Theory of Production Processes
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Lecture – 15
Problem solving on gating design and risering methods

Welcome to the lecture on problem solving on gating design and risering methods. So, in this lecture we have discussed, we have to discuss about different types of problems which we need to solve, which are related to gating design and also risering design. So, in the gating design problems we will have a the problems related to pouring, and also some problems related to how the aspiration has to be prevented. So, those conditions are to be met for that you have the different type of problems, and then in the risering you will have different risering methods we have discussed so, we will discuss how to find the riser volume.

Let us come to the first problem; the first problem is that down sprue of 180 mm length has a diameter of 20 mm at its top end.

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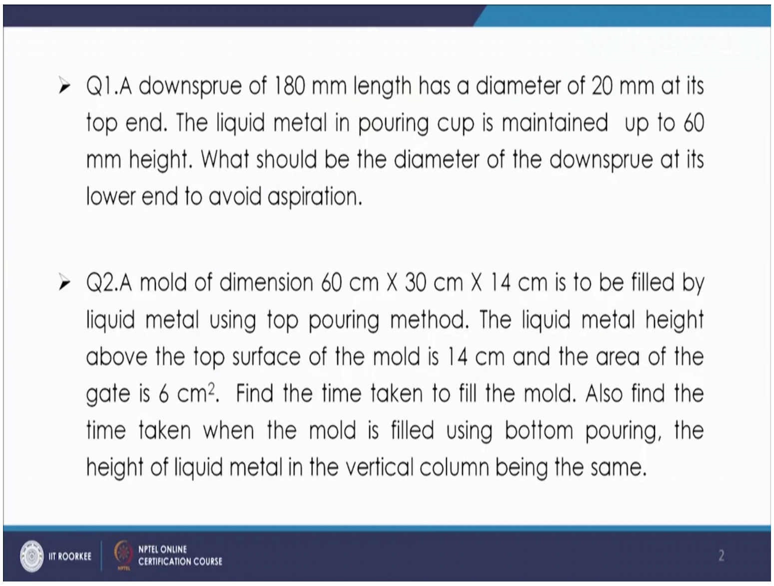

So, you have the dance blue and also the liquid metal in the pouring cap is maintained up to 60 mm height. So, the first problem is that you have a pouring cup and you have a down sprue and this is the pouring cup height and this pouring cup height is a maintained as 60 mm and the down sprue is of length 180 mm.

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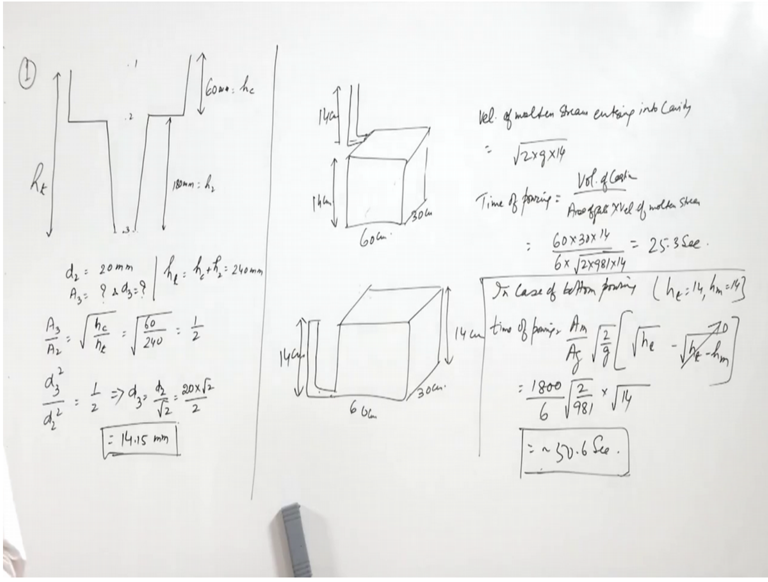

So, this length is 180 mm. So, then what should be the diameter of the down sprue at its lower end to avoid aspiration. So, basically as you know that we define 0.1, 0.2 and 0.3. So, this height is h 2 and this is known as h c this is 60 mm and. So, what we see is that r is A 3 by A 2 that is basically under root sc by ht. So, ht is this total height, and you have to find the. So, this value is given the diameter of 20 mm top ends.

So, here A 2 is given as 20 mm. Now you have to find the diameter at the lower end. So, you have to find A 3 this is A 3 here the area is A 3 and here the area is A 2. So, we know that for avoiding the aspiration and the condition is that A 3 by A 2 has to be under root h c upon h t; and h t is nothing, but h c plus h 2. So, you will have h t as h c plus h 2 that is 60 plus 180. So, 240 mm.

So, you will get s c as 60 and s t as 240. So, that is 1 by 2 and A 3 by A 2. So, you have to find the diameter A 3 will be d 3 square and A 2 will be d 2 square. See this is A 3 this is not A 2 basically this is your d 2, d 2 is given. So, you can find it A 2 the diameter is given not the area, you have to find basically d 3. So, once you know d 3 you will find the A 3.

Now, so, this d 3 by d 2 square will be 1 by 2. So, d 3 will be d 2 by root 2. So, d 2 root 2 by 2. So, you will have once you know d 2 you will find the values of d 3 and that comes out to be d 2 20 into root 2 by 2. So, 10 root 2 that is why I mean 14.15. So, 14.15 mm should be the diameter at the bottom end of the sprue so, that there is no aspiration this is how you can solve this problem.

The next problem is a related to the again the pouring; a mold of dimension 60 centimeter by 30 centimeter or 40 centimeter is to be filled by liquid metal using top pouring method. You have the liquid metal height above the top surface of the mold as 14 centimeter and area of the gate is given as 6 centimeter square.

Find the time taken to fill the mold also find the time taken when the mold is filled using bottom pouring, the height of liquid metal in the vertical column being the same. So, you have a mold of dimension 60 by 30 by 14, in one case you are pouring by top pouring and in that top pouring the liquid metal height above top surface is 14 centimeter.

So, you have 2 cases, you will have the this is how your casting will look like or you can have proper other way.

So, what you see is you will have. So, this height is given as 14 cent centimeter, this is 14 centimeter and also this height is 14 centimeter, and here you will have the dimension that is given as 60 by 30. So, this is 60 and this is 30. So, this is one case of top pouring another case will be because this height comes out here. So, in that case what will happen?

So, in that case basically this 14 centimeter height comes here, and there is a case of bottom pouring. So, your liquid column height will be maximum here and this this way it will be fed. So, this comes out to be of this height itself. So, this is 14 and also this is 14 and then and then you have this as 60 centimeter and 30 centimeter. So, once is the case of top pouring another is a case of bottom pouring.

We know that in case of top pouring the velocity will be here constant. So, the time of pouring will be basically depending upon the velocity here, and this velocity here at this point will be basically under root 2 g into height of the molten metal which is available here. So, in this case velocity of molten stream and entering into casting cavity so, that will be root 2 g into this 14, 2 g h.

So, 14. So, g can be taken as negative one you know centimeter per second square because this is centimeter. So, that can be taken. So, time of pouring will be basically volume by area of the gate into this velocity. So, time of pouring will be volume of casting by area of gate, that is given into this velocity of stream molten stream. So, this you can find it and that will be volume you know that 60 in to 30 into 40, 14 and divided by area of the gate is given as basically it is given as 6 centimeter square.

And then you will have under root 2 91, 981 into 14. So, this can be computed out and find the results. So, this is coming out to be 25.3 seconds. So, this is the case of top pouring now if you go to bottom pouring. In the case of bottom pouring as we had studied the time of pouring is; in case of bottom pouring the time of pouring is equal to A m by A g into basically 2 by root 2 g. So, that is how it comes root 2 by g and then the term comes as under root s t minus under root st minus hn. So, that comes as under root ht; because in this case the ht is 14 and is also 14. So, you have here ht as 14 and as fourteen. So, these term vanishes.

So, you have you can find directly from here. Now area of the mold is 60 in to 30 and area of the gate is given as 6 centimeter square. So, these values are known to you. So, that will be 1800 by 6 into root 2 by 981 into root ht s. So, ht is 14. So, if this value is computed this value is coming out to be about 50.6 seconds.

So, what we see is there case in the case of bottom pouring here, the value is about 2 times that in the case of top pouring and you can find these values quit. Whatever you can that can be different in that case it will be different. So, this way this value can be computed.

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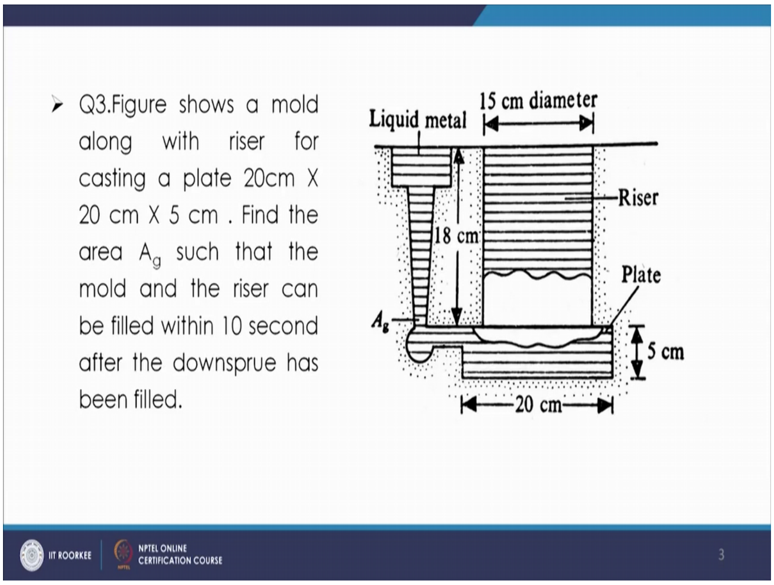

Next question is that in the figure it is shown that you have a riser, I mean along the riser it is shown. So, there is a one riser which is also to be filled. So, as you see that you have the liquid metal it is going through the down sprue and in the bottom it has. So, using the top gating it is filling the mold cavity, and using the bottom gating basically again it is filling the riser.

So, you have a mold along with the riser for casting a plate, that is 20 centimeter by 20 centimeter is the plate. So, its cross sectional area 400 centimeter square and its height is 5 centimeter and then you have that again the riser. So, riser is of 15 centimeter diameter. So, that is a cylindrical riser and the height is shown as 18 centimeters as you see that it all the dimensions are shown.

Now, the thing is that you have to find the area A g; so that mold and the riser can be filled within 10 second after the dance blue has been filled. So, what we see here is that you have a condition where a certain part is to be filled using the top gating, and certain part is to be filled using the bottom gating all the other dimensions are given except A g.

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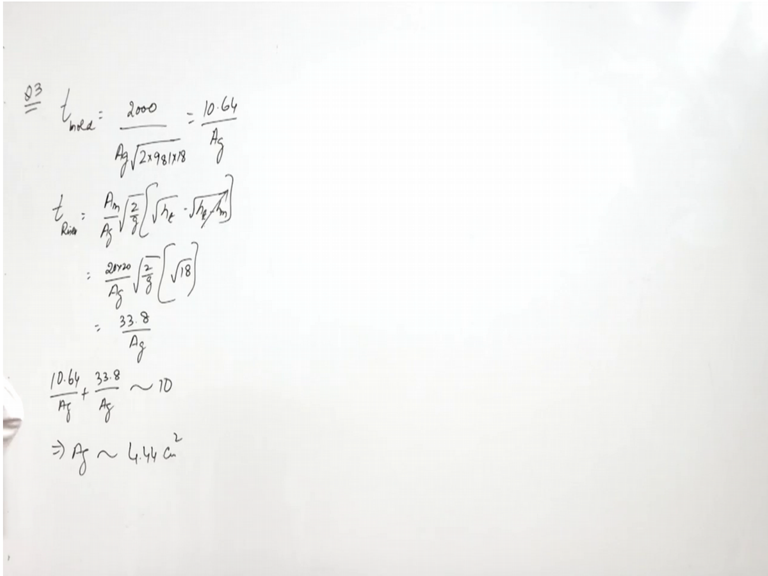

So, simply you have to have the expression and you have to equate it to about 10.

So, 10 second is the time in that case you can find the total values. So, suppose here the for question 3; now in this case since the mold part is filled using the top gating. So, for mold part the mold this will be volume of the mold. So, 20 into 20 into 5 that is 2000, and then it will be divided by A g which is unknown and then the velocity, velocity is 2 root 2 gh. So, this will be 2 into g is 981 and h will be basically 18.

So, it will be 2 into 981 into 18. So, it is coming out. So, this off this also this comes out to be 10.64 by A g. You can compute these values and you get this value then you find the time for the; for filling of the riser now in that case it is a bottom gating case. So, this value for t for riser, time of pouring for the riser again you will find A m by A g root 2 by g and then root ht minus root ht minus you have all the values given. So, A m is nothing, but 20 into 20. So, it will be all the values given 20 into 20.

Then by A g you have to find then you have root 2 by g, and then root ht. So, ht is 18. So, root 18 minus, again you have height is the same. So, this term will vanish this will vanish. So, it will be root st. So, you can have this expression as 33.8 by A g. So, this is how you get these 2 expressions now, the total time of pouring will be basically summation of the two. So, that is how you sum it. So, 10.64 by A g plus 33.8 by A g has to be equal to nearly 10.

So, from this condition you can find A g, and A g is coming out to be about 4.44 seconds 4.44 centimeter square. So, this is how you can find the area of the gate which will take basically about 10 minutes to fill the hole casting as well as the risers. So, this portions can be solved in that fashion.

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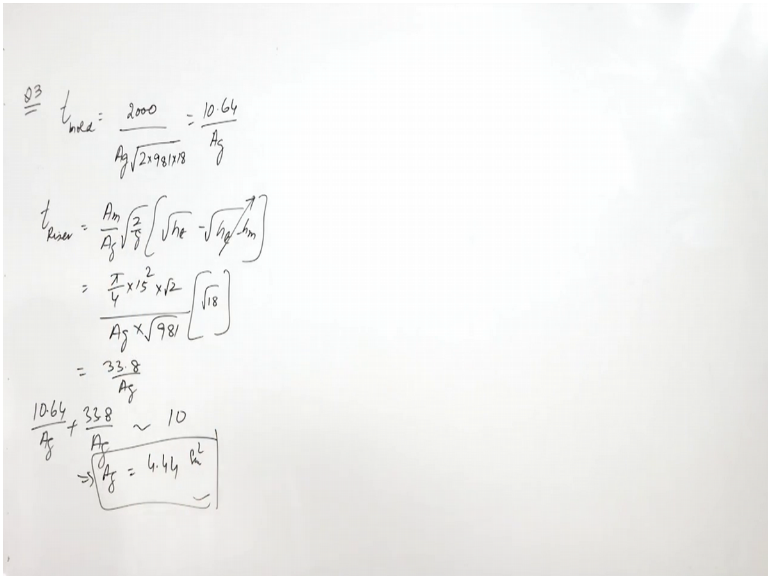

Now the time of pouring for the riser side so, that will be A m by A g root 2 by g and then root s t minus h m.

So, in this case this case A m is area of the mold and that is basically a 15 centimeter diameter cylinder. So, it will be pi by 4. So, am you know pi by 4 into 15 square. So, that is your A m and then it will be under root 2 divided by A g you have to find, and then you have root 981 and then this will basically vanish because h t is equal to. So, you will have root h t and h t is basically 18. So, root 18.

So, that comes out to be normally 33.8 by A g. So, this is at that time of pouring for the riser portion. So, total pope time of pouring will be 10.64 by A g plus 33.8 by A g and this condition is given as it should be maximum 10 seconds. So, within 10 seconds. So, if you take that as 10 then in that case you can find the value of A g as 4.44.

So, this area of the riser can be calculated for such conditions. So, that is problems can be solved in this fashion you have the top pouring as well as the bottom pouring. So, in that case you can find and give the conditions satisfied. Next we will discuss the problems related to the riser of different type.

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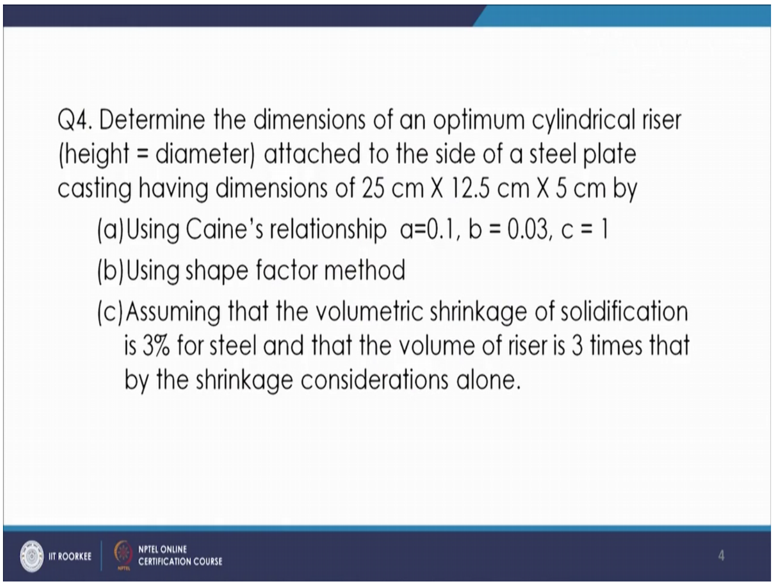

So, let us say by different methods we will try to solve such problems. Now, here the question is given as that you have to determine the dimension of an optimum cylindrical riser, attached to the side of a steel plate having casting plate casting having dimension of 25 by 25.5 by 5 centimeter using Caines relationship. So, as you know that a b and c value is given and you have to find the value of the diameter of the riser using the Caines method.

So, what we see that in the Caines method you have to find the x and y, and you know that the equation is. So, question 4 question is x equal to a by y minus b plus c; a b and c values are given and a is 0.1, b 0.03 so, it will be 0.1 by 0.03 plus c is c is given as 1.

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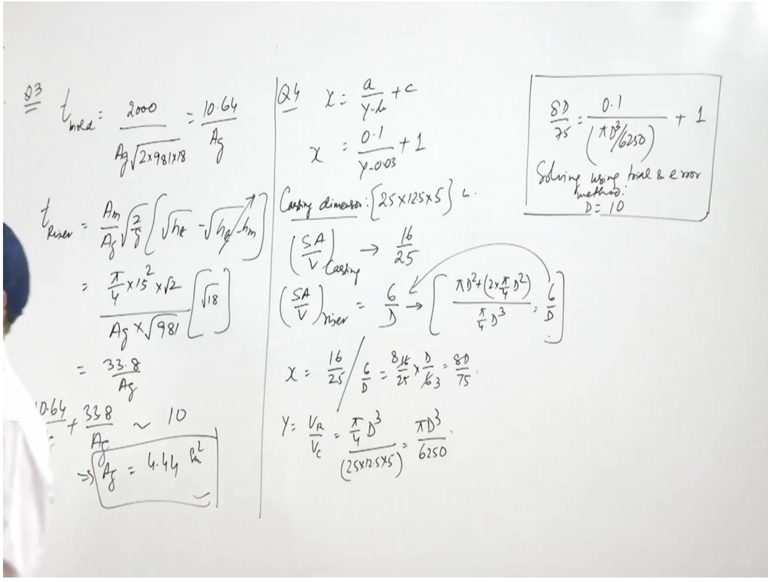

So, this is the equation in which you have to fit in. Now in this case your casting is dimension is given. So, you have to find the SA by V of casting.

So, casting dimension is given as 25 by 12.5 by 5 centimeter. So, you can find SA by V of casting and SA by V of riser for riser you have to say tip that say cylindrical shape. So, SA by V of casting you have to find. So, that will be 2 into lb plus bh plus lh and. So, that will be a SA, and then we will V will be 25 into 12.5 into 5.

So, if you find the SA by V of casting it is coming out to be 16 by 25 so, that you can find it by like 2 into 16, I mean 25 into 12.5 plus 12.5 into 5 plus 25 into 5. So, all that will be SA and v will be 25 into 12.5 into 5. So, that way you can find the v. So, that way you get SA by V of casting.

Now, if you find if you take the riser whose all the ends are basically both the top and bottom end contribute in the heat transfer that way. So, and if will and h is given as d it is written that h is written as d. So, for SA by V of riser will be 6 by d. So, as I said v of riser will be 6 by D because both hand is. So, that way you can see that the SA will be pi by 4 d square into 2 plus pi d into d. So, that way it comes; it comes out as how you can say pi s a will be pi d square plus 2 into pi by 4 D square divided by volume that is pi by 4 D cube.

So, this will be 6 pi by 4 and this will be pi by 4 and here D is more. So, it will be 6 by D this comes out to be here. So, this way you can find SA by V of riser for a cylindrical riser with all its ends contributing towards the you know heat transfer conditions. So, what you see is the on the x dimension the x value that is fusing ratio will be SA by V of you know SA by I mean you have to find the SA by V of the 2 values SA by V of casting to SA by V of riser. So, that is 16 by 25 divided by 6 by D.

So, 16 by 25 into D by 6. So, it will be 3 and it will be 8. So, 8 D by 75. So, that is how you get the this x values and further you have to find the V R by V C. So, that is y. So, y is basically V r by Rc now in that you know that d is pi by 4 D cube and then the value that is for the casting. So, you will have V r as pi by 4 D cube that is the volume of the riser and volume of casting will be basically you have the casting dimension is given. So, it will be 25 into 12.5 into 5. So, this way you will have this y term, and once you have this term. So, that will be pi D cube upon this will be basically 50.

So, 10 into 35 into 5. So, it will be pi D cube by 50 to 25 So, 20 50 into 25 6250 that is why now you have these 2 values and these 2 values are basically to be fit in into this equation and you have to solve it. So, your equation comes out as. So, it will be 8 D by 75 or you can also write it as point 3 2 D by 3.

So, whatever it be, now if you do you find this if you put this equation as like this. So, your ultimate equation comes out to be x equal to. So, x will be 8 D by 75 will be equal to point one divided by pi D cube by 6250 and then minus 1. So, plus 1 and this equation needs to be solved using the trial and error method and once you solve it using trial and error method.

So, solving using trial and error method, you can find d as about 10.89 centimeter you can solve it. So, basically what will happen you will have to take this term out and that will be in equation in d raise to power 4 term and then you can solve it. So, that is basically somewhat tedious to solve, but then you have to no other way, but to solve this using the you know trial and error method and you can get these values d.

So, once you know d that is what you require the next part is the b part. So, question 3 B.

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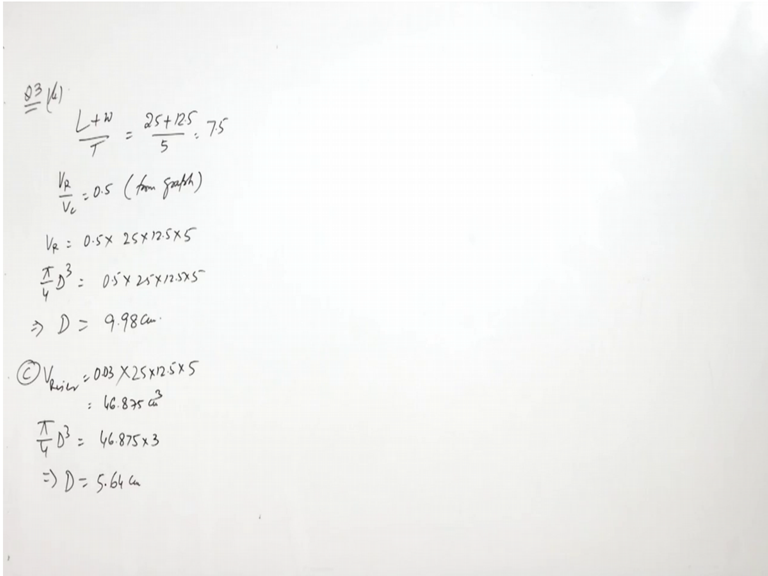

Now, in this the same question is to be solved using the shape factor method. So, in the shape factor method you will you must have the graph for 8. So, in the shape factor method as we know you have to find the shape factor. So, shape factor is L plus W by T. So, L plus W by T if you look at. So, l is given as you have the values given as 25 and 12.5.

So, l is 25 and this is 20.5 and this is 5. So, that is 7.5. So, l plus w by t is given as 7.5.

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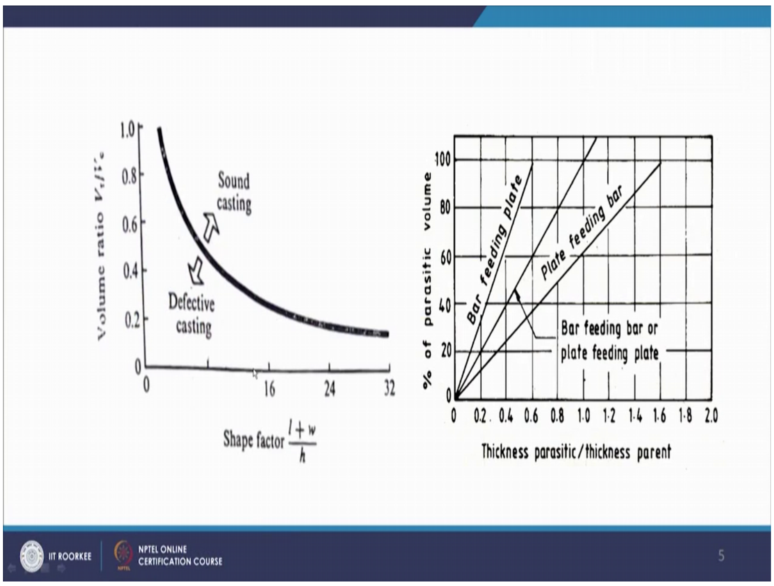

Now, you have to go to this graph and you see that this is 7.5, and against the 7.5 if you go if you go to this 7.5 you will have to find the V R by V Cvalue. So, it will be here and it will go if you have to go straight and you come here close to this 0.5.

So, if you assume this as 0.5 because it will be coming as at this point. So, from here you will have V R by Vc from the graph is 5.05 and vc you know vc is 25 into twelve point 5into basically 5. So, once you know that you can find the d. So, basically V R will be zero point five into vc. So, 25 into twelve point five into five and V R if you take the riser of diameter d and the height as equal to d.

So, it will be pi by 4 D cube that will be equal to 0.5 into 25 into 12.5 into 5. So, you can find directly D you can solve this equation and you can find D as 9.98 centimeter that is how using the shape factor method you can solve such problems.

So, it will be this way you can solve it. Now next part is you have the assuming that volumetrics in case of solidification is 3 percent for steel and that volume of riser is 3 times that by the shrinkage consideration alone. So, as we discussed that you assume that the volume volumetric shrinkage is 3 percent for the steel. So, it will be volume of amount will be required is 3 percent of the volume of the casting. So, volume of riser which is required will be point zero times. So, volume of riser has to be 3 percent of the volume of the casting.

So, 25 into 12.5 into 5. So, once you have that you can have. So, that is about 46.875. So, once you have that well as you know that you have the say riser of cylindrical shape with x equal to b. So, again pi by 4 D cube you have to compute it as 46.875 is that we equate it as that and then you can get the value of D that is coming out to be close to five point 6 4 centimeter you can do the calculations.

So, in this case you are getting 9.98, but having this that kept in mind that you are having this. Now here I think we have done some mistake here you have to further multiply it with 3 times. So, you have to have 3 times this value basically because this is the amount which is one is up 3 percent of the volume, and then further you have to have 3 times that volume which is written that this volume has to be 3 times.

So, then you will get this riser volume as 5.64 centimeters. So, then we see that when 3 times is not enough sufficient, you need somewhere close to it using the shape factor method. So, as we had discussed that those conditions may not be sufficient even 3 times maybe you may have to go even higher. So, that can be seen from here.

Now, let us go to next question.

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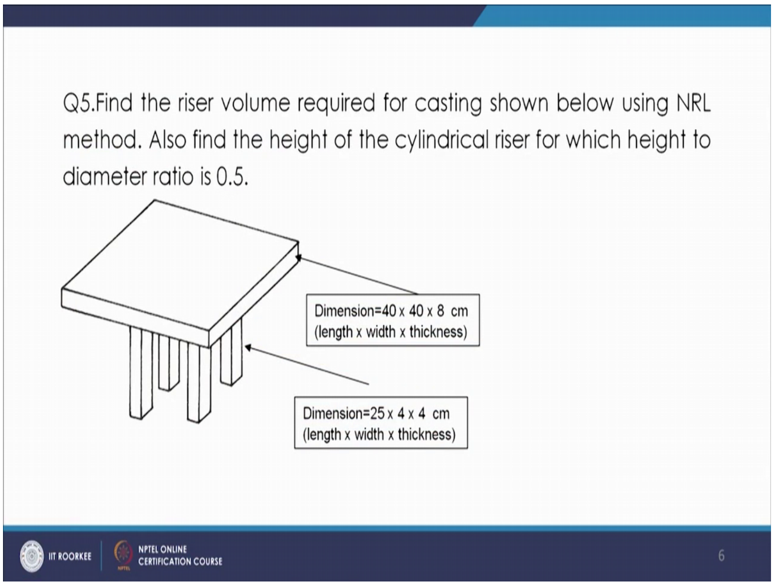

So, the next question is about the riser volume required for casting shown below using NRL method. So, say you again the safe factor method and in this case as we see you have a plate, and this plate basically is to be to feed 4 bars. So, as you see here the main casting is the plate, and this plate is feeding 4 bars. So, this is a case of appendage you know feeding, and you have the dimension of this as 40 to 40 to 8 centimeters. So, that is of the top plate normally plate is defined as the dimension, when the width dimension is more than 3 to 4 times the thickness then it is considered as a plate otherwise it is a bar.

So, you have this plate. So, first of all we have to find the riser requirement for this plate, and then additional riser requirement additional riser volume requirement for these appendage volumes. So, this way you have to find the total riser volume. Now let us see what will be the volume reserved amount required let us move to now question 5.

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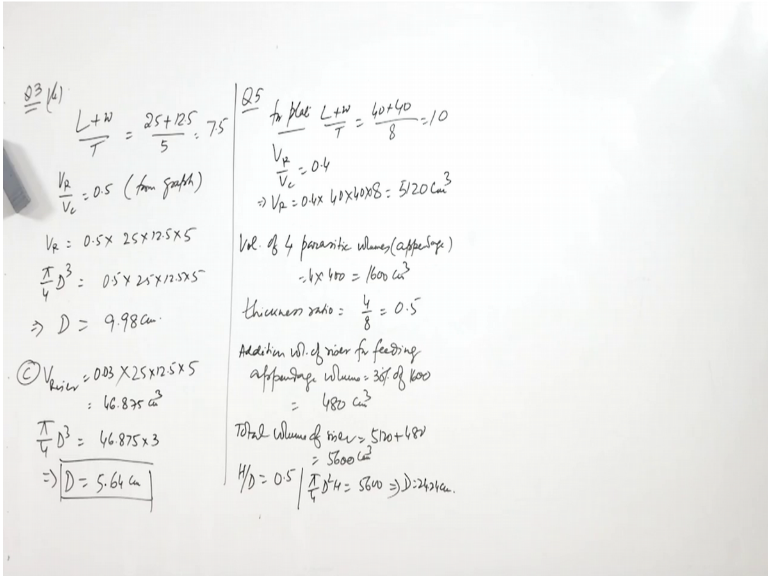

Now, in this question of five, you have the plate plates L plus W by T for plate L plus W by T. So, L is given as 40 and W is 40 and T is basically given as 8. So, it is 10 now you go to this this table again. So, against this value of 10 V R by V c if you compute if suppose let us say it comes here and goes to here. So, it is close to 0.4. So, V R by V c is coming as 0.4.

So, V R will be 0.4 times V c and V c is 40 in to 40 in to 8. So, it will be 5120 and this is the unit is centimeter. So, 2 centimeter cube this is the riser volume required only for the top plate. Now next we will move to basically for that bars; now for that bars you have 4 bars. So, the volume of these bars are 4 times the volume of1. So, volume of one bar is 400 centimeter cube. So, volume of 4 parasitic volume parasitic volumes yeah appendage it will be 4 into 400 that is 16000 centimeter cube.

Now, thickness ratio if you look at; thickness ratio of the parasitic volume that is 4 centimeter to 8 centimeter, that is 4 by 8 that is 0.5. So, again we will look at the this graph, now here you have a case of plate feeding bar and in this case you have you can see here that this is the .5, this 0.5 will be your thickness ratio and you go to this plate feeding bar case this line and this line it comes out to be 30 percent.

So, volume of riser required for additional I mean volume of the riser for feeding these appendage volume. So, for that, additional volume of riser for feeding appendages volume that will be 30 percent of 16000. So, this will be 480 centimeter cube. So, basically 5120 centimeter cube was for that plate for this plate and then 480 is required 30 percent of it. So, it is all volume will be required for additional extra volume for this you know bars which are there as appendage volume.

So, once you have that you have the total you know volume of the riser will be 5120 plus 480 that is 5600 centimeter cube. Now in this case we again see that you can find this H by D if. So, if you have the H by D ratio is given as 0.5. So, you have H by D as 0.5.

So, pi by 4 D square H can be computed out to be equal to. So, you have pi by 4 D square H has to be equal to 5600 and H by D I equal to 2 that is H equal to 0.5 D or D equal to 2 H. So, if you put that you get basically the value if you calculate D is coming as 24.24 centimeter.

You can compute these values and you can get to that. So, you can have. So, once you have D is 24.24 in that case H will be 12.12. So, this will be the size of the cylindrical riser which will be required to feed such casting. So, this is how you can solve such problems.

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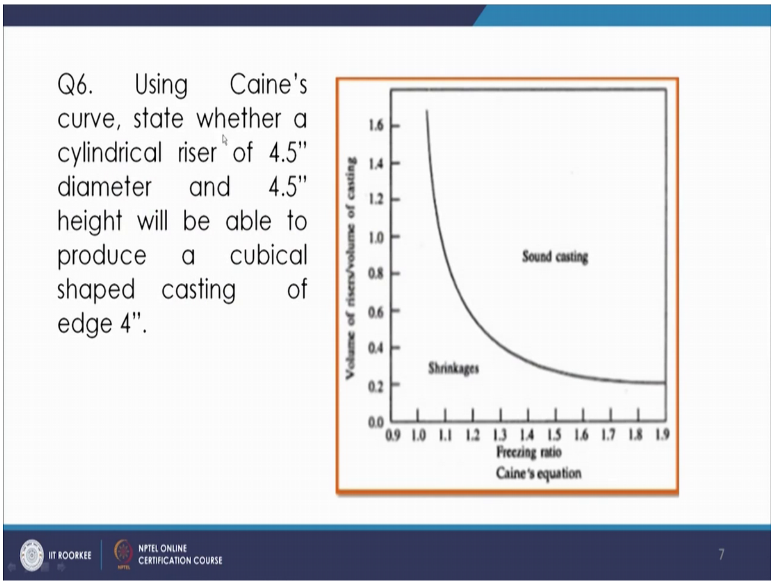

You can see another problem of another just a problem where this it is written that using Caines curve whether you can say that it is an integral riser of 4.5 inch diameter and 4.5 inch height will be able to produce a cubical shape casting of edge 4 inch.

So, again you here you have the A by V of casting you can find and A by V of casting will be 1.5.

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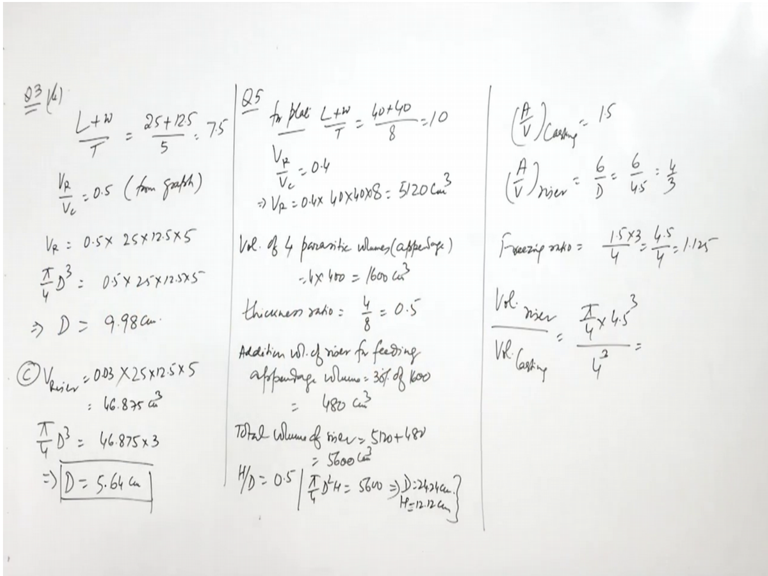

So, you can find for them A by V of casting will be 1.5, it will be A by V again 6 times you know and then 6 times the size is 4 inch. So, 6 into 4 into 4 by 4 into 4 into 4. So, that is 6 by 4 that is 1.5. Now A by V of casting is known A by V of riser will be 6 by D. So, you can have. So, cubicle you have the riser cylindrical riser of 4.5 inch diameter and height also 4.5 inch. So, you will have A by V of riser it will be 6 by D. So, 6 by 4.5. So, it will be 3 and 4, 4 by 3.

So, A by V of a riser any way of casting you can find. So, you find the freezing ratio now. Freezing ratio will be A by V of basically casting by A by V of riser. So, that will be. So, freezing ratio A by V of casting, A by V of riser. So, 1.5 by 4 into 3. So, about point 4.5 by 4, 1.125.

Now, you have to look at this table. So, if you would see the 1.125 you need something like volume of the riser, and volume of the casting ratio adds some value here from the table. Now volume of riser by volume of casting you have to find the ratio. If you find the volume ratio volume of riser why volume of casting you can calculate volume of riser will be pi by 4 D cube because d n h is same and then similarly you have the casting 4 cube.

So, pi by 4 cube into 4.5 cube divided by 4 cube. So, this value you can calculate and this value comes out to be 1.12. Now if you see from the table, what you see that this value of 1.125 you got here, and then if you go it is well above this value. So, this value is well above the line, this you are coming out 1.12which is here. So, this is well above this line it means you are going to get a sound casting.

So, this can be inferred by looking at these values. So, you can see that from 1.125 it will be somewhere here, he is in a normally this volume of riser will be close to 0.83 or 0.85, but it is since in this case you have volume of riser by casting is coming out to be close to 1.12 which is quite higher. So, in that case you are likely to get a sound casting not a shrinkage casting. So, this is where you can solve different kinds of problems in the case of gating and risering. Hope you understand it well and you practice more and more problems based on this.

Thank you very much.