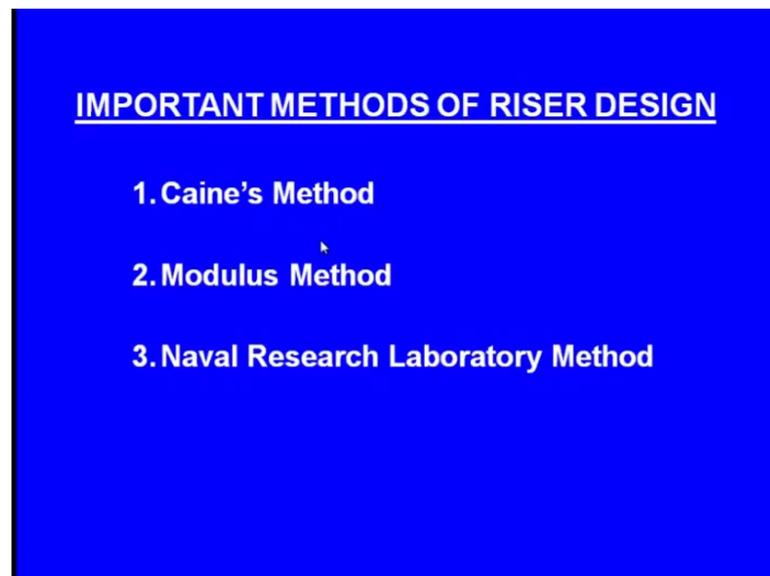


Metal Casting
Dr. D. B. Karunakar
Department of Mechanical and Industrial Engineering
Indian Institute of Technology, Roorkee

Module – 02
Sand Casting Process
Lecture – 10
Design of Riser System-II

Good morning friends, in the previous class we have been learning about the Design of the Riser system. And in the Design of the Riser system, we have seen the Caine's method and the Modulus method.

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We have seen that Caine's Method is tedious as far as the calculation is concerned more time is required and it is more complex. After that the modulus method we have seen and it offers certain advantages over Caine's Method. Now we will see the next method that is the Naval Research Laboratory method.

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NAVAL RESEARCH LABORATORY METHOD
(NRL method)

NRL method was developed by **H.F. Bishop** and **his team** at Naval Research Laboratory (US Navy), during 1955.

In their method, the Caine's freezing ratio was replaced by a '**Shape Factor**' for the casting section to be fed.

Naval Research Laboratory method was developed by H.F. Bishop and his team at the Naval Research Laboratory US navy during 1955. In their method the Caine's freezing ratio was replaced by a shape factor for the casting section to be fed. So, wherever we see freezing ratio in the Caine's method that freezing ratio was replaced by a factor called 'Shape Factor'.

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NAVAL RESEARCH LABORATORY METHOD
(NRL method)

The shape factor was defined by them as follows.

$$\text{Shape factor, SF} = \frac{(L + W)}{T}$$

Where,

- L denotes the length
- W denotes the width
- T denotes the thickness

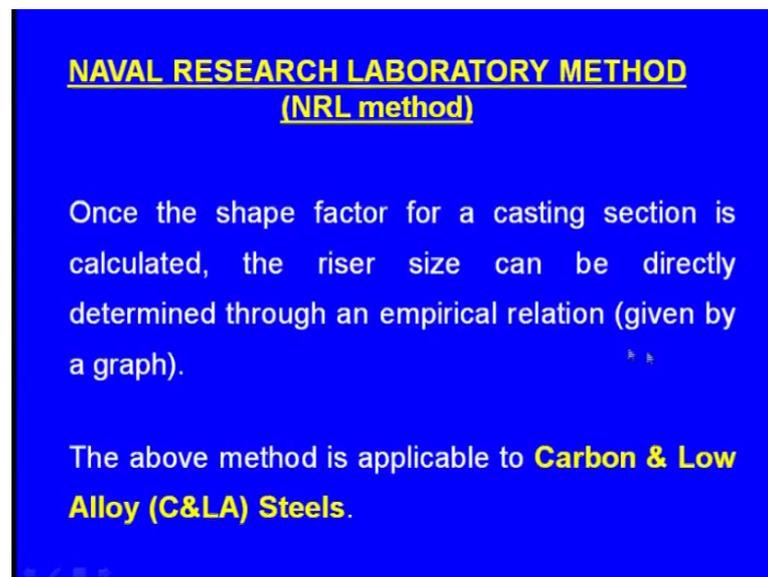
(Note: $L > W > T$)

Now what is this Shape Factor we will see the shape factor was defined by Bishop and his team as follows. Shape factor that is what say abbreviated as SF is equal to L plus W

divided by T, where L denotes the length of the section that is to be fed, W denotes the width of the section that is to be fed, and T denotes the thickness of the section that is to be fed. Now there is a class L should be greater than W and W should be greater than T. So, this is how Bishop and his team have developed the shape factor in their Naval Research Laboratory method.

Now how to design the Riser using this shape factor?

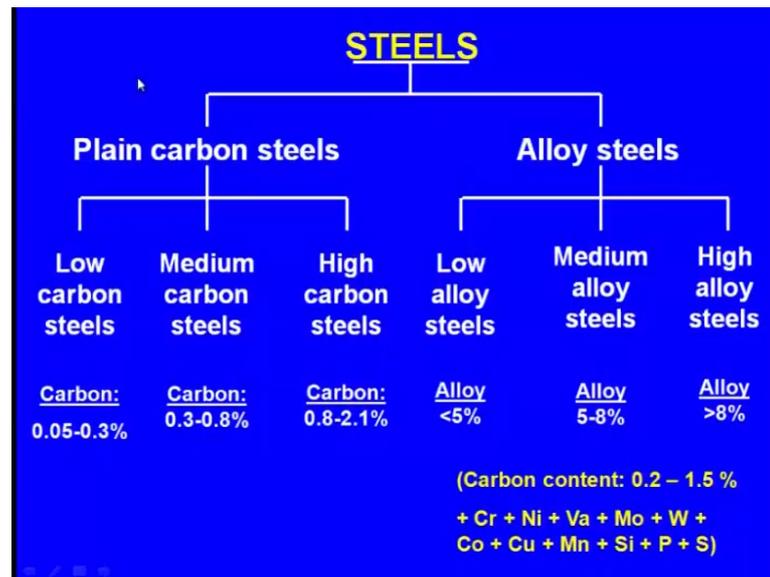
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Once the shape factor for a casting section is calculated, the riser size can be directly determined through an empirical relation given by a graph. So, here the calculation is very minimum whereas in the case of the Caine's method, the calculation was too much. Similarly in the modulus method there was considerable calculation and here there is minimum calculation. Most of the results we can obtain through the graph. Only thing is the above method is applicable to Carbon and Low Alloy Steels. It is abbreviated as CLA.

Now let us quickly review; what are these carbon and low alloy steels before going further. Now the steels can be broadly classified as Plain carbon steels and the Alloy steels. In the plain carbon steels no doubt, both in the plain carbon steels and the alloy steels iron is the base element.

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But in the case of the Plain carbon steels, Carbon is the major alloying element. There will be other alloying elements also like manganese, phosphorus, sulfur. So, apart what say considered to all these carbon is the main alloying element. Whereas, in the alloy steels here also the base element is the iron, now carbon is also present but carbon is not the main alloying element. There will be other elements will be there like Chromium, Nickel, Vanadium, Molybdenum, Tungsten, Cobalt, Copper, Manganese, Silicon, Phosphor, sulfur so this will be the dominating compared to the carbon.

Now again these plain carbon steels are sub classified as the low carbon steels, medium carbon steels and the high carbon steels. When the carbon content is between 0.05 to 0.3 percent, then it is the low carbon steel. When the carbon content is between 0.3 to 0.8 percent then it is the medium carbon steel. When the carbon content is 0.8 to 2.1 percent then it is the high carbon steel. Once the carbon content is more than 2.1 percent, then it is the cast iron, it is not the steel.

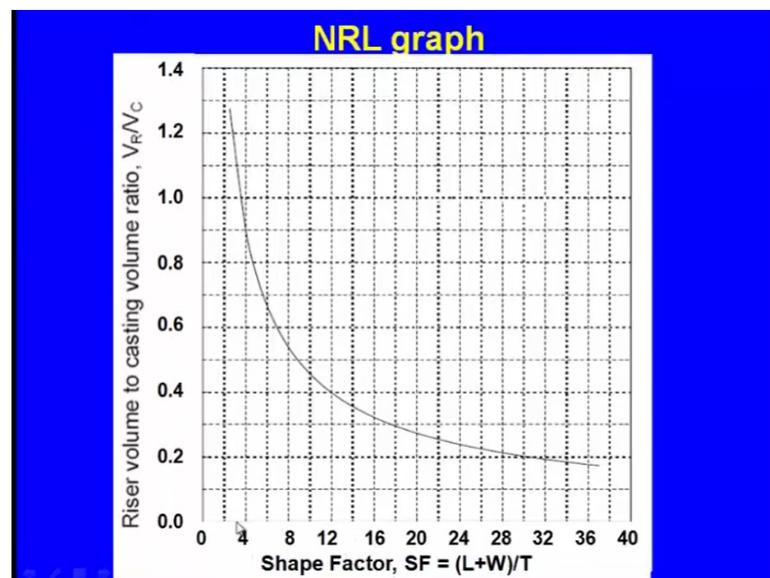
Now let us see these alloy steels, so as I have already told you the alloy steels means Carbon is present, but carbon is not the main alloying element, it is not the major alloying element.

And here other elements are present like chromium, nickel, vanadium, molybdenum, tungsten and so on. Now all these elements together if their proportion is less than 5 percent then it is known as the Low alloy steels. Now all these elements together if they range between 5 to 8 percent then they are known as the Medium alloy steels. Now all

these alloys together if their proportion is more than 8 percent, then they are known as the High alloy steels.

So, this is what say classification of the steels. So broadly they are classified as the Plain carbon steels or simply sometimes they are also known as the Carbon steels and the Alloy steels. Now the Naval Research Laboratory method is applicable only to carbon steels and low alloy steels. Carbon steels means so these are the carbon steels. So, this naval research laboratory method is applicable for all these carbon steels and also for the low alloy steels. Now they have provided a graph.

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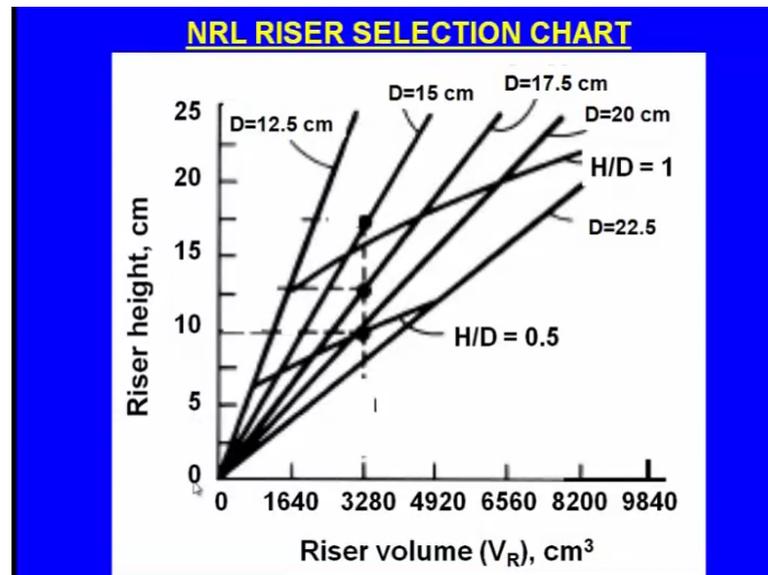
Now on this graph what is available, let us see this is the x axis, on the x axis they have plotted the shape factor, shape factor means L plus W divided by T.

Now, on the y axis let us see Riser volume to casting volume ratio. Ratio of riser volume to casting volume means V_R is the riser volume and V_C is the casting volume, ratio of V_R and V_C is plotted on the y axis. Now using the formula given to us for the shape factor initially we have to what say calculate the shape factor. Now based on the x axis we will see; what is the shape factor accordingly. So now this is the curve; now where it is what say cutting from here we will calculate the riser volume to casting volume ratio.

Once we know the raiser volume to casting volume ratio we can find out the what; say a riser volume because casting volume we always know we can always find out the casting

volume. So, from this we can find out the riser volume, once we know the riser volume we can also find out its dimensions so that is the simple approach suggested by the Bishop and his team in their Naval Research Laboratory method.

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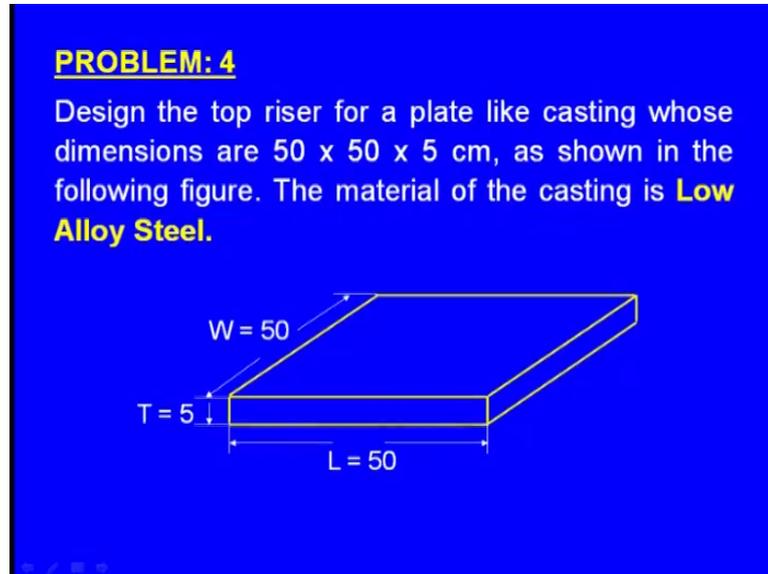


Now they have also what say furnished one more graph. What is this? From this previous graph we can find out the yes Riser volume to casting volume ratio. After finding out this Riser volume to casting volume ratio, now here is the next graph. Now this is the riser volume right this is the riser volume and we may get a particular riser volume and from here we have to go up. Now you can see there are 5 lines are there, so this line corresponds to the diameter of the riser is equal to 12.5 centimeter, this line represents the line where the diameter of the riser is 15 centimeters and this line represents where the diameter of the riser is 17.5 centimeters. This line represents where the diameter of the riser is 20 centimeters and this line represents where the diameter is 22.5 centimeters.

Now there is another class, the diameter sorry the height of the riser should be right such that the height to diameter ratio maximum it is equal to 1 and the minimum value of this H by D ratio is 0.5 means we have to select the dimensions of the riser such that the H by D ratio is more than 0.5 and it is less than 1 we should not select the H by D ratio where the H by D ratio is more than 1 or we cannot select the risers dimensions where H by D ratio is less than 1, so this line represents the H by D ratio is 1, so we have to always choose the values below this line. Now if there is another line you see this is the line, so

this line represents H by D is equal to 0.5. So, we should always choose the values above this line. Now let us solve a problem, so with that we can better understand this method.

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Problem: Design the top riser for a plate like a casting whose dimensions are 50 into 50 into 5 centimeters as shown in the figure, the material of the casting is low alloy steel. Now the naval research laboratory method can be applied to plain carbon steels and also to the low alloy steels.

So, since this casting is made up of low alloy steel, we can apply the naval research laboratory method. Now this is the casting, this is the length L that is equal to 50 centimeters, now this is the width that is also equal to 50 centimeters and this is the thickness of the section this is the 5 centimeters.

Now initially we have to find out the shape factor. So this is the length L is equal to 50 centimeters W 50 centimeters t 5 centimeters and shape factor is equal to L plus W divided by T , that is equal to 50 plus 50 whole divided by 5 that is equal to 20. So, the shape factor for this casting is equal to 20. Now this is the first graph provided by the Bishop and his team. Now this is the shape factor initially we got the shape factor as 20, this is the shape factor. Now for the shape factor of 20 what is the volume riser volume to casting volume ratio?

Now this is the shape factor, now this is the graph you see this is the graph. Now a shape factor is 20, now let us draw a line here and the line is cutting the curve here. Now we have to go along the towards the y axis you see here so this value represents the riser volume to casting volume ratio. So, this is a seems to be almost 0.27 means riser volume to casting volume is equal to 0.27.

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PROBLEM: 4
Design the top riser for a plate like casting whose dimensions are 50 x 50 x 5 cm, as shown in the following figure. The material of the casting is **Low Alloy Steel**.

SOLUTION
For a shape factor of 20, ratio of riser volume to casting volume, $V_R / V_C = 0.27$
Casting volume, $V_C = 50 \times 50 \times 5 = 12500 \text{ cm}^3$
Riser volume, $V_R = 12500 \times 0.27 = 3375 \text{ cm}^3$

For a shape factor of 20 ratio of riser volume to casting volume V_R by V_C is equal to 0.27. Now we know the casting volume, casting dimensions are already given those are 50 into 50 into 5 centimeters means volume is equal to 12500 cubic centimeters.

Now, this is the formula V_R by V_C is equal to 0.27. Now in this expression V_C we already know this is the V_C is equal to 12500 cubic centimeters, then V_R is equal to V_C into 0.27 means 12500 into 0.27 that is equal to 3375 cubic centimeters, so this is the riser volume. So, very easily we could obtain the volume of the riser.

Now the next question is what should be its height? What should be its diameter? So, again we will use the second graph given by the Bishop and the team. So, this is the second graph provided by Bishop and the team.

Now initially we have to identify the given volume on the x axis, you see this is the x axis the x axis represents the riser volume you can see here. Now we have obtained the

riser volume as the 3375 cubic centimeters. Now this volume we have to represent on the x axis yes this is the line we have to draw a line vertically parallel to y axis.

Now, this is the line corresponding to the riser volume of 3375 cubic centimeters, now you can see these are all the different lines representing what say different diameters of the risers. This line represents riser diameter 12.5 centimeters, this line represents risers diameter 15 centimeters, this line represents 17.5 centimeters, this line represents 20 centimeters and this line represents risers diameter 22.5 centimeters.

Now, yeah what happens when we are drawing this line upwards, this line is intersecting almost all of these lines. Sometimes it may not intersect some of the lines then we can leave such lines. Now what is happening? It is intersecting this line the diameter where the diameter is 15 centimeters, it is intersecting here. Now the diameter 17.5 centimeters it is intersected here, this is the line 20 centimeters diameter, it is intersected here. Now this is the line diameter 22.5 centimeters, it is intersected here means it has intersected the 4 lines, representing 4 different diameters of the different possible diameters of the riser.

Now, again there is another class the for the diameter the H by D ratio means height to diameter ratio should not be more than 1. Again the H by D ratio height to diameter ratio should not be less than 0.5. So this is the line representing H by D ratio is equal to 1, now this is the line representing H by D ratio 0.5. Now we have to eliminate certain what say diameters as there may be above the H by D ratio 1 or below the H by D ratio 0.5. Let us see now this one you see certainly our what say a line corresponding to riser volume of 3375 cubic centimeters is what say intersecting the 15 centimeters diameter line.

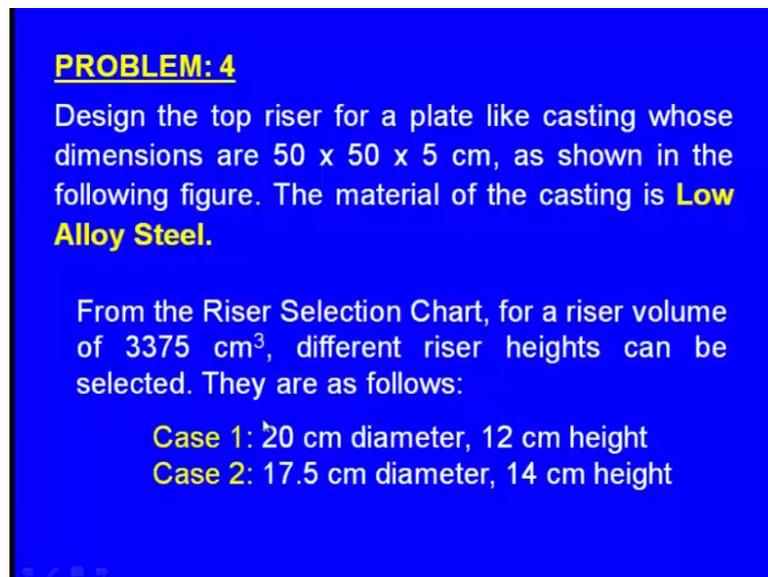
But you see this is that line, but this is above the limit this is the limit say H by D ratio is equal to 1, we should not be take a what say a riser diameter above this means this line we are not choosing. Now what about this 1 this is the line corresponding to 17.5 centimeter, this is that line this diameter is below this limit, so we are keeping. Similarly this is the line representing 20 centimeters diameter, this is also below that line we are keeping we are retaining.

Now, what about this line this line means it is intersecting the what; say a diameter of diameter 22.5 centimeters it is here. But the lower limit is you see this one this is the line which represents the H by D ratio is equal to 0.5. Now this line is intersected by this our

line or below the lower limit. So this line we cannot consider, only this line and this line we have to consider means in one case we get the diameter is equal to 17.5 centimeters and in another case we get diameter is equal to 20 centimeters.

Now, their corresponding heights are given you see the corresponding height is given here means for the diameter 17.5 centimeter the corresponding height is this much. Similarly for the what; say line where the diameter is 20 centimeters, you see here the corresponding height is given here this is the corresponding height.

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PROBLEM: 4

Design the top riser for a plate like casting whose dimensions are 50 x 50 x 5 cm, as shown in the following figure. The material of the casting is **Low Alloy Steel**.

From the Riser Selection Chart, for a riser volume of 3375 cm³, different riser heights can be selected. They are as follows:

- Case 1:** 20 cm diameter, 12 cm height
- Case 2:** 17.5 cm diameter, 14 cm height

Now we are getting the 2 cases, in one case the diameter of the riser is 20 centimeters and the corresponding height is 12 centimeters, you can see here yes 20 centimeters and this is the 12 centimeters, height is 12 centimeters. And in the case 2, the diameter is 17.5 centimeters and the corresponding height is 14 centimeters, we can choose as per our convenience. As per the height of the moulding box we can choose any of these 2 both will be equally effective. Now these are the advantages of the NRL method.

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ADVANTAGES OF NRL METHOD

1. The freezing ratio as in the case of **Caine's method** doesn't come into picture.
2. The surface area of the casting need not be calculated, as in the case of **modulus method**.
3. Most of the results can be obtained from the graphs. Very less calculation.
4. The riser dimensions can be selected in different combinations of diameters and heights, as per the convenience (**H/D = 0.5 to 1**).

NRL method means naval research laboratory method. The freezing ratio as in the case of the Caine's method doesn't come into picture. The freezing ratio calculation of the freezing ratio in the Caine's method was very complex lot of time has to be invested so that freezing ratio doesn't come into picture in this naval research laboratory method.

Next one in what say both in the Caine's method and also in the modulus method. The surface area of the casting has to be found out, again if it is a simple casting say most of the times for the sake of the solving problems we are taking very simple shapes like a rectangular block or a cylinder.

But in practice right what is happening? The surface area of what say casting will be very complex, it is very difficult to calculate the surface area of the casting because of the complex features.

Now, even in such case even the modulus method would be difficult to solve the problem whereas, that is why the surface area of the casting need not be calculated in the case of the naval research laboratory method as a which is a problem which is the drawback even in the case of the modulus method.

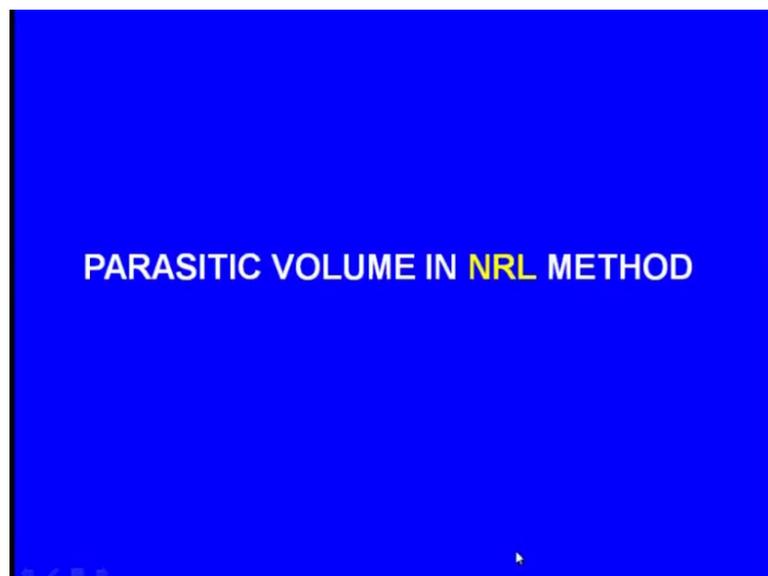
Next one most of the results can be obtained from the graphs. From the graphs, we are directly obtaining the values we are not making any calculation except in the case of the calculating the shape factor.

So, very less calculation, calculation comes into picture only when we are calculating the shape factor. Otherwise, all the values of the diameter and the heights they can be interpreted directly from the graphs. And the riser dimensions can be selected in different combinations of diameters and heights as per the convenience. So, there are 2 limits are there one line is there you can see here yes one line is here, this is the line where the H by D ratio is equal to 1, this is the line and there is one more line where H by D ratio is equal to 0.5. Now between these 2 limits we can select any riser with different what say diameters and heights so that is the flexibility of this method.

So there is a flexibility for the dimensions in the naval research laboratory method. Now these are the limitations of the NRL method. What is the limitation? This method can be applied only to carbon and low alloy steels, and what about the medium alloy steels, what about the high alloy steels, this method cannot be applied to such alloys only for carbon and low alloy steels.

Next one there is another feature in the NRL method. The NRL method the team right comprising Bishop and his team they have what say considered all possible cases of the castings.

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So, they have brought one concept called the Parasitic Volume in the NRL method. What is this parasitic volume? Let us see this casting. So this casting seems to be a simple casting right it has got the length and it has got the width and it has got the thickness it is

a simple plate like casting, only thing is it has got a an additional what say element is there on one side it is a what say cylindrical addition is there, otherwise it is a simple casting. Now how to solve this problem?

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PARASITIC VOLUME IN NRL METHOD



Initially, this parasitic volume is to be neglected and the **Shape Factor** is to be found out.

Accordingly, riser volume is to be found out.

Final riser volume = Riser volume (without parasitic volume) + 30% of parasitic volume.

So, if this element is not there straight away we can use the shape factor formula L plus W divided by T , we can obtain the shape factor and from the shape factor we can obtain the riser volume and from the second graph we can obtain the diameters and heights of the different combinations of the risers.

But because of this element, now we are unable to progress with the shape factor formula. In such case how to solve the problem? So, this additional volume is known as the 'Parasitic Volume'. You see this additional volume is known as the Parasitic Volume.

Now how to proceed further? How to calculate the shape factor? Initially this parasitic volume is to be neglected and the shape factor is to be found out means, let us assume this element is not present. Then there is it is what say a well defined casting, there is a length, there is a width, and there is thickness we can very well find out the shape factor using the formula L plus W divided by T .

Accordingly, right the shape factor is to be found out and accordingly even the riser volume is to be found out. From the first graph of the Bishop and his team we can find out the riser volume. Now we need to make some modification, because it is not what the

shape factor that we have calculated is not the actual shape factor. Because this element is present so a shape factor will be something different that we do not know. Again right the riser volume, we have neglected this neglecting this element. We have calculated the riser volume again that is not correct it needs more riser volume.

So, what is the final riser volume? Final riser volume is equal to Riser volume without parasitic volume plus 30 percent of the parasitic volume means what we have to do? Initially, we have to neglect ignore this element and calculate the shape factor from the shape factor calculate the riser volume. Then before what say getting the heights and diameters of the risers then we have to add this what; say a extra volume for this element right extra riser volume.

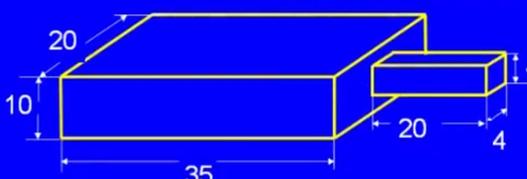
So, what is the extra riser volume that is the 30 percent of the parasitic volume. Then that is the final riser volume. So, based on this final riser volume we have to obtain the diameters and heights of the different combinations of the risers. Now let us solve a problem. Design a riser for the casting shown in the following figure.

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PROBLEM: 5

Design a riser for the casting shown in the following figure.

All dimensions in cm



SOLUTION:

Shape factor = $(L + W) / T = (35 + 20) / 10 = 5.5$

From NRL graph, ratio of riser volume to casting volume is to be found out.

Now you see this is a what; say a well defined casting there is a length that is 35 centimeters. Now there is a width it is 20 centimeters, now this is the thickness is 10 centimeters. Now but here there is a parasitic element is there. Now the parasitic element is what; say a rectangular one and length is 20 centimeters, width is what say 4 centimeters and the thickness is 4 centimeters.

Now how to calculate the shape factor and how to calculate the riser volume and how to calculate the heights and diameters of the risers. Now initially we will be ignoring this element we will be neglecting this element and we will consider only this part, the main part which is a well defined part and it has got the a length width and thickness. Now the shape factor is equal to $L + W$ divided by T , that is equal to length is 35 centimeters, width is 20 centimeters and thickness is 10 centimeters, $35 + 20$ whole divided by 10 so that is equal to 5.5, so the shape factors for this casting for this portion is 5.5.

Now from the NRL graph ratio of riser volume to casting volume is to be found out. Now this is the NRL graph, now this is the x axis represents the shape factor, y axis represents the riser volume to casting volume ratio. Now we have seen that the shape factor is yes 5.5 shape factor is. So for a shape factor of 5.5, what is the riser volume we need to find out, yes this is the 5.5.

So, let us draw a line and let us go upwards like this. Let us go upwards and this is the graph, this is the curve given by the Bishop and his team this is the curve. Now the line from this shape factor is going and touching our curve here. Now this let us come horizontally, now this point indicates the riser volume to casting volume ratio right, so this is point 7. So, ratio of riser volume to casting volume V_R by V_C is equal to 0.7, now in this expression V_C means volume of the casting, V_R means volume of the riser. Volume of the casting we know $35 \times 25 \times 10$; that is equal to 700 cubic centimeters.

Now, V_R means volume of the riser is equal to V_C into 0.7 or 0.7 into casting volume, so that is equal to 4900 cubic centimeters. Now remember that this is the riser volume we have obtained, when we have neglected this element. But if this elemental is also coming into picture actually that has to be considered. If we consider this also this element also then their riser requires more liquid metal then only it can feed this portion also. Now what is that extra liquid what say metal to be added to this riser volume. Volume of the parasitic element is equal to parasitic element is this one, $20 \times 4 \times 4$ that is equal to 320 cubic centimeters.

Now, the total volume of the riser is equal to volume of the riser without considering the parasitic element plus 30 percent of the volume of the parasitic element means 4900 cubic centimeter is the volume of the riser when we have neglected this portion. Now we are calculating the total volume so $4900 + 0.3 \times 320$ that is equal to 4996 cubic

centimeters. So, this is the total volume of the riser, after we consider this parasitic element.

Now we obtain the total final riser volume. Now we have to find out what say a diameter and the height of the different combinations of the risers. Now this is the line corresponding to the riser volume of 4996 cubic centimeters, now from here let us draw a line upwards yes like this. Let us draw, now what is happening? These are all the different lines indicating the different diameters right this line represents 12.5 centimeters diameter, this line represents 15 centimeters diameter, this line 17.5, this line represents 20 centimeters and this line represents 22.5 centimeters.

Now, our line is going and intersecting I think 4 lines, this line 15 centimeter, 17.5, 20 and 22.5 centimeters diameters, it is intersecting right. So, wherever it is intersecting let us draw the horizontal lines, so 15 centimeters diameter line is intersected here. So let us draw a line so this is the corresponding height for the 15 centimeters diameter. Now this is the line representing 17.5 centimeters. Now our line this riser line volume line has intersected here.

So, here let us draw the horizontal line so this indicates the riser height for a diameter of 17.5 centimeters. Next one the line representing 20 centimeters diameter is intersected here. Let us draw a line now this is the volume, height this is the height representing the volume say diameter of 20 centimeters right again this is the line representing diameter 22.5 centimeters right. So, here it is intersected let us draw a line this represents the height of the riser with the diameter 22.5 centimeters.

Now there is another class, the height to diameter ratio should not be more than 1. Again the height to diameter ratio should not be less than 1, now in this case you can see we got the 4 lines or the 4 heights or the 4 diameters. Let us see this one, this is say this line represents H by D ratio 0.5, height to diameter ratio 0.5 and this line represents H by D ratio or height to diameter ratio 1. Now this what; say a line where the diameter is 22.5 centimeters and height is this much is above the minimum limit. So we can accept this.

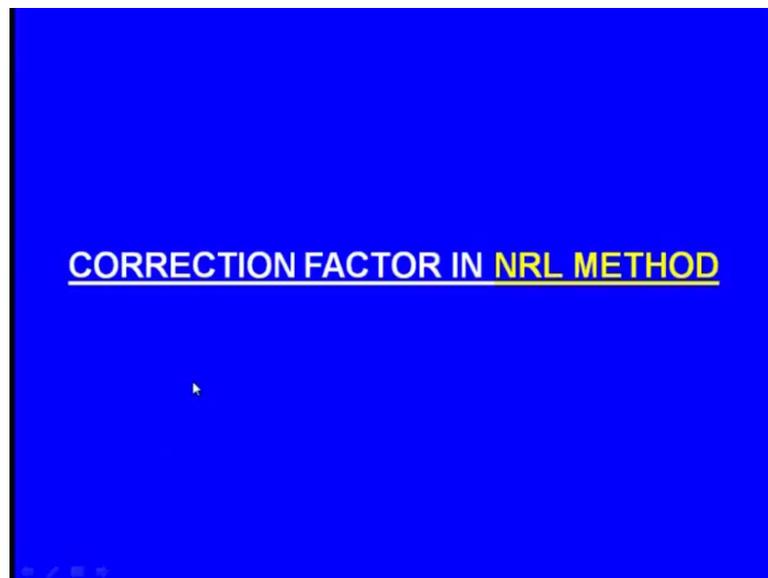
Next one let us see this one, this is the line where the diameter is 20 and the height is this much so we can consider this. Because it is between the limits next what about this one you can see this one this what; say this line corresponds to the diameter of 17.5 centimeters and height is this much close to 19 centimeters. But what is the problem with

this line, this is above the upper limit, see this is the upper limit H by D ratio is equal to 1, but this is above the upper limit means H by D ratio will be more than 1.

So, this we cannot take this we have to drop. Next one let us see this one this point, so this line represents where the diameter is 15 centimeters and what is the height, height is 25 centimeters. But what is the problem it is above the upper limit, so right this is the upper limit, this is the upper limit and for this what say a diameter and for this height the H by D ratio will be more than 1. So, this height and this height we have to drop we are considering only this one and this one only 2 diameters we are considering.

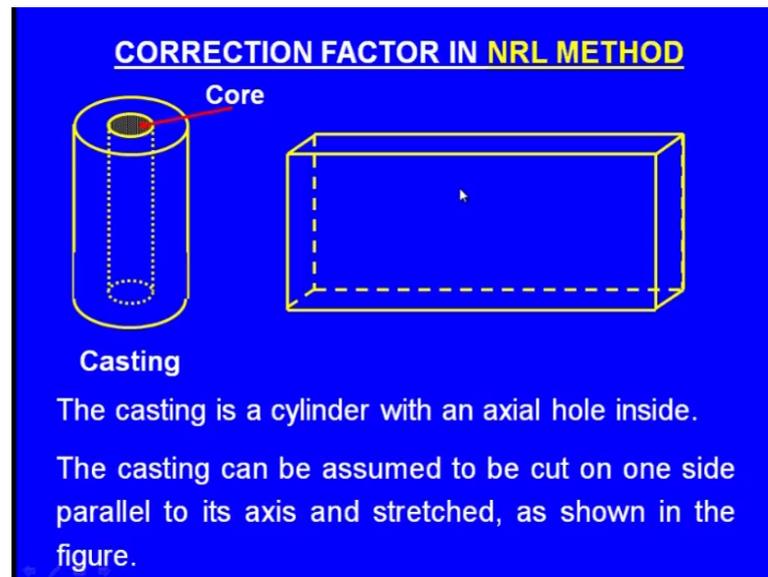
So, what is the result you can see here case one we are getting 2 cases, in first case the diameter can be 22.5 centimeters and the corresponding height is 12 centimeters and in another case the diameter will be 20 centimeters and the corresponding height will be 16 centimeters. So, any we can use based on our what; say a requirement and based on the height of the moulding boxes we can take any of these 2, according to our convenience. Next one there is another feature in the NRL method that is the correction factor.

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What is this Correction Factor?

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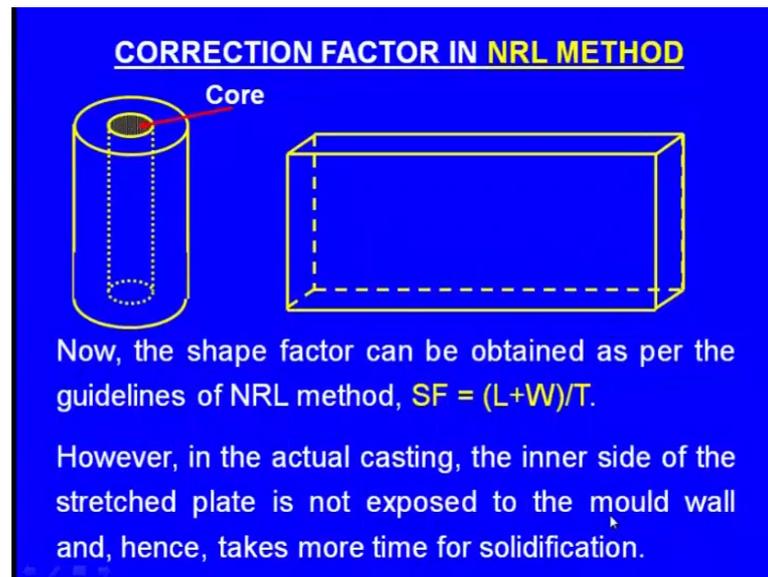


Now, let us consider this casting this is a cylindrical casting inside there is a what say hole is there an axial hole is there from top to bottom. So, let us assume this path is made by a casting this is the casting. Now what is happening is how to calculate the shape factor for this casting. Certainly, say what is shape factor? Shape factor is L plus W divided by T , where L is the length, W is the width and T is the thickness. Now how to calculate the shape factor for this casting it is very difficult to arrive at the shape factor with the formula L plus W divided by T .

But one thing we can do we can assume that it is cut along what say here on the what; say a circumference right on the side parallel to the radius, parallel to the axis, parallel to the axis, it is cut and it is stretched. Now what is happening, it can be considered like a casting like this, if it is stretched of course one side the length will be more and on the other side the length will be less. But if we consider the average length then it will be a like a again it will come to be a plate like casting.

Now, you can see here this has got the length, this has got the width and this has got the thickness. Now we can go ahead with our shape factor formula L plus W divided by T . So what we have done here we have assumed that the casting is cut on the side parallel to the axis, then it is stretched, then we will get a plate like casting. The casting is a cylinder with an axial hole you see the casting can be assumed to be cut on one side parallel to its axis and stretched as shown in the figure.

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Now the shape factor can be obtained as per the guidelines of the NRL method. What are the NRL method guidelines? Shape factor is equal to L plus W divided by 2; however in the actual casting what is happening? The inner side of this stretched plate is not exposed to the mould wall and hence takes more time per solidification.

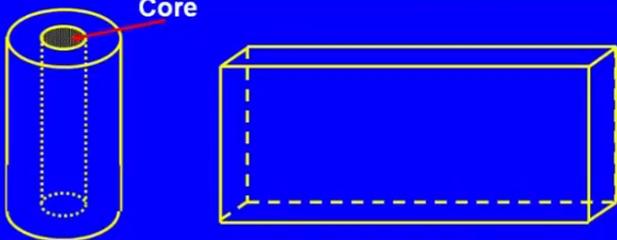
Now if this is the actual casting, now this whole thing will be inside the mould. Now the outer portion is more exposed to the mould wall whereas, this inner side is less exposed to the mould wall and it is what say heat dissipation is minimum. Whereas, on the outer portion the heat dissipation is maximum, but we are modifying in our assumption we are thinking that it is cut and it is stretched and it is made like a plate like casting that be the case you see. Then all the 6 sides are equally exposed to the moulding wall so that be the case it takes a less time for the solidification. But actually what is happening, the actual casting is this one. In this case what is happening the inner side means the other side is the inner side or the other side of the stretched casting is less exposed heat dissipation is very minimum. Then that what happens that be the case it takes more time for solidification, if it takes more time for solidification the volume of the riser should be more.

But what happened here in our assumption we have assumed the casting to be a plate like casting, where all the 6 faces are equally exposed to the moulding wall. Accordingly it takes a particular what say solidification time and requires a certain volume of the riser,

but actually because it has got a core. Because the inner portion is not exposed to the moulding wall it requires more time for solidification, then that be the case. It requires more volume of the riser then here is the error we have arrived at the error.

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CORRECTION FACTOR IN NRL METHOD



Accordingly, riser volume should be more.
Hence, a correction factor is required while calculating the shape factor for such cases.

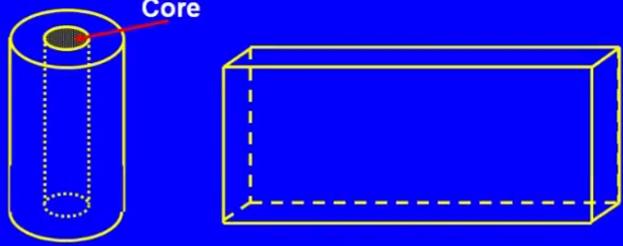
Corrected shape factor = $(L + W) / k T$

Where, **k** is the correction factor.

So, we need the correction so that is why we have to incorporate the correction factor. Accordingly hence a correction factor is required while calculating the shape factor for such cases. Now where is the a correction factor you see corrected shape factor is equal to L plus W divided by k T, where L is the length of the section, W is the width of the section, k is a correction factor and again T is the thickness of the section of the casting, k is the correction factor. Again so the k depends upon the diameter of the core and also the thickness of the section to be fed.

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CORRECTION FACTOR IN NRL METHOD



The correction factor in different cases is given below.

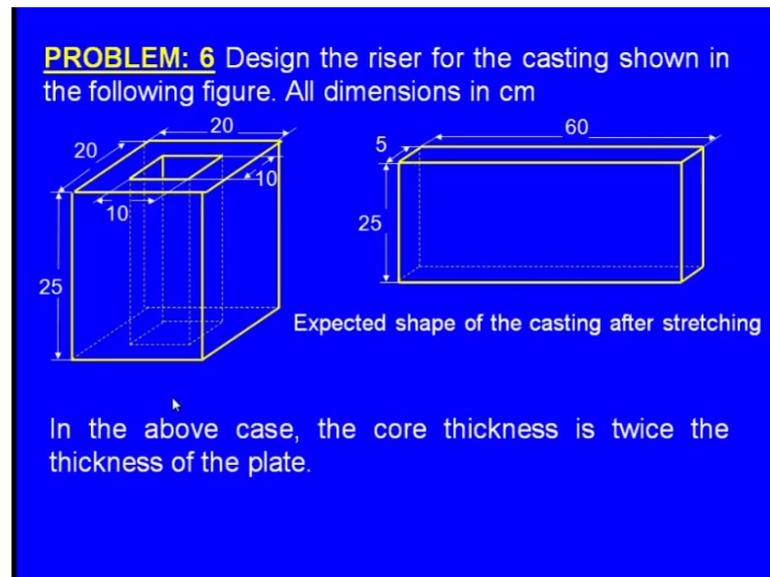
Core diameter (Or thickness)	0.5 T	T	2T	4T
Correction factor, k	1.17	1.14	1.02	1.00

How to decide this k value? Now you see here when the thickness of the what; say a section when the what; say thickness of the what; say core diameter is 0.5 times the thickness of the casting, then the correction factor is 1.17. When the thickness of the core is equal to section thickness then the correction factor is 1.14, when the core diameter is double the thickness of the section to be fed then the correction factor is 1.02.

When the core diameter is 4 times the thickness of the section to be fed, then the correction factor k is equal to 1. So we can see there are 4 cases in one case the core diameter is 0.5 times; the thickness of the section. In the second case the what; say core diameter are the thickness of the what; say a core is equal to thickness of the section. In the third case the core diameter or the core thickness is double the thickness of the section. And in the fourth case the core diameter or the thickness of the diameter is 4 times the thickness of the section. Accordingly we have the 4 correction factors, 1.17 in the first case, 1.14 in the second case, 1.02 in the third case and 1 in the fourth case.

Now, let us solve another problem. Design the riser for the casting shown in the following figure and all the dimensions are in centimeters.

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We can see this is a what say a rectangular or what say cubed like casting right, but only thing is inside there is a hole, rectangular hole is there, the height of the casting is 25 centimeters, the width of the casting is here this is 20 centimeters. Again you can see this dimension this is also a 20 centimeters and inside there is an axial hole is there and the what; say shape of the hole is what say square hole; square shaped hole is there and what is the dimensions here it is the side of the hole is 10 centimeters and here also a 10 centimeters. The line is from top to bottom.

Now we need to find out the dimensions of the riser for this casting. Now how to proceed further, how to calculate the shape factor using the NRL method. Now first of all we have to assume that we are cutting this casting on a side you cut here on the side vertically parallel to the axis and stretch it then what happens it becomes like a plate like casting. Now what will be what say a length if we stretch like this, so you can see there are 4 sides are there and one side it will be 80 centimeters length will be there. On the other side right may be the length will be here you can see this is 10, 40 centimeters.

But if we take what say average 80 is one side, 40 is the other side and if we take the average the length will be 60 centimeters. And what will be what say height of this section, now you can see whatever is height here, this is 25 centimeters and here also we are getting 25 centimeters. Now what about the thickness you can see here, here the thickness is so here you can see this is 10 centimeters and this whole thing is 20

centimeter means this is 5 centimeters and this is 5 centimeters, so the thickness is 5 centimeters. So, this is our imaginary casting.

After we assume that the casting is cut on one side parallel to the axis and stretched. So, this is the expected shape of the casting after stretching right. So, in the above case the core thickness is twice the thickness of the plate what is the thickness of the plate you see 5 centimeters, but this is the core, core has got the dimension 10 into 10 into say 25 centimeters that is the dimension of the core.

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The correction factor in different cases is given below.

Core diameter (Or thickness)	0.5 T	T	2T	4T
Correction factor, k	1.17	1.14	1.02	1.00

Now what is the relation the core thickness is 10 centimeters it is twice the thickness of the casting is it not that be the case you see what is the correction factor when the core thickness is twice the thickness so this is the correction factor 1.02.

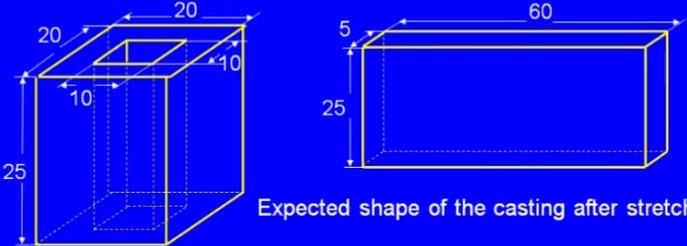
So, the correction factor is 1.02. Now the corrected shape factor SF is equal to L plus W divided by $k T$. Now length is 60 centimeters you can see this is the 60 centimeters and width is this is the 25 centimeters this much 25 divided by k , K is 1.02 and T is the 5 centimeters. So, that is equal to 16.67; so this is the corrected shape factor for this casting. Now this is the what; say a graph which gives us the riser volume to casting volume.

Now, what say shape factor is 16.67; now let us draw the line at 16.67, so this is the line here this is 16.67. Let us draw a line upwards such that it touches the graph our curve.

Now from here let us draw what say a line parallel to x axis and such that it touches the y axis you see here now this point indicates the riser volume to casting volume that is the V_R by V_C that is equal to this is 0.3 from the graph. So, ratio of riser volume to casting volume V_R by V_C is equal to 0.3.

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PROBLEM: 6 Design the riser for the casting shown in the following figure. All dimensions in cm



Ratio of riser volume to casting volume, $V_R / V_C = 0.3$
 Casting volume, $V_C = 60 \times 25 \times 5 = 7500 \text{ cm}^3$
 Riser volume, $V_R = 0.3 \times V_C = 0.3 \times 7500 = 2250 \text{ cm}^3$

Now in this expression V_C we know, what is the V_C casting volume that is 60 into 25 into 5 that is equal to 7500 cubic centimeters? Now from this; what is the riser volume, riser volume is equal to 0.3 into V_C that is equal to 0.3 into 7500 that is equal to 2250 cubic centimeters. So, this is the riser volume.

Now, this is the riser selection chart. Now we have the 5 lines are there representing 5 diameters. Now first we have to draw a line corresponding to 2250 cubic centimeters. So, this is the riser volume just now we have obtained. So, let us this is that point.

So, let us draw a line from at the what; say raiser volume of 2250. Let us draw a line and take it upwards like this, like this. Let us take it and it is what say intersecting all the 5 lines representing 5 diameters.

It is the intersecting the line of the diameter 22.5 centimeters here and this is the corresponding height. Now our line is intersecting at the line showing the corresponding to 20 centimeters diameter of the riser and this is that point, now this is the corresponding height. Again our line is intersecting with the line corresponding to 17.5

centimeters here. Now you draw a line horizontally, this indicates the corresponding height again this line is intersecting the line corresponding to 15 centimeters diameter riser here draw a line horizontal this indicates the corresponding height.

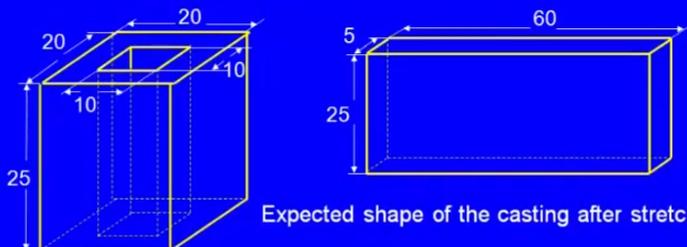
Again our line is intersecting the diameter line showing the corresponding to diameter 12.5 centimeters here, you draw a line here. Again there is a class the height to diameter ratio should not be more than 1, the height to diameter ratio should not be less than 0.5. Now let us see the first 2 cases here, so this is the line representing the H by D ratio 0.5 and this is the line indicating the H by D ratio is equal to 1. Now in the first 2 cases with the diameter 22.5 and the diameter 20 those are falling the H by D ratio is equal to we write 0.5. So, these are to be dropped out.

Next one, the third one where the diameter is 17.5, it is within the range. So, this we will retain next one fourth one that is also within the range. Next one, fifth one let us see yes the diameter is 12.5 centimeters but it is above what say upper limit H by D ratio is equal to 1. So, this is our upper limit and this line or this height or this diameter is above the upper limit again we have to drop it.

So, finally we are selecting only 2 cases. Now what is the result?

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PROBLEM: 6 Design the riser for the casting shown in the following figure. All dimensions in cm



Expected shape of the casting after stretching

From the riser selection chart, for a riser volume of 2250 cm^3 , different riser heights available are as follows:

- Case 1: 17.5 cm diameter, 10 cm height
- Case 2: 15 cm diameter, 12.5 cm height

So, from the riser selection chart right for a volume of 2200 and 50 cubic centimeters different riser heights available are as follows. Case 1: The diameter of the riser can be

17.5 centimeters and the height is 10 centimeters. And in the next case the diameter can be 15 centimeters and the height will be 12.5 centimeters. We will continue more problems in the next class.

Thank you.