Principles of Casting Technology
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Lecture – 22
Riser Design
Risering methods- 1

Welcome to the lecture on Risering methods under the Risering design. So, we will discuss about few methods, there are 3 to 4 methods for risering design, and we will discuss one by one the different design methods or risering volume calculation methods or shape, shape is anyway fixed. So, size calculation methods. So, first of the method that we will discuss is the Caine's method. So, a Caine's has developed, and gave certain equation for finding the riser volume.

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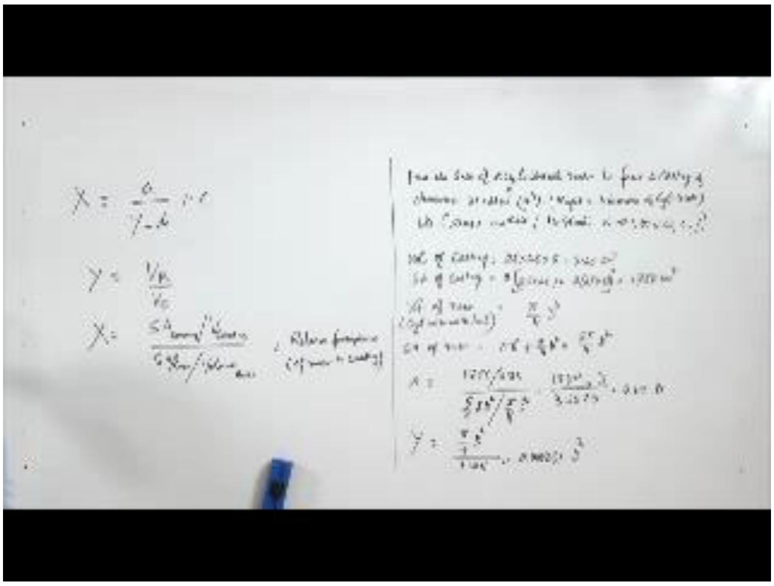

And this equation is X equal to a upon Y minus b plus c. So, basically he has advocated the relative freezing time of the riser and the casting. So if the freezing time of the riser so freezing ratio it is nothing, but the relative freezing time of the riser to the casting.

Now, the freezing time is taken as to be proportional to somewhat b by s a, volume by surface area that we have understood earlier, we have seen that t is normally proportional to b by a square. So, they have taken v by a, as a parameter which is indicative of somewhere the freezing time.

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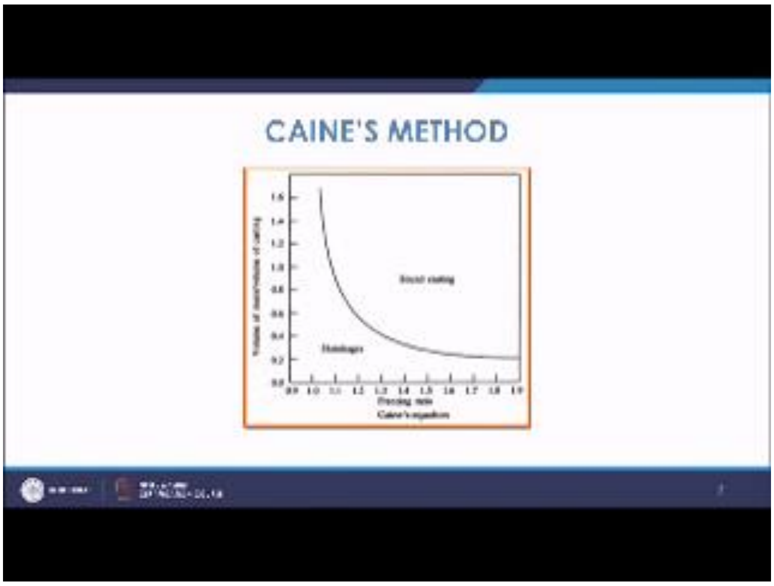

So, this freezing ratio is nothing but the relative freezing time of the riser to the casting, and that is y, this freezing ratio why this x is the ordinate, this is the volume of riser to volume of casting. So, this is x, x is volume of riser to volume of casting.

Now, the freezing ratio that is y, y is the relative freezing time of the riser to that of the casting. So, it comes out to be surface area of casting, to volume of casting divided by surface area of riser to volume of riser. So, this is the parameter basically you can have it like this, volume of riser by surface area of riser, divided by volume of casting upon surface area of casting, and that is basically the relative freezing rate of that of the riser to that of the casting. And he found that there is a curve, which represents this equation here a, b and c are constants, and this constant values are having different values for different materials, which is given in the books and whenever we calculate for that material we have to use these a, b and c values.

Now, what it tells is that, once this freezing ratio or the relative freezing time of the riser to the casting, if the freezing time of the riser to the casting. So, this is nothing, but relative freezing time of riser to casting. So, if we look at this point, as this curve indicates, as this ratio increases, the volume of riser to volume of casting is decreasing. Means if the riser will have such a shape or size so that it has larger values of freezing time as compare to that of the casting, in that case this value will be larger. And once this value is larger, and if the riser as adequate amount of liquid metal, and also it is adequately shaped, it is appropriately shaped. So, that it is solidifies in a larger time than the casting, in that case the risering requirement. So, volume of riser to volume of casting will be basically a small. So, smaller size volumes even can suffice that. So, that is the basically a sense of his findings.

And this way once you develop one equation then you can solve that equation and get the values of the riser dimensions. For example, suppose you are given with a problem. So, the problem is that you have to find the size of a cylindrical riser to feed a casting of dimension 25 by 25 by 5 centimeter cube, and you have to if I mean given height equal to diameter of cylindrical riser, and use Caines method. So, you are given a plate type of casting, which has this is a rectangular cross section of 25 by 25 centimeter, and it has a thickness of 5 centimeter. You need to have a riser cylindrical shaped riser, with height equal to diameter and that should be able to feed this casting and you have to calculate using the Caines method, and you have to do it for steel. So, for a steel a is given as 0.1, b is given as 0.03 and c is given as 1. So, this is casting of steel, and that is of this particular dimension

So, once you are given, in that case you can solve such problems. So, what you have to do? You have to first find out the volume of casting, volume of casting will be 25 multiplied by 25 multiplied by 5 and this comes out to be 3125 centimeter cube, then comes the surface of the casting. So, surface area of casting will be 2 times 25 into 25 plus 2 in to 25 into 5. So, it will be 625 plus 250, that is 875 and this will be 1750 centimeter square.

Similarly, volume of riser: that is cylindrical riser, with height equal to diameter. So, once you have a cylindrical riser with height equal to d, in that case volume will be pi by 4 d cube, on the other hand surface area of the riser, now in the surface area of the riser if you take this side riser, and if you assume that the bottom portion does not contribute as the surface which is exposed through the cooling surface or which is exposing the heat or which is radiating the heat, in that case virtually we have the curves surface as well as the top surface. So, in that case the surface area becomes you have pi d square, pi d is the perimeter, and d is the height. So, it will be pi d square, plus the top surface area that is pi by 4 d square. So, that comes out to be 5 pi by 4 d square.

Now, after this, you are going to have the values of x and y. So, x is nothing, but the freezing ratio. So, freezing ratio is nothing, but surface of casting by volume of casting. So, surface area of casting is 1750 upon volume of casting is 3125, divided by surface area of riser upon the volume of riser. So, that will be 5 by 4 pi d square divided by pi by 4 d cube. In fact, this is the freezing ratio which is there on this line, I feel that there is a mistake here, this is basically y this is the ordinary axis, and this is your x part. So, this x part is the freezing ratio that is relative freezing time of the riser to the casting. So, x you will calculate from here, and that will be 1750 upon 3125, multiplied by here this pi and pi will go this 4, and 4 will go and d square will go. So, this d will come on the up and the 5 will be at the bottom.

So, once we calculate this value, it will be 1750 divided by 15625. So, it is 0.112d. So, this is the value of the ordinate or abscissa that is ordinate, since x in this equation. Then the y, y will be v r upon v c. So, volume of riser that is, pi by 4 d cube divided by the volume of casting. So, volume of casting is 3125. So, we have to calculate it. So, it will be 3.14 divided by 12500. So, it will be 0.000251 and multiplied by d cube. So, this is how you get this value of x and y.

Now, we have to substitute these coefficients as well as this value in that equation, and then we get the value of d. So, if we substitute these values, what we see is x is 0.112d.

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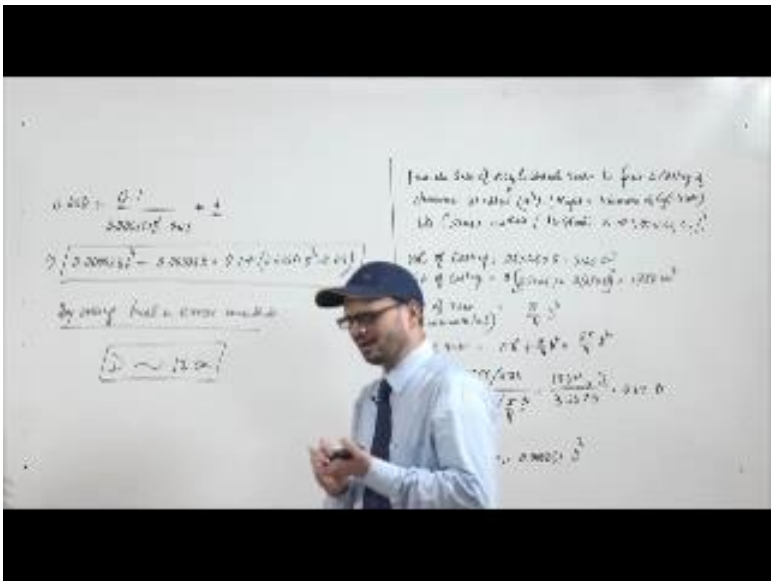

So, we have x equal to a by y minus b plus c. So, 0.112d equal to a is given as 0.1, upon y is 0.000251 d cube, minus b, b is given as 0.03 and plus c 1. So, this way you are getting an equation you can get further the equation. So, this equation will be, it will be 0.0 0028128 d to the power 4 minus 0.00. So, this will be 0.112 multiplied by 0.0 3 that is 0.00336 d. So, that will go that side and you will have 0.1 plus 0.000251 d cube minus 0.03.

So, this way you are basically finding 1 equation, which has the d to the power 4 terms d raise to the power 3 terms all that, and this can be further simplified and you have to basically solve this equation by using the trial and error method. And once you use the by using trial and error method, if you find the solution of this equation, you get the value of d somewhere close to 12 centimeter. So, for that basically you will have to solve this equation, which is certainly somewhat cumbersome to solve it will take a lot of time little bit and then you can get the value.

From this graph also if you can just assure yourself, if you know the casting dimension, if you know the dimension of the riser in that case what you see is, if the freezing ratio you have calculated and if it falls somewhere, if you get this volume of this riser to volume of casting, and if you are getting this particular point which you get in this part of the casting, then you can assure that you are casting will be sound and there will not be any defect related to shrinkage; however, if that point rise below this line, the line which is supplied, even if the point lies below this line in this zone in that case, it will be having the shrinkage problem, there is probability of having shrinkage in such cases. So, this is the method of solving this Caines equation and getting the risers sizes.

Next method of calculating the riser size is the modulus method. Now what do you mean by modulus? So, in the earlier method in the Caines method what we have seen, is that you have to find the surface area of a volume of casting to surface area of a volume of casting to surface area of a volume of riser, that ratio will be working as a value on the x axis and then volume of riser to volume of casting will be in the y axis, and then you can have solve this equation and get the volume of the dimension of riser. Now another method is modulus method.

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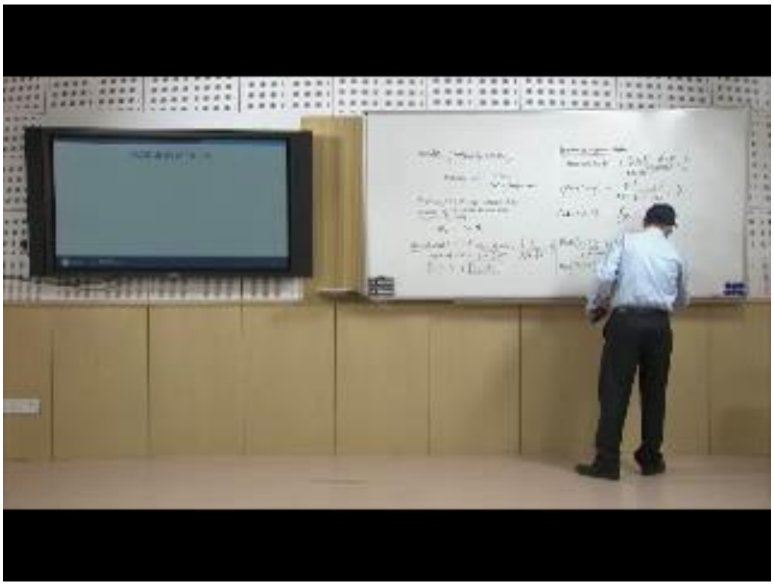

So, what is modulus? Now to get rid of such cumbersome equations and solving them, another method which he has been proposed by Wlodawer. So, he has proposed that the modulus of casting. So, modulus is defined as volume upon cooling surface area. Now the volume upon cooling surface area is certainly related to the freezing time, the volume upon cooling surface area has only been taken by Caines also, but he has modified it and he has simplified it, what he has suggested? What this method has suggested that, if the modulus of casting and modulus of riser is calculated, certainly for the casting to have no shrinkage defects, the modulus of casting must be less than the modulus of the riser or in other words modulus of the riser must be more than the modulus of the casting.

So, for avoiding any shrinkage related defects, modulus of riser should be more than modulus of casting. So, it was suggested that it has to be more and a typical value of 1.2 was seem to be satisfactory, and they told that modulus of riser should be somewhere near to 1.2 times the modulus of casting. So, if the modulus of this riser is 1.2 times the modulus of casting, in that case the casting can be sound.

Now, if you take for a cylindrical riser, where what we have option in the earlier case, where we take a side riser with only one top surface to be the one which is taking part in extracting the heat, in that case if you take modulus of that riser . So, it will be volume of riser upon volume of or cooling surface area of riser. So, volume of riser is pi by 4 d cube, we are taking height equal to diameter; if we take the riser with height equal to diameter, in that case volume of riser will be pi by 4 d cube, and cooling surface area of the riser will be pi d square that is the curved surface area plus pi by 4 d square that is one of the top surface of the riser, which is extracting the heat. So, it will be d upon 5. So, it will be 5 r for d cube and it will be 5 pi by 4 d square. So, this d will remain here and 5 will be remaining here, so d upon 5.

Now, if you put this condition in this case, in that case the modulus of riser comes out to be d by 5. So, d by 5 should be equal to 1.2 times modulus of casting, and subscript c. And from there what you get is, d will be equal to 6 times modulus of casting. So, it becomes very simple to calculate the diameter of the riser, for which you have to simply multiply the modulus of casting with 6. So, once you have a casting given, you find its modulus multiply it simply with 6, that will give you the diameter of a cylindrical riser whose height and diameter are same, and you are basically avoiding all sort of problems, which you had to do regarding the computation of the diameter in the case of Caines. So, it becomes very simple.

Now, this modulus how to calculate; we know that modulus is volume by cooling surface area. So, if you try to calculate the modulus of different shapes or sizes you can calculate it. So, we will see how to calculate the different shapes of I mean the modulus for different shapes of the casting like spherical, cylindrical, cubical or different place and bars and. So, so let us find how to find the modulus of different geometries, modulus of different shapes. So, if you look at the modulus of spherical shape, spherical dia d. So, for this what you get is, the volume is 4 by 3 pi r cube. So, pi into d by 2 cubes upon 4 pi r square. So, it will be 4 pi d by 2 square. So, it will be 4 and 4 getting cancelled, so d by 2 cubes. So, d cube upon 8 into 3 multiplied by d square, into multiplied by 4. So, it will be d upon 6. So, for a spherical shape you get the modulus as d upon 6.

Similarly, for a cylinder with h equal to d, and you assume that both the surfaces suppose are acting as a surface which expose the heat, in that case the volume will be pi by 4 d cube and surface area will be pi d square the curved surface area, plus pi r 4 d square on the top and pi r 4 d square on the bottom. So, it will be pi by 2 d square. So, it will be pi by 4 d cube upon 3 pi by 2 d square. So, it is 6 pi by 4 d square. So, it will be d by 6. What we see is for a spherical casting of diameter d, the modulus is d by 6. For a cylindrical casting of height equal to d with both its flat surfaces actively engaged in extracting the heat, in that case it becomes d by 6, it will be different if we do not take 1 of the surface so it will be different. Then in the case of suppose cube in the cube if size is taken as d. So, in that case the volume becomes d cube and the surface area total becomes d square, you have 6 faces every face has the area of d square. So, there it also becomes d by six

This way you can calculate the different value of the modulus for different geometries; similarly for a plate with dimension a as length, b as width, and t as thickness, and a is less than 5 t, in those cases it is calculated out to be 0.5 t, similarly a bar causes some a b cross sectional area is a b and it is a bar, in that case it comes out to be area upon 2 into a plus b. You may calculate this value of modulus for different shapes, even for hollow shapes by using this formula volume upon cooling surface area.

So, this is how you calculate the different volumes, this volumes are directly used to calculate the diameter of the cylindrical riser, and basically it is a simple method for calculating the riser dimension.

Thank you.