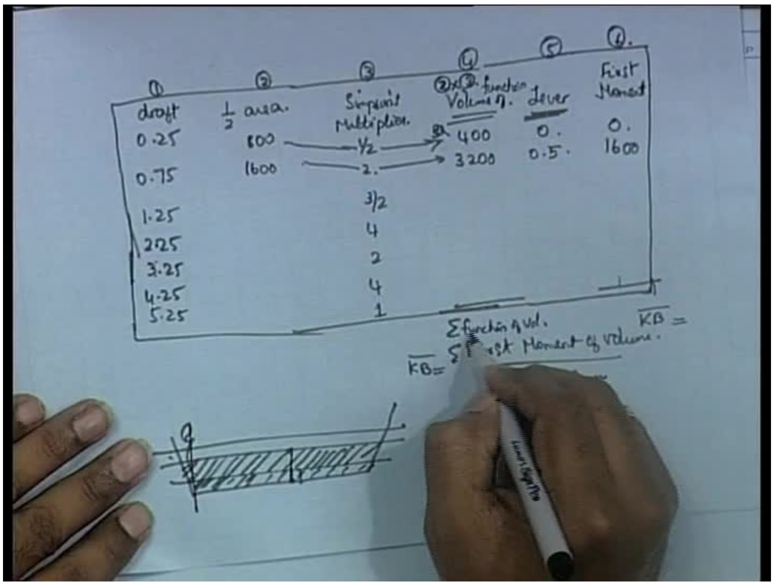

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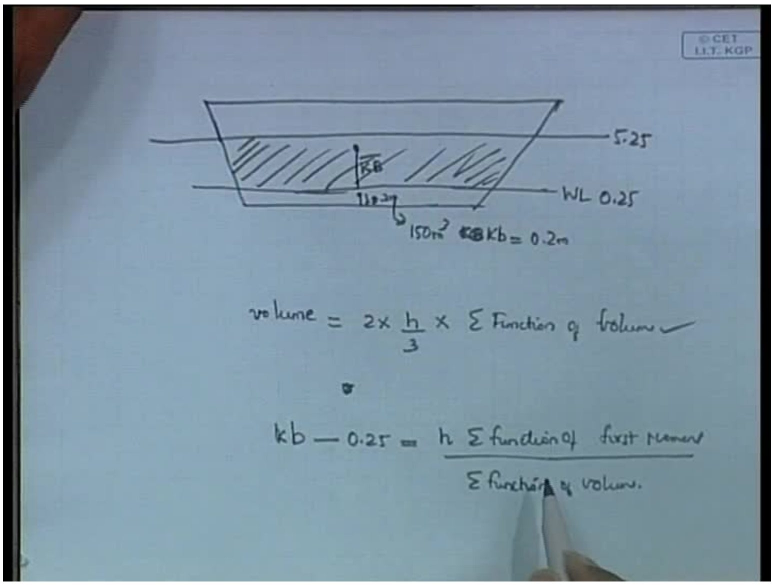

We will come to that first; let us do this that is volume. Volume is this; we are using this function of volume. From this function of volume you get - first of all you have these functions of volume different. Let us call this sum up and let us call this as sigma function of volume, means all this is added up that is the meaning of this sigma function of the volume.

So, the total volume really is 2, because its half ordinates, you need this two that will give you the total volume - 2 into this is the formula. You know how this h by 3 has comes, it is because of that definition of Simpsons rule. It is h by 3 into 1 4 2 4 in general, for body, for a shape. Then, this becomes alright, you just do that this is how you find the volume of that whole section (Refer Slide Time: 14:00).

So, you get this volume that we have seen. These are small things, but you have to note this; that is, note that we have put the keel point as 0. I will just explain this. Let us say that this is the kb that you are getting for this whole thing, kb minus 0.25 will be equal to h into sigma function of first moment divided by sigma function of volume.

The right side is obvious (Refer Slide Time: 15:00). Let us say that we are finding the kb here, the kb is equal to h into this - I think this is obvious. Now, h into function of first moment - this thing sigma function of first moment, sigma function of first moment is this one, is sum total of all these moments.

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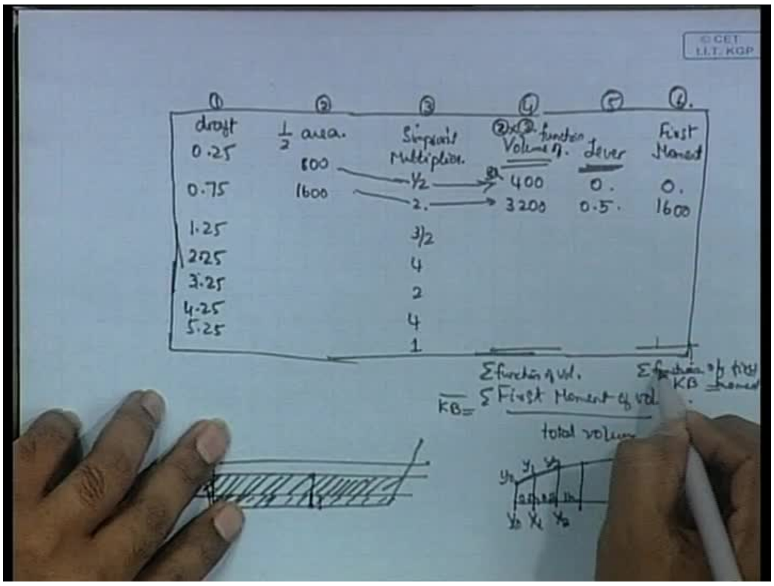

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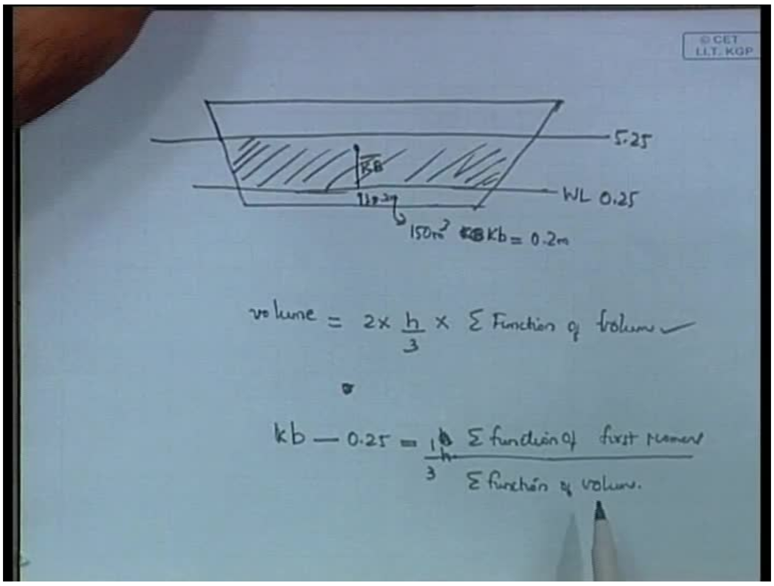

So, sigma function of first moment into h divided by sigma function of volume, it is not there - h by 3, it is not actually, I think there should be an h by 3. I will check this and tell you, but I believe it there should be a 1 by 3 h, 1 by 3 h into sigma function of first volume - first moment divided by this is function of volume that is this (Refer Slide Time: 16:34). This is the function of volume; that is, all this volumes added up. Actually I am telling a lot of things, if you are not really following then whole thing will be confused. So, is it becoming clear to you what we are doing really, because I have said a lot of things here and there; sigma volume, sigma function of volume, if the whole things will becomes a muddle, then the exam is going to be a disaster.

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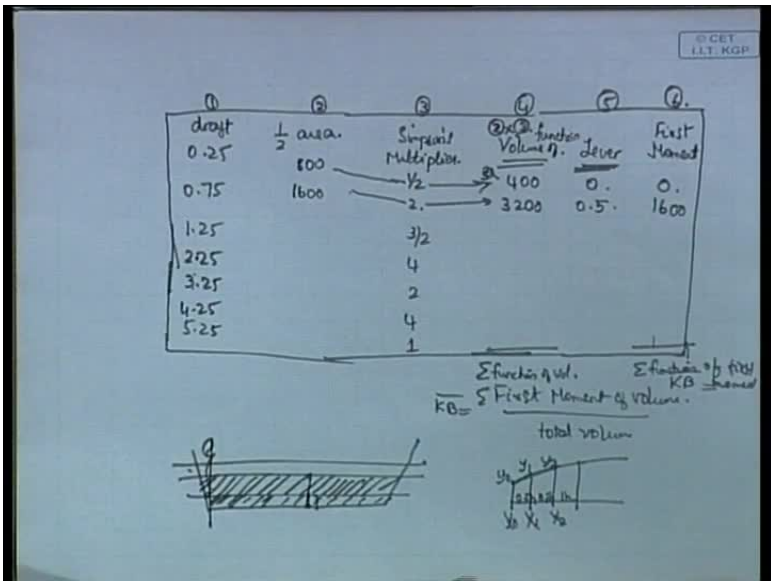

Should I explain once more? I will do that. I thought it, because I have said a lot of things. That is why before I explain this problem let us explain the basics first of such a problem; that means, details I am going to skip like 0.25 and all, like that go for the timing. Let us explain what the important things are; first of all the problem given is this; that is, you have a ship, you are given a table which says that at different drafts like this. First of all, it is not that the ship is put in this particular draft. It means, at different drafts, if the ship is at different drafts, what is the value of the half area of water plane. Means, this area is given, this area at one draft, area at another draft, area at another draft like that different drafts is given, so that is the first data that is given (Refer Slide Time: 17:30).

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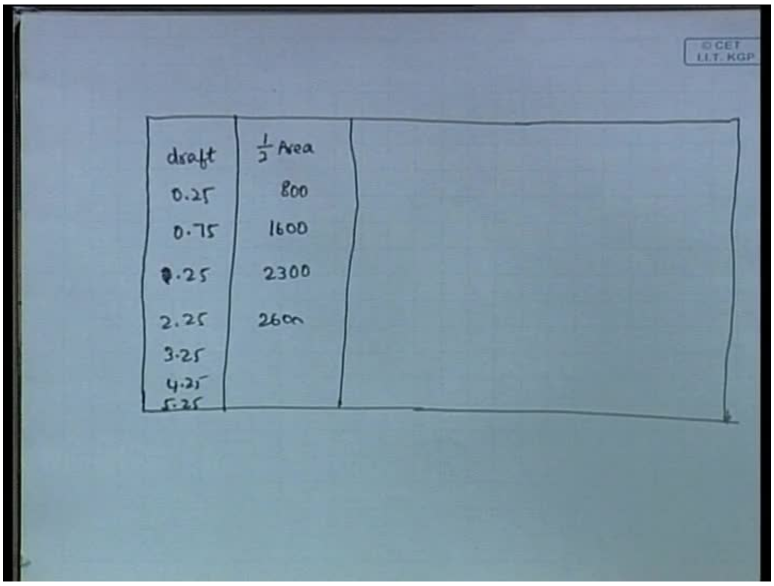

While making this table – this is the first table; I will make the table again in a systematic fashion. So, same table I am writing in a different fashion that is, you have the draft that is, I will write the value also 0.25, 0.75, 1.25 4.25 and 5.25; these are different drafts. At each of these different drafts you are given the half area. We will write the half area; this is a given data, it says 800, 1600, 2300. It is clear to you what this area is? This is the half areas of the water plane at different drafts.

Now, given that half area, what is the volume below that? We need to find that volume enclosed in that region. Means, from the keel to that height - to that draft what will be the volume enclosed? We need to find that how will you find the volume? Volume is always that area; it is the summation of areas - area in summation of volumes, first area into the length for which that area exist; that is, still then draft below.

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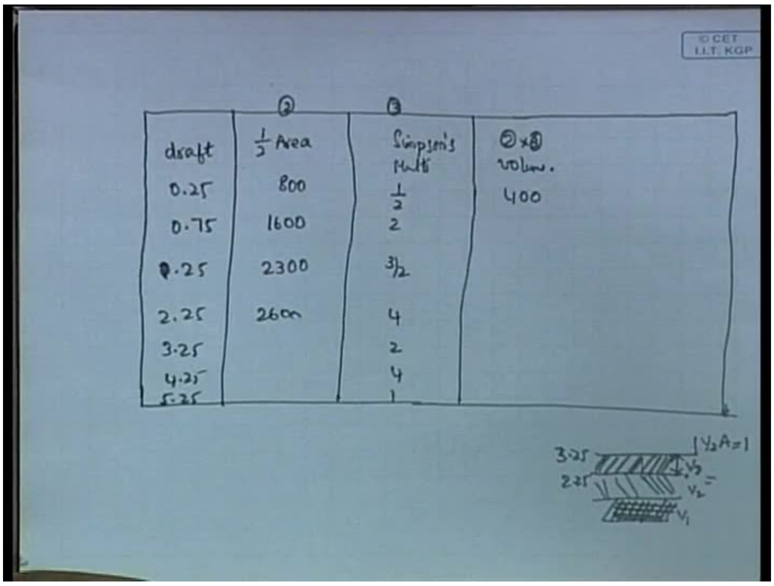

Means, it is like these different drafts. Here, let us say the half area is 1. Now, I want to multiply with this distance, this draft is let us say 3.25 and this is 2.25. So, till 1 into that 3.25 will give you - that means you need not 3.25, 2.25 to 3.25 this region - this volume will be given by actually this area into this distance multiplied by a Simpsons multiplier that is always there.

So, that will give you this volume, this volume is given by this area - the area here multiplied by this distance multiplied by the Simpsons multiplier that will give you this volume. Summation of all these volumes will give you the total volume beneath whatever is the final draft. So, this is what we are doing here.

This is what I mean. Simpsons multiplier has to be there that do not forget; that is Simpsons multiplier. Now, the exact values of that I will explain next, but let us just assume that the Simpsons multipliers are like this for this problem. Like this 4 you will have Simpsons multiplier, like this (Refer Slide Time: 20:40).

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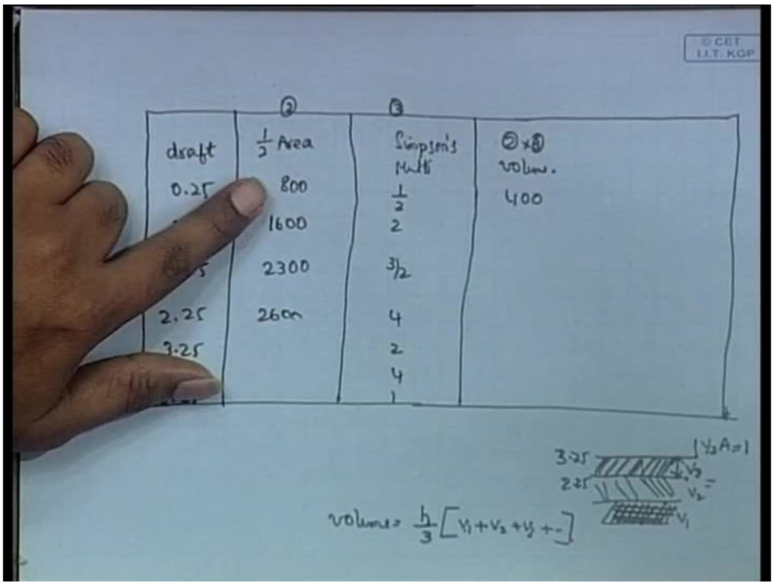

Now, the volume that we are finding is like this. Let us call this is v 1, v 2, v 3, so the volumes are clear, what volumes we are calculating and how it is coming because of this multiplication. So, this multiplied gives you what you are having. Let us call this 2, this is 3, so 2 into 3 is giving you a volume. The volume is 800 into half, this will be 400. This 400 is this volume - first volume. It is not 400, it actually has to be multiplied by h by 3, but it is the function of volume that is how you are getting the volume.

Volume is equal to - what is the total volume? Volume is defined like this - h by 3 into v 1 plus v 2 plus v 3 plus v 4 plus v 5 like that. This is not volume; it is a function of volume. It cannot be a volume, because there is an h here. It is a function of volume v 1, v 2, v 3 - v 1, v 2, v 3 are given by this into this (Refer Slide Time: 22:10). Because, this into this into this small v 1 into h by 3 into that Simpsons multiplier will give you the volume of that section - this v 1. Like that you will get v 1, v 2, v 3. So, this is gives you some function of volume when multiplied with h by 3. When you sum them up you multiply it with h by 3, you will get the total volume under that whole draft. So, this is the function of volume.

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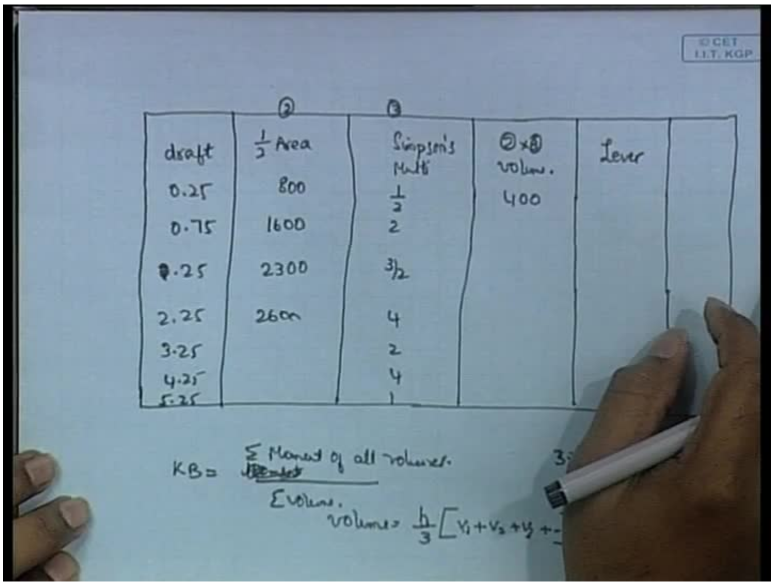

The next one is to calculate a lever. This is to calculate kb, means our final aim in doing this lever is to calculate kb. To calculate kb, note that you have to find as the total moment - moment of each of the volumes, I will write it as sigma moment of all volumes divided by sigma volume. This will give you the kb, means you find one volume, you find the position of that volume, so you multiply the two position of the volume into the volume at that point. You sum each of them up like that and divided by the total volume that will give you the position of kb that is center of buoyancy. That is the purpose.

So, lever is to find the position of each of that volume. The best thing is to find the center instead of taking the one end. I told you it is not an end, better you take the center. So, the first one 0.25, let us see what they have? Basically, this problem they have done like this. This table starts from 0.25, means we are finding the volume from 0.25 up, not below 0.25 (Refer Slide Time: 24:15).

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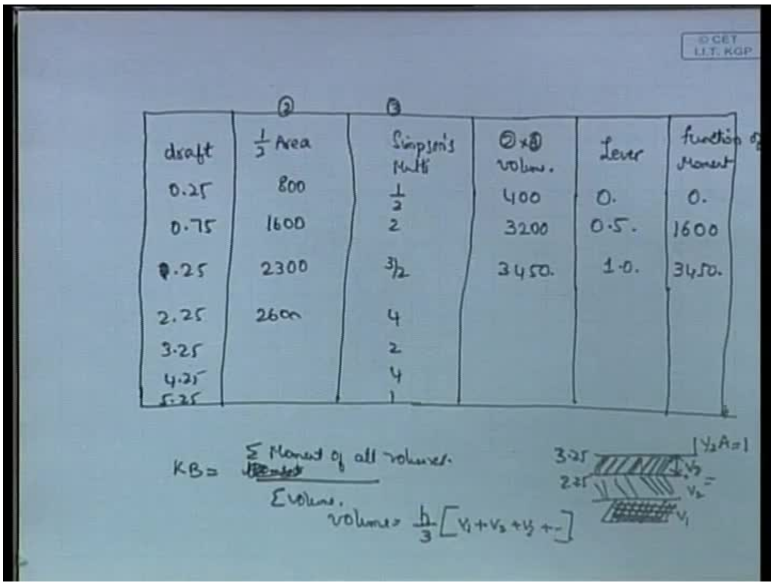

Let us take this to be 0 - the first one is 0. The next one is, this is multiplied 1000 to 1600 into 2, so this becomes 3200. It is between 0.25 and 0.75, let us take the middle that is the position of that volume, which is 0.5 let us take it like that, so 0.5. The next one will be like that between 0.75 and 1.25; that is, 1. Is there any confusion here? This will be 2300 into 3 by 2, whatever it becomes, it will be 3450. So, this will give you the lever.

This is the function of moment. Function of moment is the product of these two volume into lever, 400 into 0 is 0, 3200 into 0.5 is 1600, 3450 into 1 is 3450; this is pretty much how you fill up the table. If you can really fill up this table without any error, then more or less you have got the answer.

(( )) 0.257 is (( )) Yes (( )) then 0.15 (( )) volume is only 0.552

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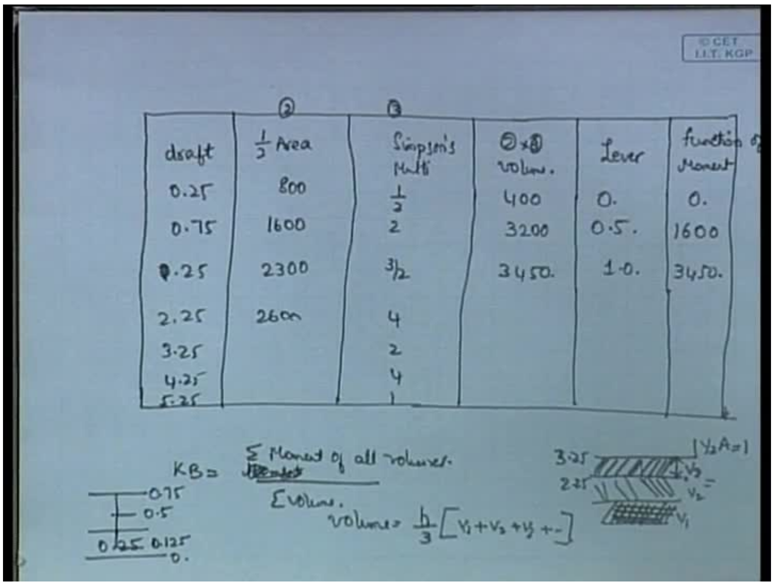

If 0.25 is taken as 0, then the next level will be 0.75 (( )) 0.5 minus point (( )) that seems to be correct. What you are saying let me check this out. I have to do this, you are right, wait. Now, that what I am saying is 0.25 to 0.75 is 0.5 and half; let me see that alright. Then, I will check that and tell you.

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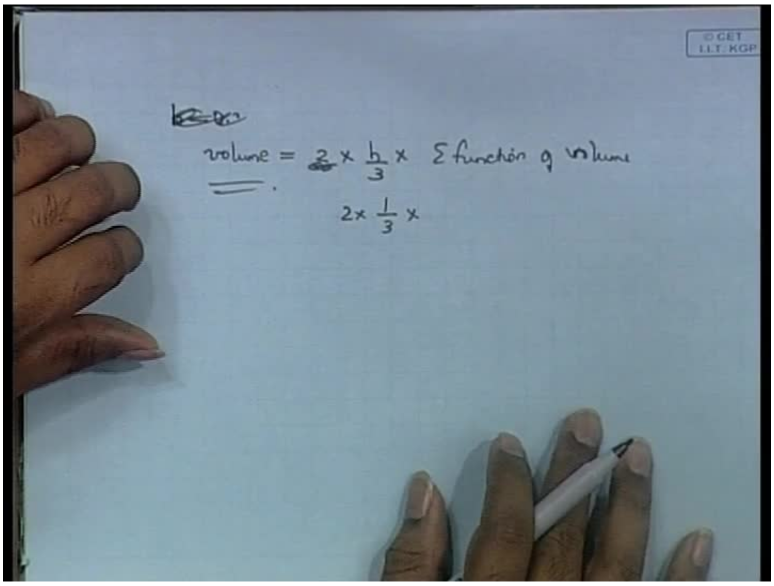

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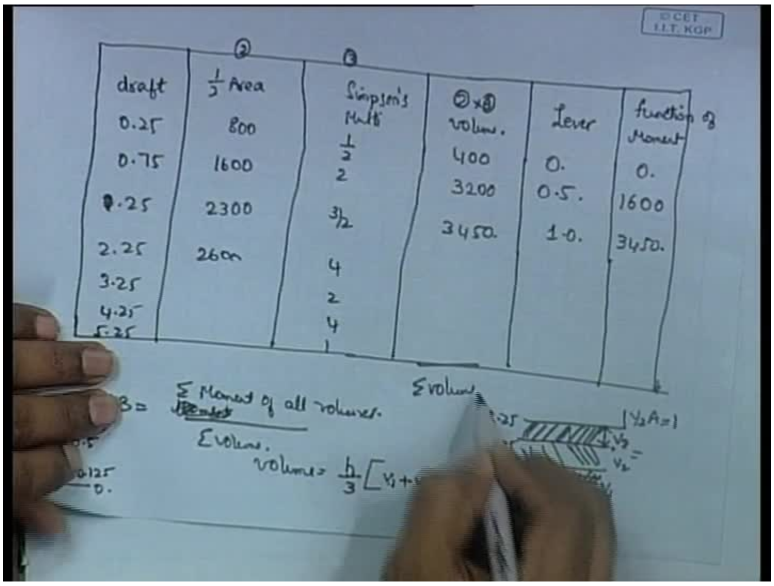

So, you do that then you will get the volume is equal to 2 into h by 3 into sigma function of volume. So, 2 into 1 by 3 into whatever that will give you the total volume; that is the first thing, you have found the volume. Then, you know how to find the volume. Volume is equal to h by 3 into the summation of this volume, so this sigma volume.

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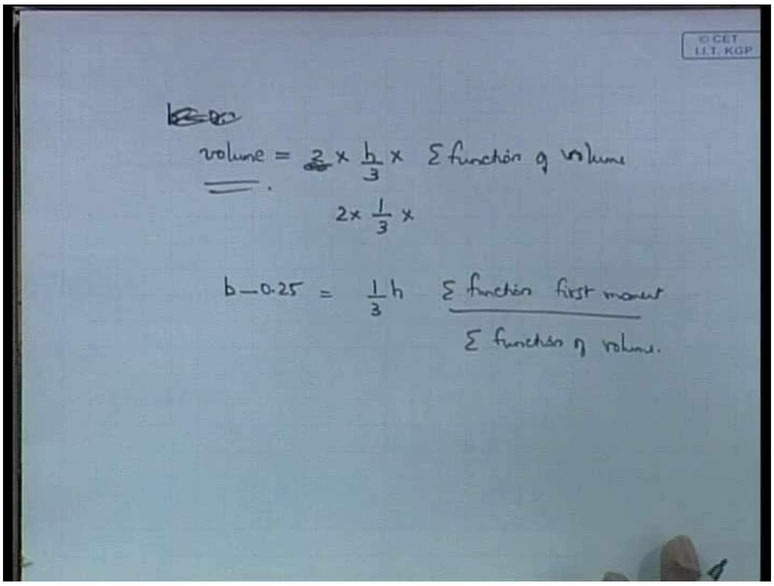

So, sigma volume into - that is the some sigma functions of volume into h by 3 into 2; that will give you the total volume. Now, b minus 0.25, actually they have taken 0.25 to be the origin. So, b is equal to 0.25 plus whatever they have taken it as such that is a point. Actually I will check that b minus 0.25 is equal to - actually this should be 1 by 3 h into sigma function of first moment divided by sigma function of volume.

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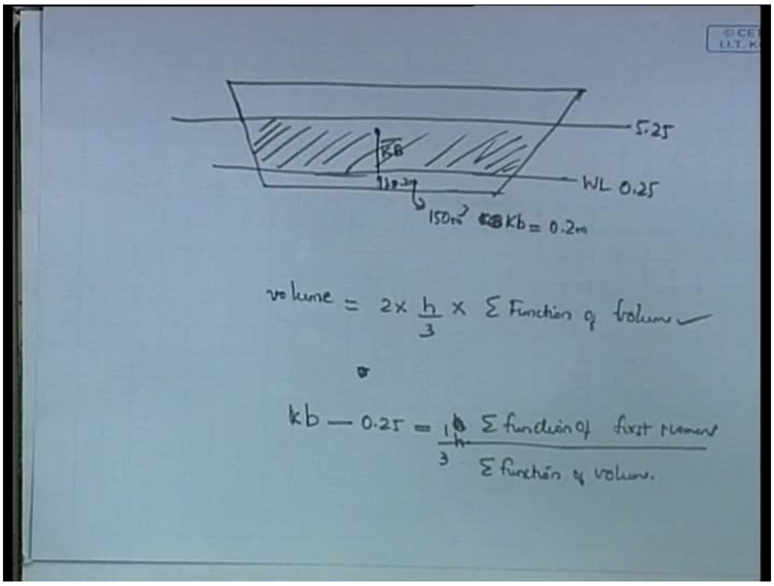

So, what you are getting here? See, you are getting some b here. To get the real b of that let me look at the figure here. See this figure, you will get - what you are doing is you have taken 0.25 to be the origin and you are finding the kb of this. When you get that kb you have to add 0.25 to it to get its coordinates in the final coordinate system. We are using - that is for our final coordinates system say this is the origin - always k is the origin; that is how we are defining it (Refer Slide Time: 29:30).

So, plus 0.25 will give you the kb for this volume alone, remember. It is for this volume alone, it is not the kb of - it does not include the kb of this region. It is just the kb of this region based on our old - based on the general coordinates system.

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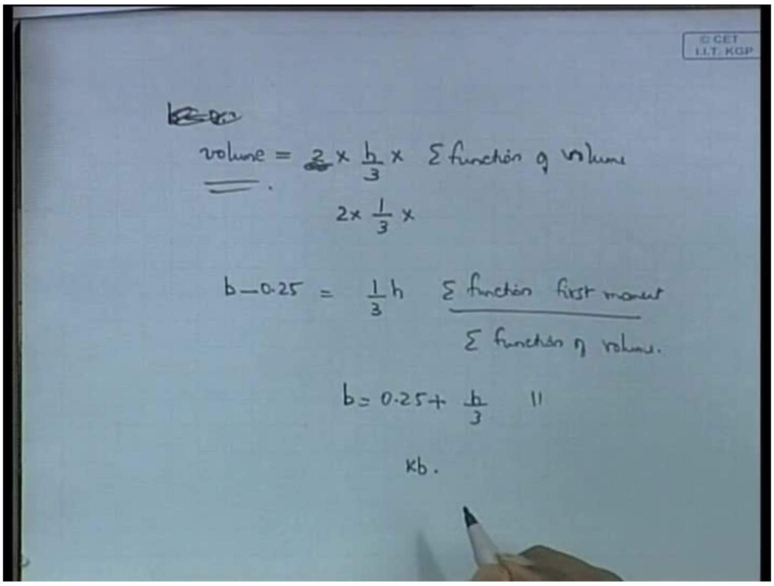

So, b will be 0.25 plus - that is why this expression comes - b is equal to 0.25 plus h by 3 into this thing - sigma function of first moment divided by sigma function of volume. This you do, you will get some value for kb. This gives you the value of kb for this volume above 0.25 based on this as 0 that gives you 1 kb. Then, now you have to find the kb for the whole that means that volume plus the volume below 0.25 meter that is very easy. You have the kb for that; you know the volume of that; you have the kb for this; you have the volume of this.

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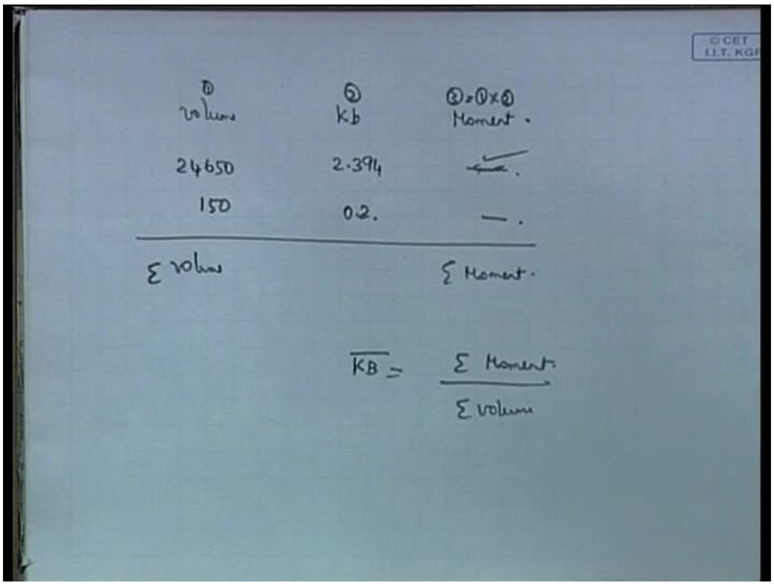

So, just same thing, you can do like this volume, KB’s, moment. This gives you the total volume of the ship, from the table we have calculated total volume and this is what it comes to. Then, this is that KB you are getting, this is the moment, this is like this is 1, this is 2, 3 is equal to 1 into 2, so you will get the product of these two here. Then, here you are told - given that this volume that is below has about 150 meter cube and that volume has a kb equal to 0.2 meter.

You find the product of this again, it comes here. Sum up, you get this volume - sigma volume, you get sigma moment. Then, you are getting total KB of the whole system, is given by sigma moment divided by sigma volume, again this gives you the KB. So, it is really very important, there are lots of points here like finding the origin, shifting the origin, then finding the KB of that volume, two volumes, finding the averages.

So, you are going to have the problem like this, I very strongly suggest, you please do this problem very carefully. Go through the whole details of that problem, once if this is clear, I think you can, but what he asked - I mean that shows he has understood more or less that is the good point.

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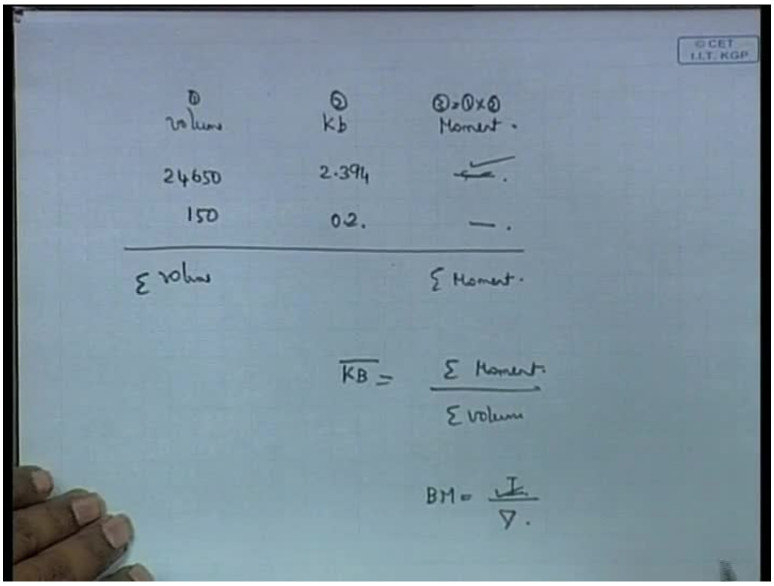

Then, you will get KB that gives you the KB of the system. Now, how do you find the moment of inertia? We need to find BM. This is another problem only, it is also a long lengthy process, BM is equal to I by del.

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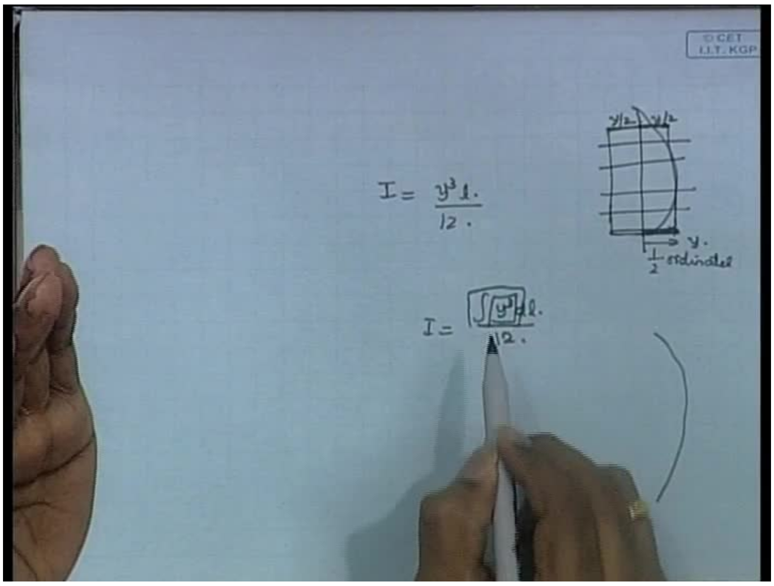

So, we need to find I, let us see how to find I. How will you find I of a system? We know that let us say somebody like this, I am assuming this to be a ship. This is look from above. This whole - this is the transverse section, this is the longitudinal section. What is this? We have like this - we are given like this, what do we call these things? Half, you call them half ordinates. You have to know this word, because nothing else will be given, it will be just mentioned the half ordinates of the ship are these values. It will be just given as the table; you have to know what that means.

So, half ordinates, it means these regions, these distances. Of course the ship would not be a box bar; means, if it is a box bar there is no point giving half one, you just need this one distance y. The ship will be like this, it will be totally different, means half ordinates at different stations you need. To do the complete ship this is a real ship, so these are the half ordinates. Now, what are we talking about? I for a rectangle, in general is given by this half ordinate cube into l divided by 12. If this is y, let us call this y, this is y, sorry y by 2, y by 2, if this y, then y cube into l by 12 it gives you the I - the moment of inertia.

So, how do you find the moment of inertia of such an irregular shape? It is like this, you do integral, y cube dl divided by 12. Integral y cube dl by twelve will give you I for this shape. We have to make another table, so what do you need? You need y cube, it is not simple as such and it is tedious. So, you need to get y cube, what is y cube? It is half ordinate cube. Means, these half ordinates cube you have to do, at each station you have to put and then you have to find the total means summation.

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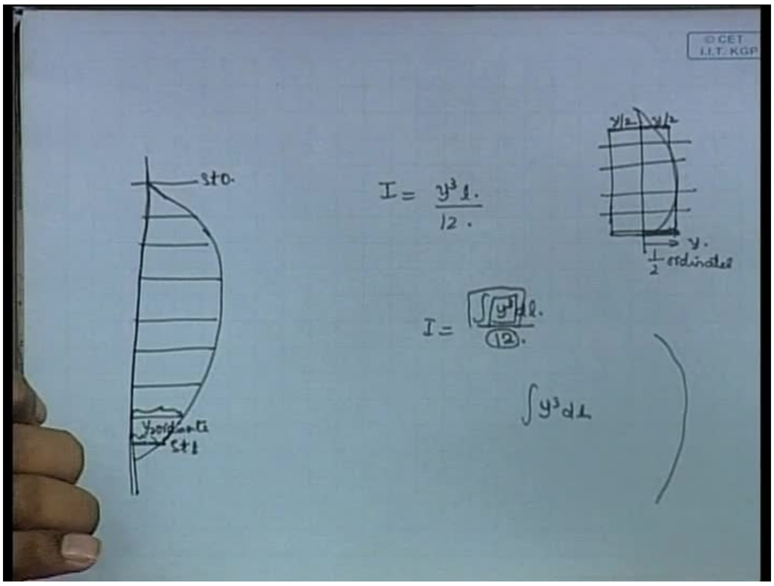

So, what exactly do you have to sum here? You have to sum to get this I, you have to sum the half ordinate cubed to get this, this is what you are of summing. This half ordinate cube you have to sum over the whole length of the ship that will give you I. Means, I am explaining from the basics so that you know what this I is and how it is coming here. Note that I will just repeat if you want. I - what we want the moment of inertia - actually the I of this means, if the ship is like this, this is of course the top view of the ship, this is the center line, this is 1 half ordinate, the ship is like this. So, half ordinates are like - these are different stations looking from above.

These are different stations; I think they are called - this to be station 8. This is the aft of the ship, this is station 0 and here it is station 8. So, the ship is divided into different stations, you have - at each station you are given the half ordinate. Now your real moment of inertia comes as - I am not exactly sure if there is a 12 in the derivation, I think it is just for a rectangle that 12 comes, I have to check that. I think the general expression is y cube dl. The general expression for I is I cube dl, probably that is correct. I do not know, I do not remember, but I will check that and tell you, it becomes y cube; you need to get y cube dl.

So, you need to find this summation. This half you are actually going to sum, this half ordinate cubed over this entire section of the ship, if that is clear then you will be able to do later also - if you want to find I later, because the shape is not going to be similar. But, the concept is clear, means you will be able to extend it to two different kinds of problems.

So, the idea is I always come as y cube dl, in general. It comes as integral of you cube dl, not y cube dl, integral of y cube dl, where y is this distance. If this is the center line, y is y at each of these points and dl is this distance. It is like this, this is your y, this is your x, so integral y dx, y is it clear, if it is not clear then.

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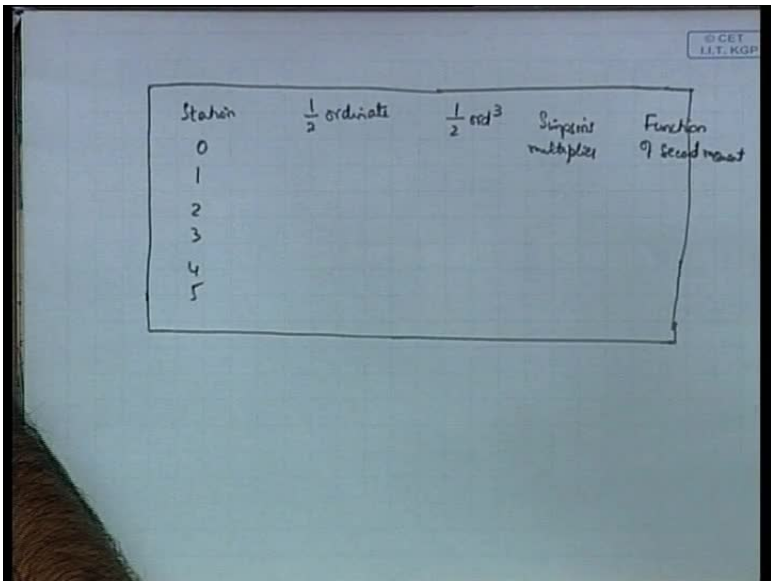

The table probably should help you. Actually I am seeing a lot of confusion, I think I will explain this probably further once more; that is, I will do one thing, before I do this probably - that is suppose I will do something just to make simpler.

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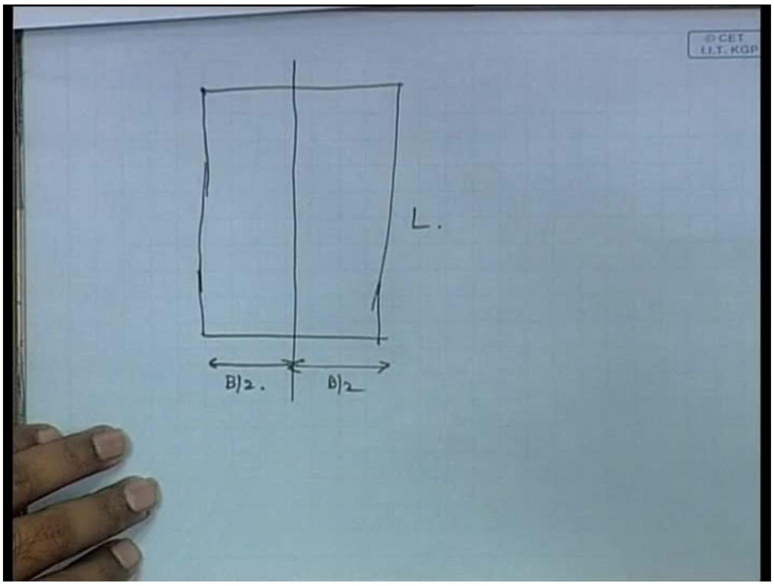

That is suppose you have a rectangular strip and suppose you are told that this is B by 2, this is B by 2 and let us say that the total length is L. Now, suppose you have to find the moment of inertia of this area about this axis that I have drawn here. Let us do this very simple thing.

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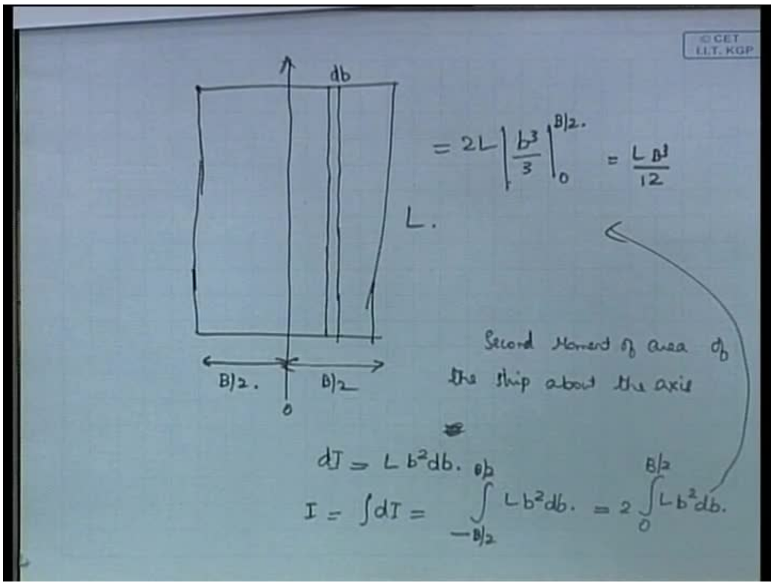

Note that the moment of inertia is also called the second moment of area. You will see it is the same thing, I will write it in both the ways. Let us call this axis about that axis is given by - let us do one thing, let us consider our idea is to find the moment of inertia of this whole strip about this axis. Let us take a small region of length db. First, we find the moment of inertia of this small region about this axis, it is given by - let us say it as dI is equal to this moment of inertia L into b square db. This is the basic definition moment of inertia.

So, you get dI - what you are seeing is, from this, it is basically coming like this, d cube into L divided by that is how you are getting? We will see that is I of this one - small region. If you want to find the total I of this entire body, it will be given by - let us call this 0 - I will continue here, B by 2. Now, this becomes L b cube by 12, this derivation was given just so that you get some idea of what is moment of inertia. This is the basic definition of I. From this dI this is how you proceed to get moment of inertia of some surface.

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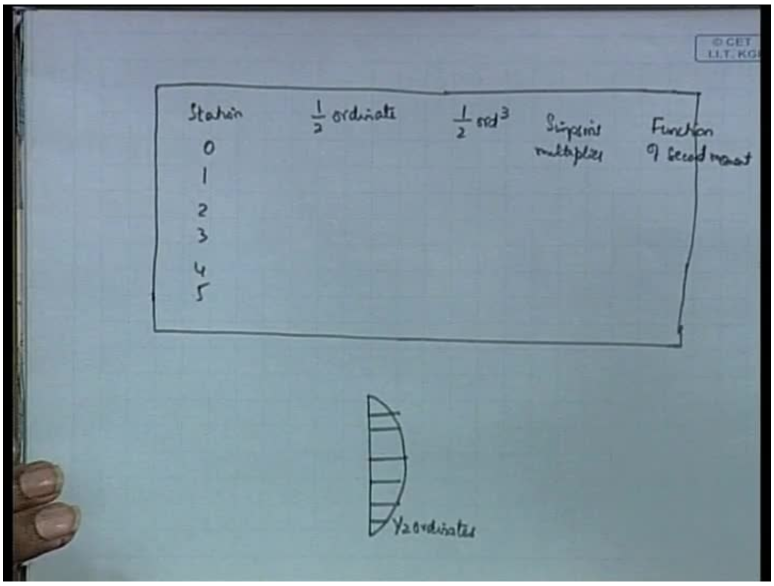

For this problem, if we come back, we have - just like that rectangular strip we had. In this case, we have some other body and likewise we have this half ordinate. Just like your L b cube by 12, what are you doing here? You are actually applying that L b cube by 12 for small strips and then you are summing it up using a Simpson’s multiplier. You are getting I for the whole strip. So, how do you find? You see that we need that half ordinates cubed to get the b cube, for that we need L into b cube.

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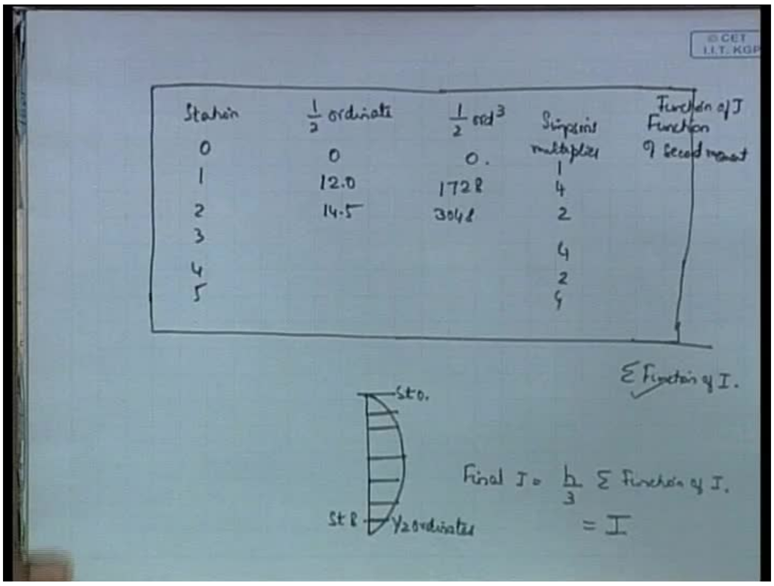

For 1 strip, we need that b cube that is half ordinate cube and then you multiply it by 2, so that you get for the whole. So, half ordinate cube let us see what this is. This is 0, half ordinates cube will become 0 that means station 0 is taken as station 0, I think half most they have taken this time. So, station 0 has half ordinates, here the half ordinate is 0, so 0, 0. Simpson's multiplier we will wait. Then, 0, this is actually 12 - half ordinates are 12, for half ordinate cube 1728, 14.5, 3048. I will write three of these and you will have Simpsons multiplier 1, 4, 2, 4, 2, 4 - like that Simpsons multiplier.

Then, using this half ordinate cube you multiply this half ordinate cube with the Simpsons multiplier. I hope it is clear to you, what we are doing is, it become too complicated now. That is you have got the half ordinate cube, you multiply with the Simpsons multiplier, you get a function of the second moment. You get here - you are actually getting your function of I. From the function of I you sum them up - sigma function of I. To get your total I - final I, you will get - it will be again h by 3 into sigma function of I - h by 3 into sigma function of I will give you that is this thing. When you do this you are actually getting the I of the whole body, so this I you need.

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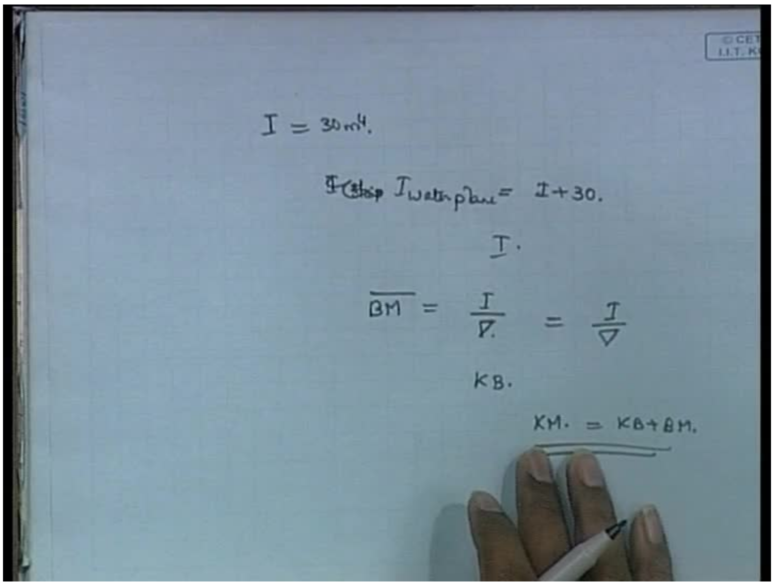

Now, in addition to this, they have also said that – remember, we started from station 0, this set of table that is given goes till station 8, it has solved till station 8. They are saying that in forward of station 8 there is an appendage area, which has a second moment of area of 30 meter power 4 in addition. Means, beyond this station 8 there is some area, which has an I equal to 30.

Note that it is very easy to add the moment of inertias if you just add them. There is nothing to do here; there is no moment or anything. To get the total I of the ship, let us call it I of the water plane, is therefore equal to whatever I you are getting from this, whatever you have got here - this final I, this summation plus 30, so I plus 30. This gives you the total water plane of the ship, this is your I and this more or less ends with the problem.

Now, it is very simple. What are you supposed to find? You are supposed to find BM. Note that we have already calculated del which is the volume - total volume - under water volume of the ship. Here, we have calculated I, therefore you have I by del, you just apply that you will get the value. Then, they have already calculated KB as well and then their question was to find KM, I think; the problem of question is KM.

So, you just add them together and you get KM. The problem as such is not complicated, but there are lots of things in it. That is why I said if you are trying to do this for the exam it will take probably 45 minutes and surely it will take. Because, note that you are using the calculator for each of these stations, you have to multiply the half ordinate cube, then you have to multiply it with the Simpsons multiplier, then you have to sum them, it is a long process.

So, I would not ask such a big problem, but may be half of this, like this. Alright, then I guess one thing that we saw is how to calculate I for a body if you are given some half ordinates. That method tries to understand properly, but definitely we are able to do it for the exam. That is you have to find the half ordinates, you have to find its cube, you have to sum that cube over the whole length of the ship and that will give you the I. In case you have some other left I, you just add the I to it, I can be added just like that.

Similarly, you might have a volume. KB I have already defined many times - I mean described many times how to find the KB of a ship. These are the different things. In case, I gave a problem which has these half ordinates, I will explain to you how exactly to get the Simpsons multiplier or that part of that problem, it will have a region where you have to derive the Simpsons multiplier. That is why I have explained you how to derive it. You know how to derive it, now I will derive one case if you want, we will see that.

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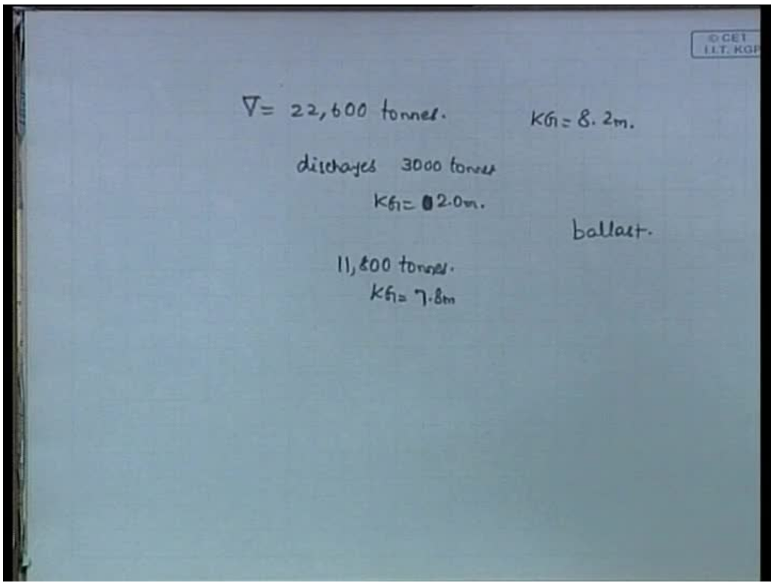

One more problem is there, this is not that complicated. That is you are told that there is a vessel with a displacement of some value 22600 tones. So, just to repeat, these problems are simple, I mean these are just applications what I am going to do, but what I have done just now, long making of the tables and all that, go through that as many times until that thing is very clear, how they have done, because that is the main problem. It is not just for this course, when you are doing - that is what you will be doing in shipyards. All if you take up a job shipyard, later you will be trying to find these kinds of K's, KB's, BM's, GM's like that, so that is very important.

Now, here you are told that the displacement of a vessel is 22600 tones; you are told that KG is equal to 8.2 meter. Then you are told that it discharges 3000 tons of cargo of ballast. Does anyone know what ballast is? Have you heard that word? Ballast means water that is taken into the vessel for many purposes; you take that vessel in, you leave that water out. Means, usually taken from the sea itself, from the port they take water.

The main reason for this ballast is, suppose you want to increase the draft, means you want to push the ship down, you take in water and then obviously it will come down. Similarly, when you want to push the ship up, you remove the water. So that concept of going up and down, because of by taking in and relieving water that process is called ballasting.

Do I have time to finish this? So, I will just explain this, so that is ballast. So, you will take in water and leave it and that water is called also ballast. So, ballast water, so it says that it discharges 3000 tons of ballast and this that KG of that ballast is 2 meter. Means this is just to find the net KG, you are told that the KG of the ship is something, then you are told that some ballast that is water is removed at a KG of 2 meter - means that water itself is a body - is a weight with a KG. Its center of gravity is that KG, it is that value and therefore, using the 2 KG's you can find the final net KG that it is just to do that. Similarly, just to make the problem - that is it says that then she loads 11,800 tones that is the ship, then loads 11800 tons of cargo at a KG of 7.8 meter. There is a new KG, not new KG, note that these are the different KG's of different weights, KG of the ship, KG of that ballast, KG of that cargo that is added.

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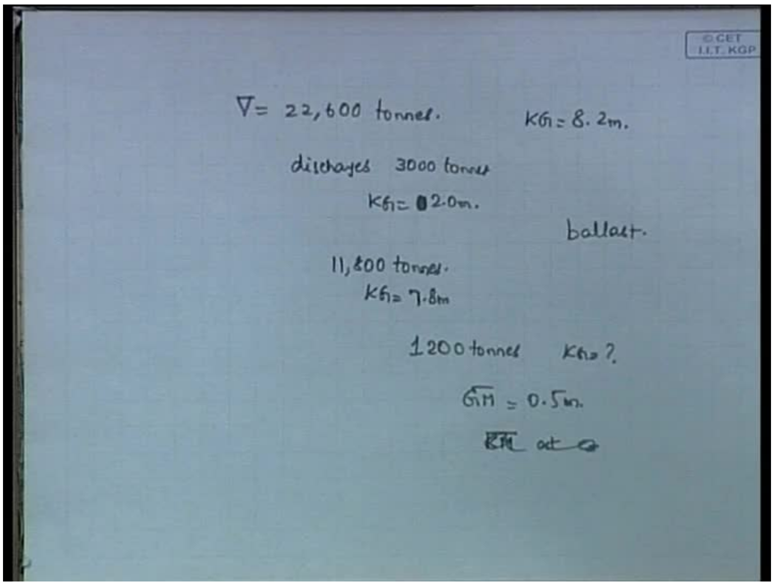

Now, you are told that you need to add a further of 1200 tones somewhere, with KG of something you have to add - now this is what you have to find. You are told that GM has to be at least 0.5 meter.

Now, what will be the - you are also told that KM at 32. I will do this; actually there is no time, so we will continue this problem in the next class. This is a very simple problem, but as I said before, do the other problem carefully;- big problem is making that table and getting it correct, it is a big problem; thank you.