Metal Casting
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Module – 02
Sand Casting Process
Lecture – 12
Design Of Risering System-IV

Good morning friends, in the previous classes we have learned how to design the riser using the Caine's method modulus method and the NRL method.

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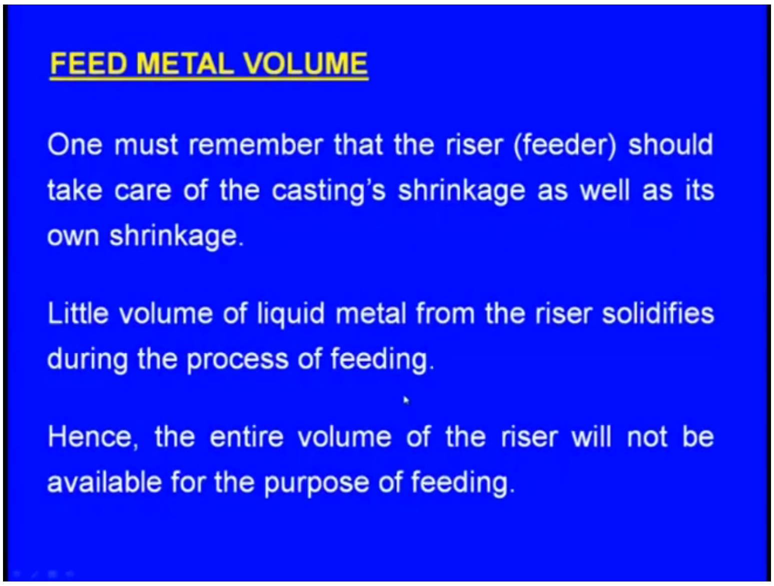

Now, let us see another topic today that is the feed metal volume. What is this feed metal volume? Right one must remember that the riser or the feeder should take care of the castings shrinkage as well as it is own shrinkage. Because during the solidification casting undergoes shrinkage and the riser also undergoes to shrinkage. So, the riser has to take care of the castings shrinkage as well as it is own shrinkage.

Now little volume of the liquid metal from the riser solidifies during the process of the feeding. Hence the entire volume of the riser will not be available for the purpose of the feeding. So, this is clear right. So, if we are designing a riser with a particular amount of volume of the liquid metal, this entire liquid metal will not be available for the purpose of the feeding because part of that will be freezing before it could. What say feed the casting.

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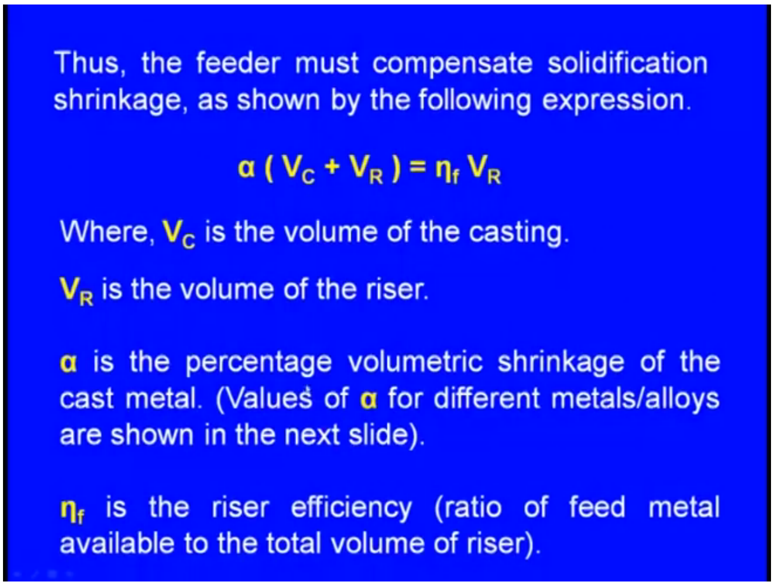

Thus a feeder must compensate solidification shrinkage as shown by the following expression.

Alpha into V c plus V R is equal to eta f into V R, where V c is the volume of the casting V R is the volume of the riser; alpha is the percentage volumetric shrinkage of the cast metal. So, different what say shrinkages for different metals we will be seeing in the next slide. Now eta f is the riser efficiency which is defined as the ratio of feed metal available to the total volume of the riser. So, that is the definition for the riser efficiency.

Here we can see alpha into V c plus V R is equal to eta f into V R. Here we can see this is the volume of the casting and this is volume of the riser. This is multiplied by the percentage volumetric shrinkage, means this is the total shrinkage of the casting as well as that of the riser. Now this total shrinkage is to be compensated by the riser. Now what is the riser, this is this is eta means this is the riser efficiency multiplied by the volume of the riser gives us the amount of liquid metal that is available for the purpose of feeding the casting as well as the riser.

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% Volumetric shrinkages of important cast metals

S.No	Metal or alloy	% Vol. shrinkage
1	Pure aluminum	6.6
2	Aluminum-12 % Si alloy	3.8
3	Aluminum-4.5 % Cu alloy	6.3
4	Grey cast iron	0 to1.8
5	White iron	4 to 5.5
6	Plain carbon steels	2.5 to 4
7	Copper	4.5
8	Tin bronze	5.5
9	Aluminum bronze	4.0
10	Magnesium	4.2
11	Zinc	6.5
12	Lead	3.2
13	Gold	5.5

Now, these are the volumetric shrinkages of different cast metals. Pure Aluminum volumetric shrinkage is 6.6 percent, Aluminum 12 percent Silicon alloy and the volumetric shrinkage is 3.8 percent, Aluminum 4.5 percent copper alloy and the volumetric shrinkage is 6.3 percent, Gray cast iron 0 to 1.8 percent, White cast iron 4 to 5 per 5.5 percent, Plain carbon steels 2 to 2.5 to 4 percent, Copper the volumetric shrinkage is 4.5 percent, Tin bronze the volumetric shrinkage is 5.5 percent, Aluminum bronze the volumetric shrinkage is 4 percent, Magnesium the volumetric shrinkage is 4.2 percent, Zinc and it is volumetric shrinkage is 6.5 percent, Lead and it is volumetric shrinkage is 3.2 percent, Gold and it is volumetric shrinkage is 5.5 percent. So, these are the values of alpha the volumetric shrinkage is different cast metals or alloys.

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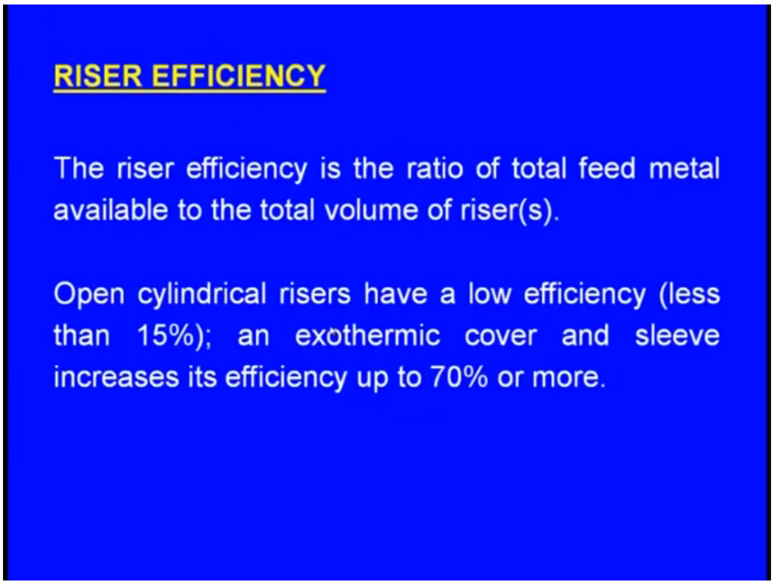

Now let us see another definition that is the riser efficiency. What is this riser efficiency? The riser efficiency is the ratio of the total feed metal available to the total volume of the riser. So, this total feed metal available for the purpose of feeding is always less than the total volume of the riser. Because part of the liquid metal in the riser solidifies before it could be it could feed the casting that is why this feed metal volume is always less than the total volume of the casting.

So, open cylindrical risers have a low efficiency less than 15 percent whereas, a cylin what say riser with an exothermic cover and sleeve it is what say riser efficiency will be more than 70 percent.

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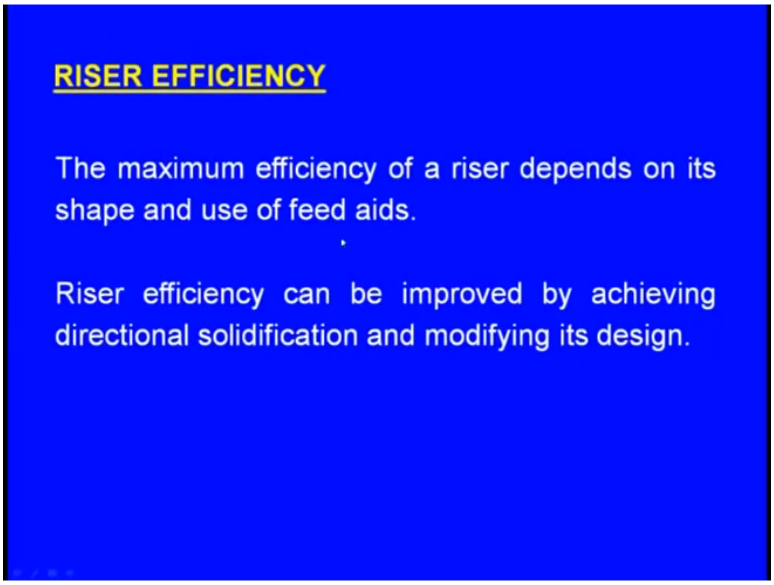

The maximum efficiency of a riser depends on it is shape and use of the feed aids. What is it is a shape? And what are the feed aids? Are we using any aids first of all what are these feed aids we are going to see very shortly these feed aids.

Next one riser efficiency can be improved by achieving directional solidification and modifying it is design what is this directional solidification.

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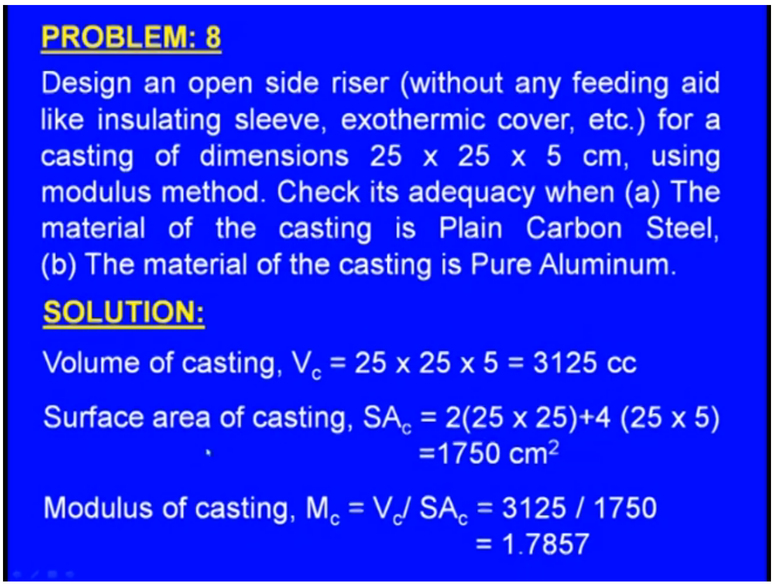

Let us, quickly review before that let us take a problem. Design an open side riser without any feeding it like insulating sleeve, exothermic cover, etcetera for a casting of dimensions 25 into 25 into 5 centimeters using modulus methods. Check it is adequacy when a, the material of the casting is plain carbon steel and in the second case the material of the casting is Pure Aluminum, means we have to design the riser for this simple casting whose what say length is 25 centimeters width is 25 centimeters and the thickness is 5 centimeters using modulus method.

The methods that we have learnt in the modulus method and the NRL method that is the main guideline right, afterwards we need to check whether what we have designed is correct or not. What we have designed is sufficient or not because different cast metals have different shrinkages. Unfortunately in the modulus method and also in the NRL method the material of the casting are the what say percentage shrinkage percentage volumetric shrinkage does not come into picture. Only the caines method takes care of the material of the casting. That's why when we are designing using what say modulus method or NRL method we need to cross check whether what we have designed is sufficient or not. So, that is the adequacy check it is adequacy means it will it be a sufficient or not.

Solution now volume of the casting V c is equal to 25 into 25 into 5 into 5 centimeters. That is equal to 3125 cubic centimeters. Surface area of the casting is equal to 25 into 25 such phases are 2 multiplied 2 plus 4 into 25 into 25. These faces are there are four such faces. So, we are multiplying by 4 that is equal to 1750 square centimeters. So, this is the surface area of the casting.

Now, modulus of the casting, what is the modulus? Ratio of the volume to the surface area. So, V c by SA c is what say here c stands for the casting. That is equal to 3125 divided by 1750. Thus, the modulus of the casting is equal to 1.7857. So, this is the modulus of the castings. Next one now we need to find out the modulus of the riser.

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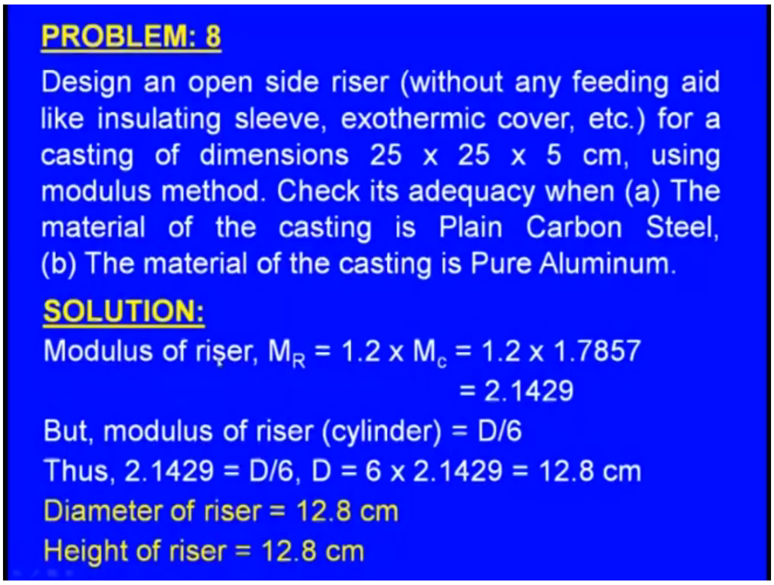

Now, in the during the what say when we have learnt about the what say design of the riser of using the modulus method. We have seen that the modulus of the riser should be 1.2 times the modulus of the casting. Thus M r the modulus of the riser is equal to one point two multiplied by M c the modulus of the casting. That is equal to 1.2 into 1.7857. That is equal to 2.1429. So, this is the modulus of the riser.

Now, but for a cylindrical riser that to, when the diameter of the riser is equal to height of the riser. We have seen that the modulus of the cylinder cylindrical riser is equal to D by 6. This we have already learnt when we are learning about the modulus method. Thus, this 2.1429 is equal to D by 6 or D is equal to 6 into 2.1429. That, is equal to 12.8 centimeters. This is the diameter or the height of the riser. So, diameter of the riser is equal to 12.8 centimeters and also the height of the riser is also the same 12.8 centimeters.

Now, this is the what say design of the riser or the dimensions of the riser. We have obtained by the modulus method. Now we need to cross check, whether this design is sufficient for feeding the casting or not or what we need to check does the what say liquid metal present in this riser of size 12.5, 12.8 and 12.8 what say size. Will it be what say will it have sufficient to liquid metal to feed the casting or not. So, we need to cross check.

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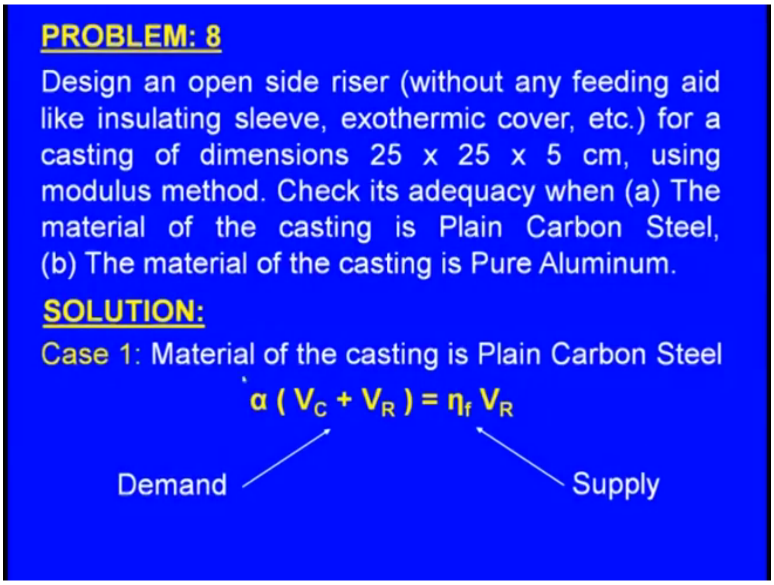

Case 1: Material of the casting is Plain Carbon Steel, the case one. Now, this is the what say expression we have learnt previously, alpha into V c plus V R is equal to eta f multiplied by V R where this what say this expression on the left hand side represents the total shrinkage. Whereas, the expression on the right side represents the total liquid metal available for the feeding or we can say the expression on the left side indicates the demand. This much liquid metal this much shrinkage is there or this much liquid metal is required. On the other hand the right side expression tells us this much liquid metal is available for the purpose of the feeding. So, one side we can see this is the demand and the other side we can see the supply. So, always in the design of the riser the supply should be more than the demand. Then only that riser is what say sufficient for feeding the casting.

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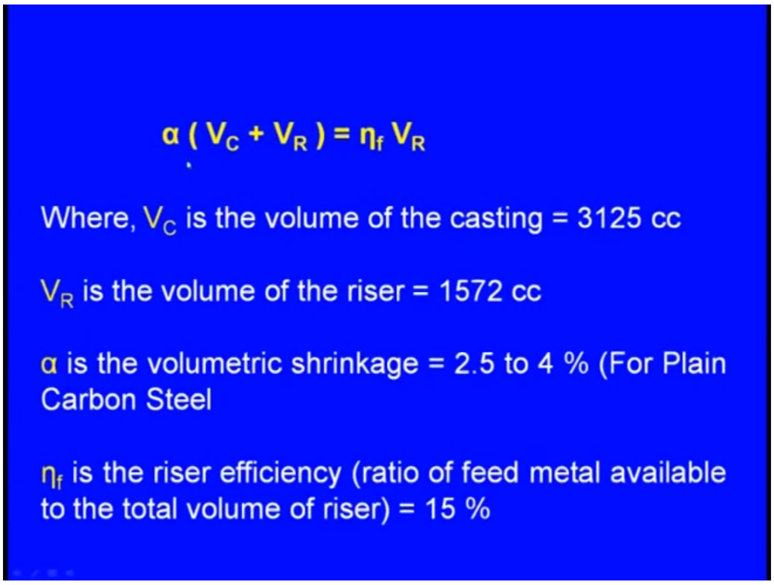

Now, we need to find out these two expressions and check. Now, in this expression what is V c it is the volume of the casting 3125 cubic centimeters, V R is the volume of the riser that is equal to 1572 cubic centimeters, alpha is the volumetric shrinkage that is for the plain carbon steels it is say 2.5 to 4 percent. We are taking the maximum what say volumetric shrinkage right and eta f is the riser efficiency for an open riser without any feeding aid.

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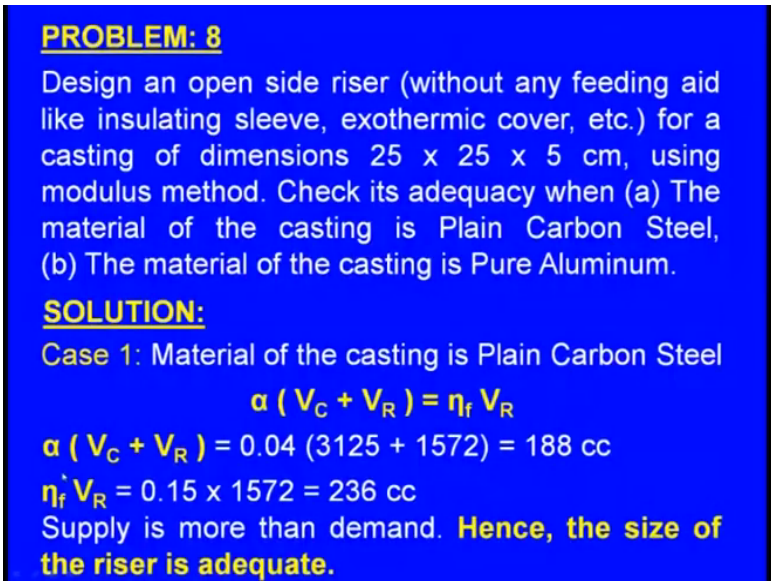

Now, what say riser efficiency is 15 percent thus alpha into V c plus V R is equal to alpha means 4 percent means that is 0.04 into this is the volume of the volume casting 3125 plus 1572, the volume of the riser is equal to 188 cubic centimeters. Means the right side sorry the left side expression are the demand for the liquid metal is 188 cubic centimeters.

Similarly, let us calculate this right side expression eta f into V R eta f into V R eta f means what is that. That is the efficiency of the riser that is 15 percent. So, point one five into V R volume of the riser 1572, that is equal to 236 cubic centimeters. Now the demand is 188 cubic centimeters whereas, the supply of the liquid metal is 236 cubic centimeters. Right, supply is more than the demand. Hence there is no chance for the shrinkage because there is more liquid metal to what say compensate the shrinkage. So, there hence the size of the riser is adequate means it is sufficient.

Now, let us see the second case: Material of the casting is Pure Aluminum again the same expression we need to calculate. This left side this is alpha into V c plus V R right side eta f into V R. So, this is the demand for the liquid metal and this is the supply of the liquid metal or available liquid metal. Now, again V c is the volume of the casting that is 3125 cubic centimeters V R is the volume of the riser that is equal to 1572 cubic centimeters, alpha is the volumetric shrinkage for pure aluminum it is 6.6 percent and eta f is the riser efficiency. Since, the riser is an open one and without any feeding it is 15 percent. Now, in this expression alpha into V c plus V R is equal to alpha that is equal to 0.066 into 3125 plus 1572 that is equal to 310 cubic centimeters.

Now, let us calculate the right side expression eta f into V R is equal to eta f is point to what say 15 percent that is 0.15 into 1572, that is equal to 236 cubic centimeters. Now, let us see this is the what say total shrinkage or this is the demand for the liquid metal. This is the supply this much liquid metal is available for the purpose of the feedings. This is the demand this is the supply means here the supply is less than the demand. This much is 310 cubic centimeters shrinkage is there, but the available liquid metal is 236 cubic centimeters only, means the shrinkage will be more than the what say liquid metal that is available for feeding. Hence the size of the riser is not adequate this is not sufficient, means the casting requires still a bigger riser. So, that is how we can cross check what we have designed is sufficient or not what we have means we design of the riser is adequate or not we can check using this expression.

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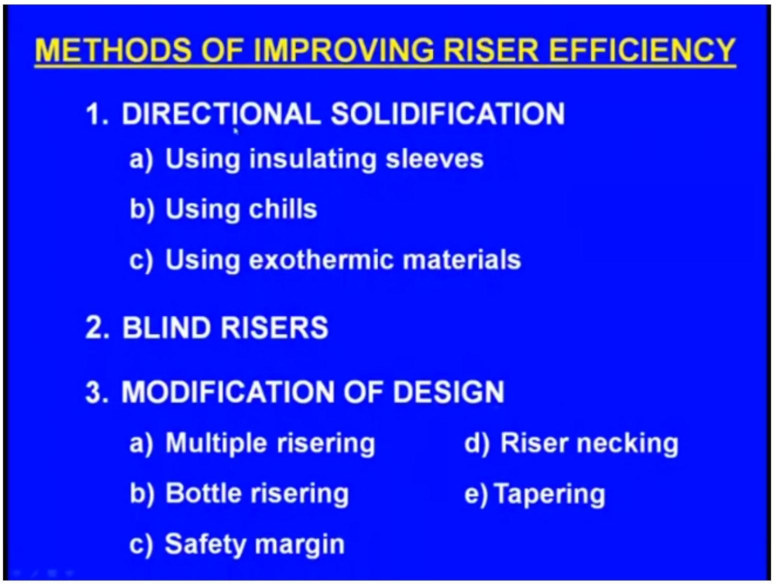

Now, let us see the methods of improving the riser efficiency. One is the directional solidification, second one is the by using the blind risers, third one is the modification of the riser design. So, first we will see the directional solidification. Under that this directional solidification can be achieved by using insulating sleeves, directional solidification can be achieved using chills, directional solidification can also be achieved using exothermic materials. First of all quickly review, what is this a directional solidification here.

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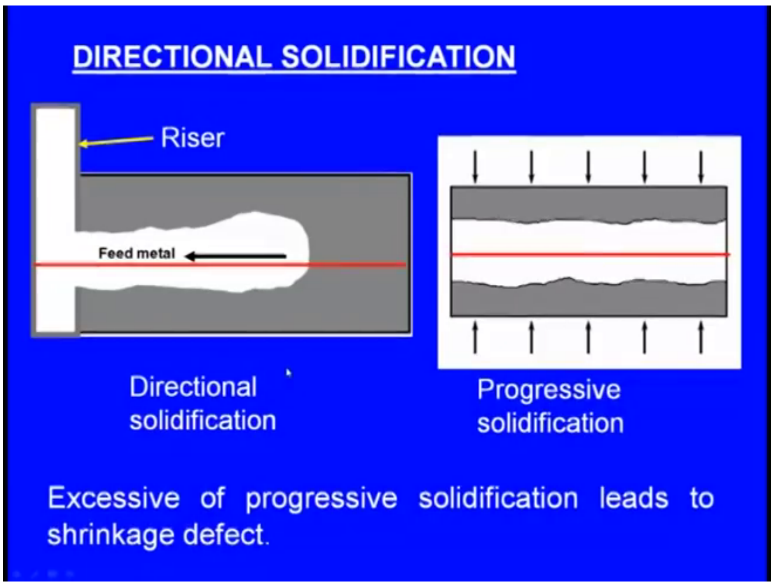

You can see this is the casting and this is the riser and here we can see one more casting and a riser is somewhere here.

Now, here we can see this is the riser and this white color indicates the liquid metal whereas, this gray color indicates the solidified metal. Now, the solidification is progressing in this direction and this is the riser and here there is liquid metal and the solidification is progressing in this direction. You can see slowly more and more material will be solidified more and more material will be solidified and it is going towards the riser. This is the directional solidification.

Now, let us see the second case here we can see the riser is somewhere here, but you see this is the solidified metal. The gray colored one is the solidified metal whereas, the white one is the liquid metal and here we can see the red colored one see is this that is the centerline of the casting. Now, the solidification is progressing perpendicular to the centerline of the casting now what happens the riser is somewhere here. The riser is what say it has sufficient metal to feed the casting, but before it could feed be casting this is slowly coming.

See this portion is coming towards the center of the axis similarly the bottom portion is progressing towards the axis. Finally, what will happen somewhere there will be shrinkage will be there and the riser though it has got the sufficient liquid metal it is not able to supply the liquid metal to the shrinkage area, why because the what say solidification is progressing perpendicular to the axis of the casting. So, this is the progressing progressive solidification always the directional solidification is good for the casting. If we want there should not be any what say the shrinkage cavity then there must be perfect directional solidification.

Whereas, sometimes because of the geometry or because of the what say pouring temperature or the material of the casting. Sometimes this progressive solidification dominates compared to the directional solidification. Generally, in any solidification there will be directional solidification there will be progressive solidification also. But the progressive solidification should be less the directional solidification should be more, but if the progression modification is dominating certainly that would reduce the efficiency of the riser. Though sufficient liquid metal is there it is not able to flow into the casting because the solidified metal is obstructing the flow of the liquid metal into that portion where there is shrinkage. So, that's why direction solidification is very important. So, when we are designing the riser we have to see that there is directional solidification right. So, we have to remember that excessive of progressive solidification leads to shrinkage defect.

So now, let us see how to achieve this directional solidification. Again we can see here, casting whose geometry does not permit directional solidification here.

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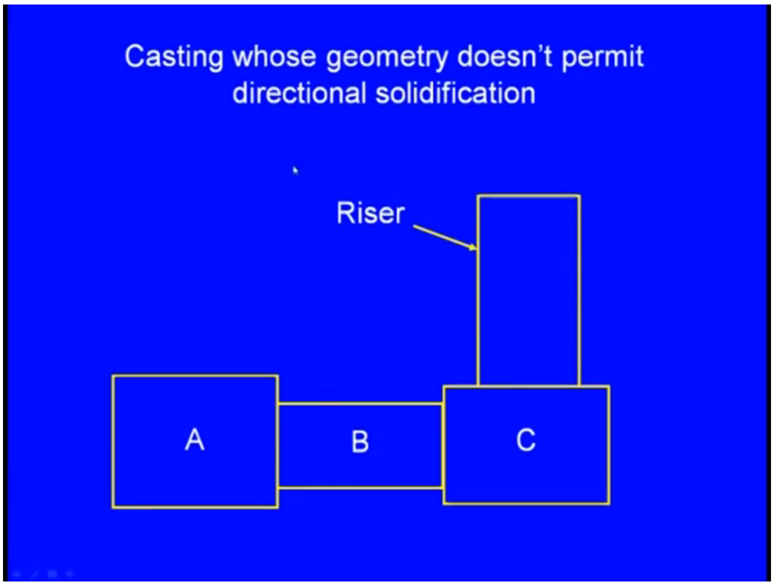

We can see this is the casting the casting has got three sections one section a another section b and another section c and this is the riser. Now you can see the section a has got the largest thickness whereas, the section t c has got the moderate thickness and the section b has got the minimum thickness. Now, what will happen the liquid metal form the riser it has to feed the casting in this direction. Now, solidification has to start from here slowly it has to progress towards the riser then only it will be able to feed the casting.

Now, what is happening in this case the thickness of the first section a is larger than compared to the other two sections. So, the thickness of the central section the middle section is minimum. So, this portion freezes quickly then what happens this portion does not quick as fast as the section b. Now, because it has frozen the liquid metal has to come and it has to feed this portion. Now, the liquid metal is not able to flow into section a the first section why because the center section has already solidified. Now, how can we ensure the directional solidification certainly this casting doesn't permit directional solidification.

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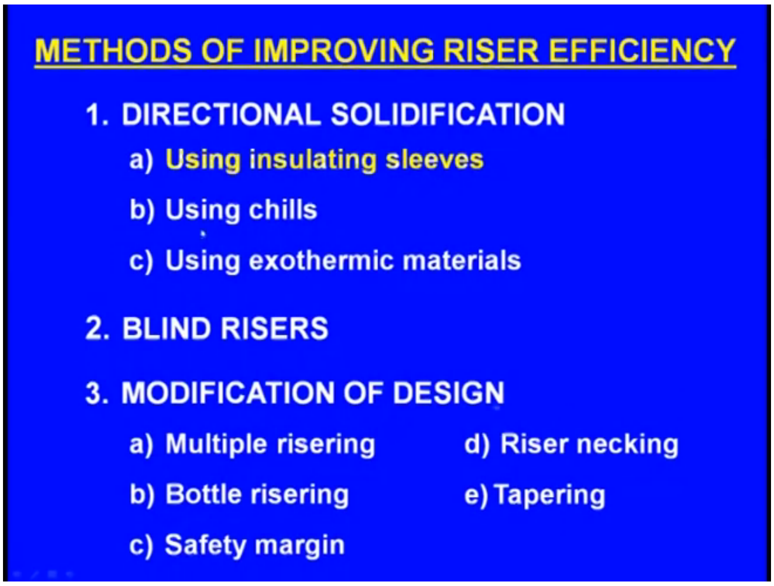

Now, let us see how to achieve the directional solidification, using insulating sleeves we can achieve the directional solidification. What are these insulating sleeves? Here we can see the same casting where what say the directional solidification is very difficult to achieve. So, we are taking the same casting now what we are doing here this section is covered by the insulating sleeve.

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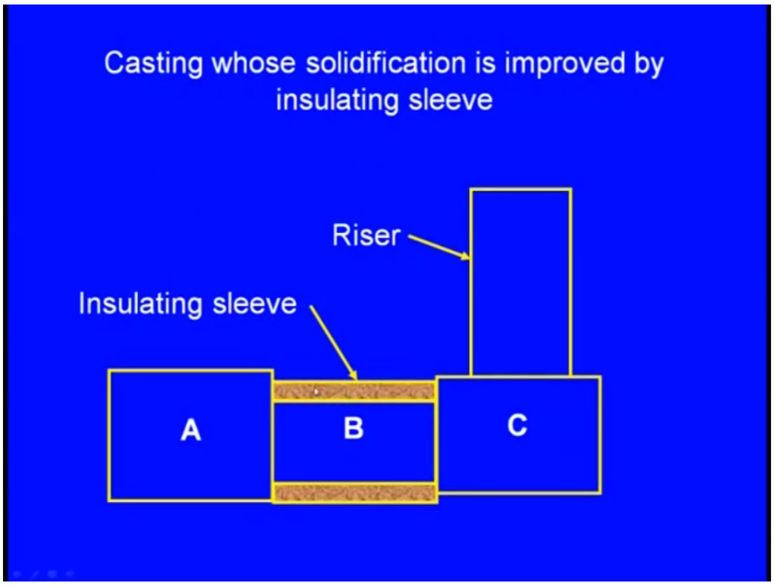

Now, what happens because of that there will be less heat transfer to the mold wash because of that this portion takes longer time for solidification, by the time this before this portion is solidified this portion will be solidifying. So, first the section a will be solidifying because of the presence of the insulating sleeve. Next only the second section will be solidifying, next section c will be solidifying. Now, the liquid from the riser is able to flow into the initially into the section a next b section c, slowly the solidification is progressing towards the riser. So, by using the insulating sleeves we can achieve the directional solidification.

Next one using chills also we can achieve the directional solidification. What are these chills? Now let us take the same casting where directional solidification was found to be difficult previously.

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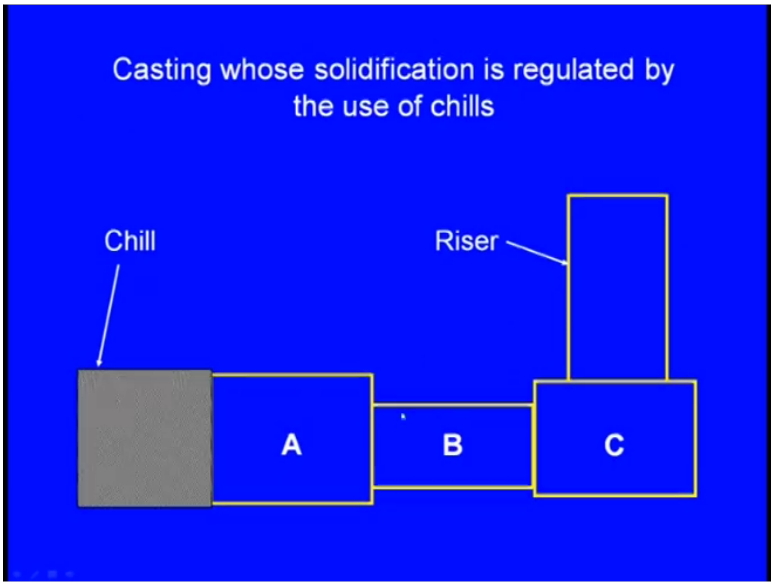

We have seen somewhere here we have kept the insulating sleeve because of that it has taken longer time. So, before that because of that first section a has solidified faster then the direction of solicitation was possible. Now, instead of using insulating sleeve we can place a chill here, chill is a steel block and this chill observes heat rapidly. Now what is happening in this casting? Thus what say thickness of this section a is larger than the b and c. That is why this takes longer time for solidification before that section b can solidified. Now we have to see that section a takes lesser time for solidification after a section a solidifies next section b should solidify after that section c should solidified. So, that is our what say plan that is our aim

So, for that what we are doing we are placing a chill here, chill means a steel block close to the mold wall. Then what will happen what say liquid metal comes in contact with this chill the steel block. The steel block rapidly observes to heat because of that this portion solidifies faster compared to the previous case, where there was no feed aid. Now this takes lesser times compared to the other sections. Now, now the section b solidifies after that section c solidifies. Now the liquid metal is able to initially it is able to flow into a next into be next into see slowly the solidification is progressing towards the riser. So, by placing chill also we can achieve the directional solidification.

Next one by using exothermic materials also we can achieve the directional solidification. What are these exothermic materials?

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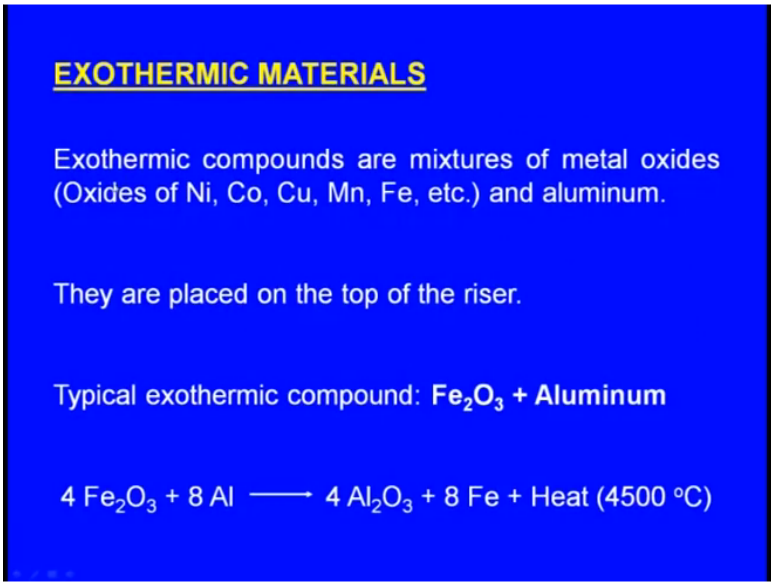

These are the what say mixtures of metal oxides, oxides of nickel, cobalt, copper, manganese, iron and aluminum. Now, these exothermic mixture are placed on the top of the riser. Then what will happen an exothermic reaction will be taking place on the top of the riser. Now a typical exothermic compound is you can see Fe 2 O 3 plus Aluminum. When this mixture is placed on the top of the riser now you see this reaction will be taking place. Now, right you can see here this is the exothermic material this much right and now when it is placed on the top of the riser. The reaction will be like this 4 aluminum Al 2 O 3 plus 8 Fe plus heat. Now, you see their temperature produced it is very high temperature is produced.

Now, what is the directional solidification first of all, directional solidification means the point which is away from the riser must solidify first. Then the solidification slowly it should propagate towards the riser and the riser should be the one which will be solidifying at the last. Now, we are increasing the riser to a very high temperature then what will happen because of the high temperature of the riser it will be taking longer time for solidification. So, because of this a longer time for solidification, more metal is available for feeding for a longer time. That is how it is able to the feed the liquid metal to the casting and finally, because of this high temperature of the riser. Finally, it will be solidifying at the end. So, that is the directional solidification.

So, by placing exothermic materials on the top of the riser also we can achieve the directional solidification. Now the there is a method another method of improving riser efficiency is by using blind riser.

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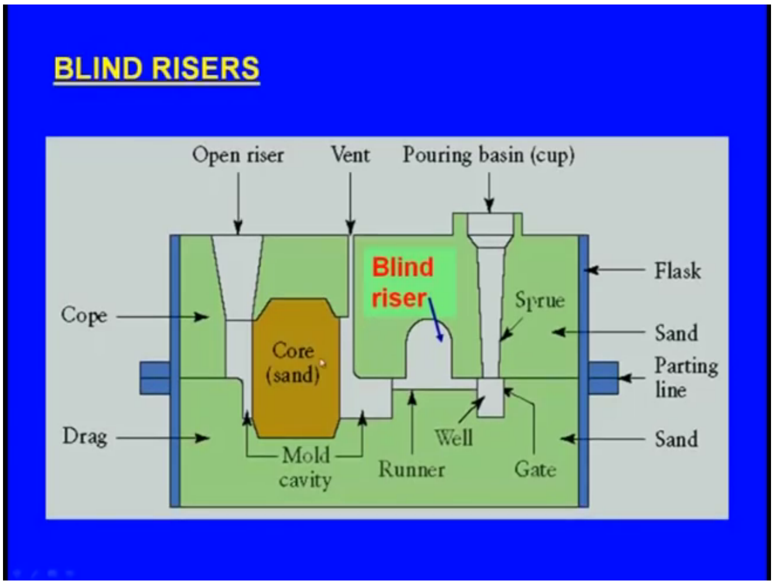

What is this blind riser? Yes this is the mold, you can see here this is the pouring cup, pouring basin. This is sprue, the molten metal will be flowing like this and this is the sprue well and this is the runner and this is the runner finally, this is the cavity and here of course, here there is a core and it flows around the core finally, it risers through the riser. An open riser is expose to the atmosphere because of that there will be more heat transfer. So, to minimize this heat transfer we can use a blind riser.

Here you can see this is a blind riser you can see. So, this certainly this contains enough liquid metal, but it is not expose to the atmosphere. Because of that it will be in liquid state for a longer time because it is in a liquid state for a longer time it can feed the casting for a longer time. Finally, it will be the one which will be solidifying at the last. So, casting will be solidifying first and this will be solidifying last. So, that is the directional solidification right by achieve what say by incorporating the blind riser also, we can achieve the directional solidification.

Next one by modifying the design of the riser, we can improve the risers efficiency. Right modification of the design again there are five ways of modifying riser design. One is the multiple raisering by using multiple riser, we can what say increase the riser efficiency. What is this multiple risering? Right a riser can feed the casting only up to a certain distances right. So, if we place a riser it may have as a what say sufficient volume of the liquid metal to feed the entire casting, but it can feed only up to a certain distance beyond that distance though it contains more than sufficient to liquid metal it cannot feed the casting. So, this distance is known as the feeding distance of the riser.

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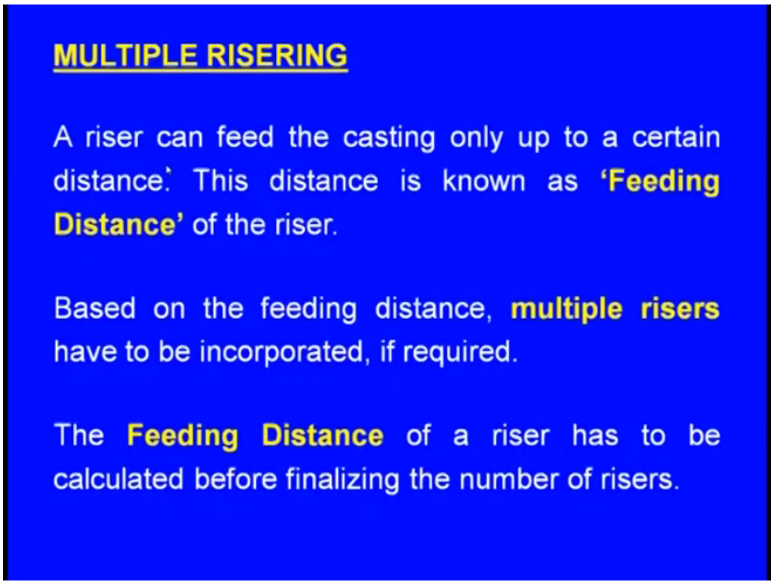

Based on the feeding distance multiple risers have to be incorporated if required. So, once we know that there is a feeding distance once we know that a riser can feed only up to a certain distance which is known as the feeding distance and if the length of the casting is more than the feeding distance. Then what we have to do we have to adopt multiple risers means we have to use two risers or three risers or even more depending upon the length of the casting. Right the feeding distance of a riser has to be calculated before finalizing the number of riser.

Now, the question is so there may be a long casting. So, how many risers does it require. How to know? First we need to find out the feeding distance. What is the feeding distance of each riser? Then we can find out how many risers are required to feed that casting. So, by adopting multiple riser we can increase the efficiency of the riser.

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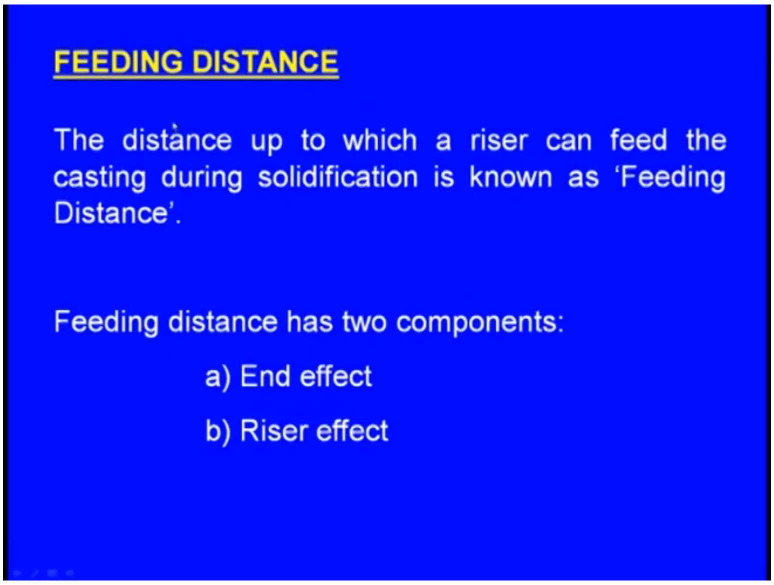

Now, the now we are defining the feeding distance. The distance up to which a riser can feed the casting during solidification is known as feeding distance. Feeding distance has got two components one component is the end effect and the other component is the riser effect. Let us see what are these end effect and the riser effects end effect.

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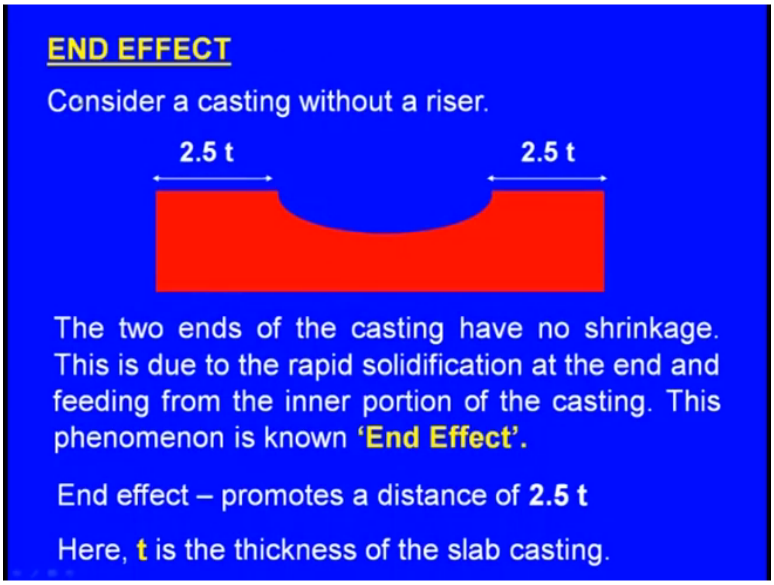

Now, this is a casting for example, a casting without a riser practically it may not be a case right. Generally, we make a casting right with risers. Let us consider a casting without riser. Now, what is happening here this portion the extreme portion is more subjected to solidification because it is more exposed to the mold wall. Similarly, the other end is also more exposed to the mold wall. So, here the solidification what say will be more here and this end. So, this center portion will be solidifying after some time. Whereas, this extreme end the left hand end the right end will be solidifying faster.

Now, what happens is because of that while is solidifying this portion will be supplying the liquid metal because the center central portions has got the liquid metal. So, that acts the riser for the end portion. So, there is no shrinkage in this portion. Similarly, there is no shrinkage in this portion. Now, we can observe one thing. For the certain length of the casting without riser there was no shrinkage. Why because the central portion is acting as the riser. So, the two ends of the casting have no shrinkage. This is due to the rapid solidification at the end and feeding from the inner portion of the casting. This phenomenon is known as the end effect means there is no shrinkage at the end. End effect promotes a distance of 2.5 t. Where t is the thickness of the section t is the thickness of the section or the slab.

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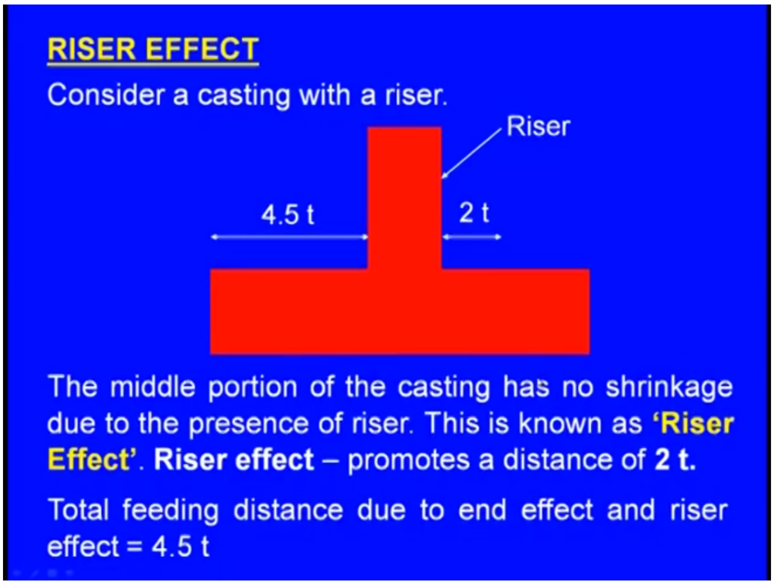

Now, let us see another casting .This casting has a riser, previously we have seen that 2.5 times the thickness was there without any shrinkage. Now we are placing a riser this is the riser. Now to this central portion this is supplying the liquid metal and because of that there is no shrinkage cavity, previously there was shrinkage cavity without riser. Now there is no shrinkage cavity.

Now this length is 2 t where t is the thickness of the slab or thickness of the section. Why now here there is no shrinkage in this portion central portion. Here also there is no shrinkage and what is it is length and if we measure it will be 2 t and if you measure here it will be 2 t. Again a distance of 2 t in distance of 2 t there is no shrinkage. Why? Because we have placed the riser because of the presence of the riser there is no shrinkage in that two lengths. This is known as the riser effect right. The middle portion of the casting has no shrinkage due to the presence of the riser. This is known as riser effect.

Riser effect promotes a distance of 2 t. Now, the end effect we have already seen. The end effect is 2.5 t and riser effect is 2 t. Then what is the total distance feeding distance. Total feeding distance due to end effect and riser effect is to put 2 t plus 2.5 t that is equal to 4.5 t. So, this is the total feeding distance for a riser or when we use a riser. So, this much distance is covered by the riser and in this much distance there would not be any shrinkage. Now, here we can see the illustration and concept of the feeding distance.

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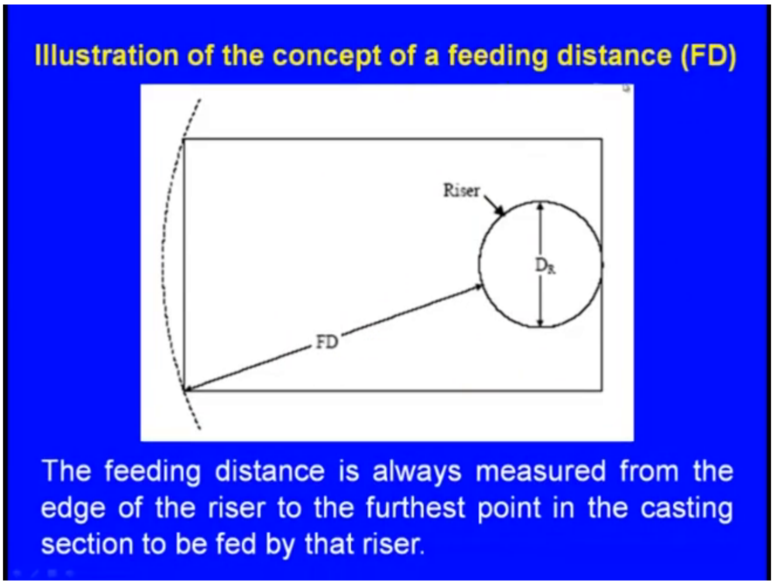

Now, feeding distance is the length of the casting, where there would not be any shrinkage. Whether it is due to the end effect or due to the riser effect. Now, the question is how to measure this feeding distance is it from the center of the riser or from the end of the riser right. So, the feeding distance here you can see this is the FD and this is the riser this is the riser and this is the casting. Now, the feeding distance is always measured from the edge of the riser, you see from the edge of the riser to the furthest point in the casting right. Or the casting section to be fed by that riser right. It starts from the edge of the riser to the furthest point in the casting that is fed by the riser. So, it is starts from here and it ends here. So, this is the feeding distance.

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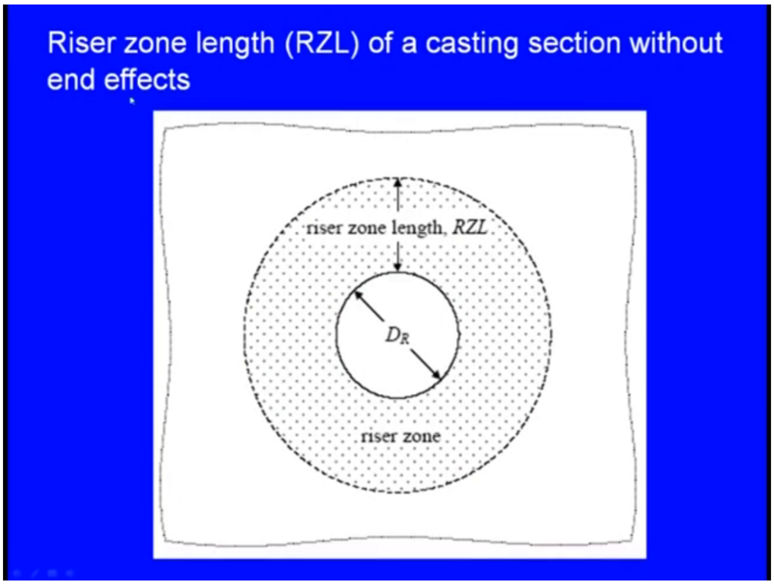

Now, again we will see riser zone length RZL of a casting section without end effects. Suppose, let us assume there is no end effect, only riser effect is there. So, here the this is the riser. This is a cylindrical riser. Then what happens to the riser zone. So, zone will be a cylindrical portion. So, this in this much portion there would not be any shrinkage. So, this the riser zone.

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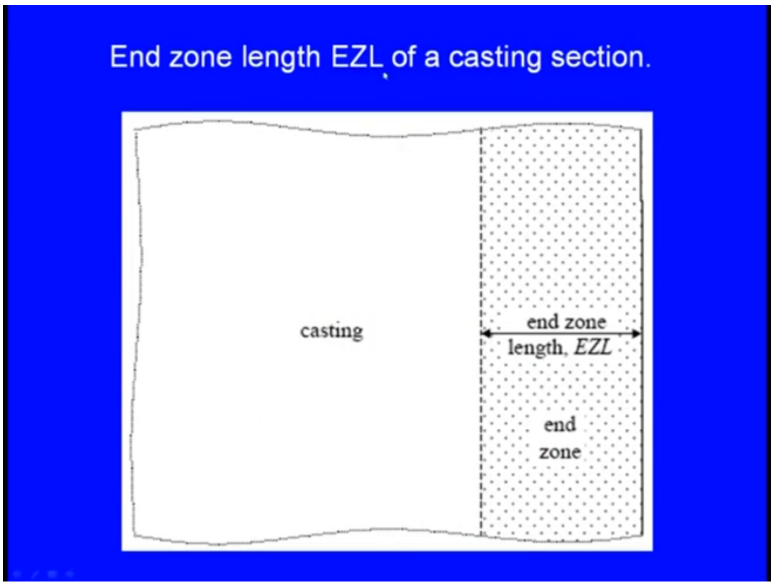

Now, let us see another case end zone length AZL of the casting means if we again if we ignore the riser because of the end effect. So, this much portion there would not be any shrinkage. So, this is the end zone or this is the end zone length.

Now, let us see a problem. A steel casting of size 40 into 25 into 10 centimeters is to be fed by a side riser. Calculate the feeding distance of the riser.

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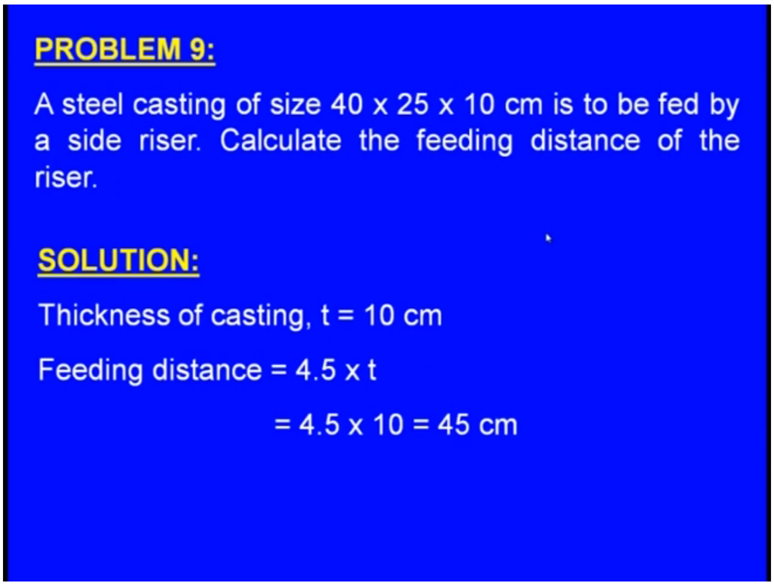

So, we need to calculate the feeding distance of the riser. It is a simple problem, thickness of the casting t is equal to 10 centimeters this much. Now, what is feeding distance 4.5 times the thickness of the slab or thickness of the casting .That is equal to 4.5 into 10, that is equal to 45 centimeters. So, that is the feeding distance. It is a simple what say example to calculate the feeding distance.

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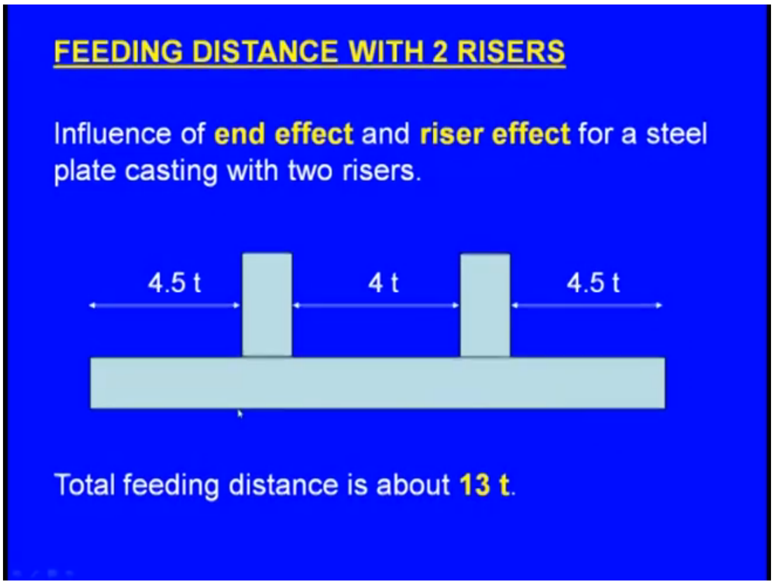

Now, feeding distance with 2 risers. Influence of end effect and riser effect for a steel plate casting with two risers. Here we can see this is the casting. This is the casting and this is one riser and this is one riser. Suppose if we have placed two risers for this steel casting. What will be the total feeding distance? On one side there will be 4.5 t will be the feeding distance. Again this 4.5 t means it has got two components say 2.5 times t is the end effect and 2 t is the riser effect. So, total this side of the riser there is a feeding distance of 4.5 t. Again this side there is a riser effect. What is how much is it? It is 2 t. So, this is 2 t again for this riser again on one side there is riser affect. How much is that? That is 2 t.

So, in the center from this riser to this riser there is 4 t distance of the feeding distance. Again from this riser from this end up to here 2.5 t, 2 t is the riser effect and from here from the end to here 2.5 t is the end effect. So, the total feeding distance on this side is 4.5 t. Now what is the total feeding distance, when we are using two risers, it is 13 t. So, remember that when we are using two risers for a steel casting the total feeding distance is 13 t.

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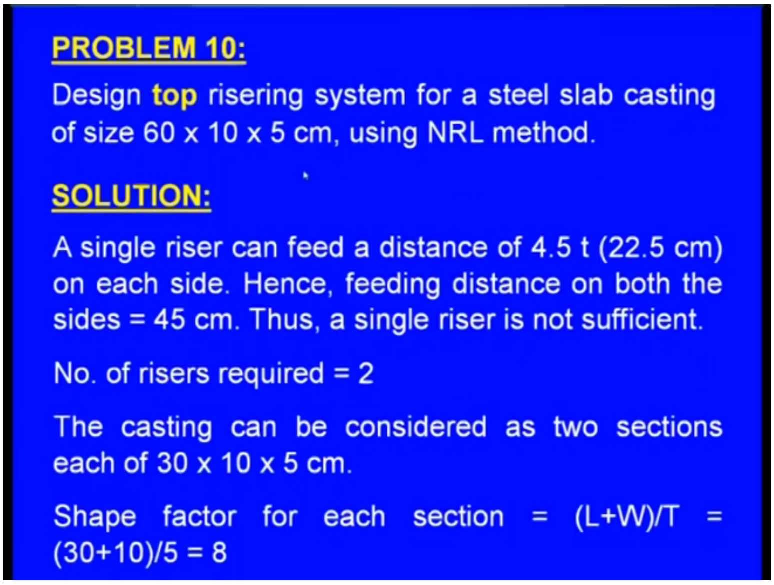

Now, let us see one more problem. Design top risering system for a steel slab casting of size 60 into 10 into 5 centimeters using, NRL method. Naval Research Laboratory method now this is the solution, a single riser can feed a distance of 4.5 times the thickness of the casting. So, here it comes to be 22.5 centimeters on each side. Hence, the feeding distance on both the sides is equal to 45 centimeters. Thus, a single riser is not sufficient in this case. Number of risers required in this case is equal to 2. The casting can be considered as two section each of 30 into 10 into 5 centimeters. Actually the length of the casting is 60 centimeters, but we are considering this as two sections each sections length is 30 centimeters. So, this is the one section. So, other section is also of this much size only. So, if we design the riser for this section. So, other section also will be requiring the same riser.

Now, the shape factor for each section is equal to L plus W divided by T. So, that is equal to 30 plus 10 divided by 5. That is equal to 8.

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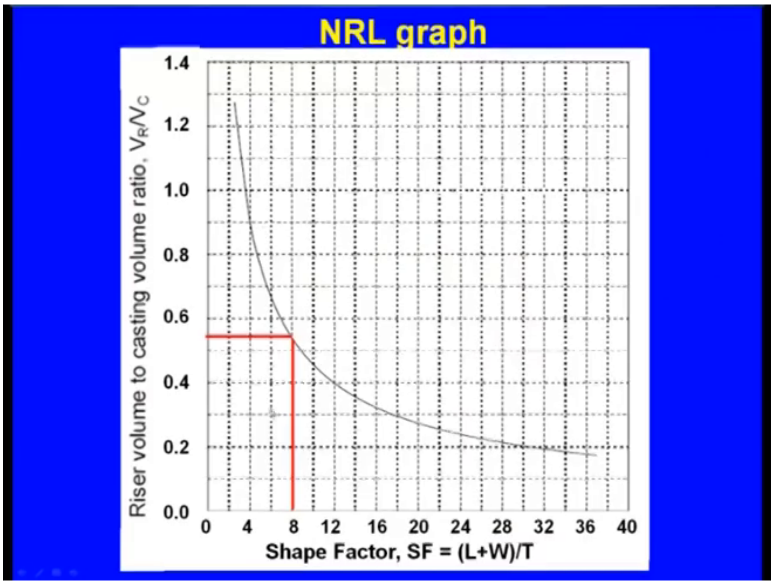

Now, this is the NRL graph. On the x axis we see the shape factor that is L plus W divided by T and on the y axis we see riser volume to casting volume ratio, V R by V c. Now, just now we have seen the shape factor is 8. So, if we what say put this shape factor that is 8 on the x axis you see. So, this is the shape factor you draw a line such that it touches the graph. So, here it is touching now from here we draw a horizontal line towards the V R by V c.

So, this is a point where the line is touching the y axis. Now, it is something between 0.4 and 0.6. If we more approximate it will be say 0.45 and something more.

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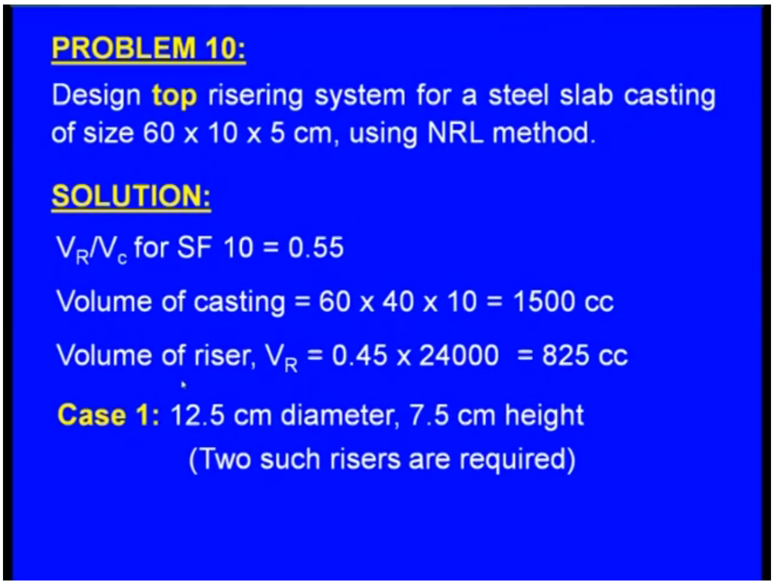

So, it is right shape factor for 8 is equal to 0.55 right. Now, volume of the casting is equal to 30 into 10 into 5 that is equal to 1500 cubic what say centimeters. Volume of the riser V R is equal to, now shape factor this is the V R by V c, V R by V c is equal to 0.55. So, V R by this what say V R by V c ratio 0.55 into 1500. That is equal to 825 cubic centimeters. Now, this is the NRL riser selection chart.

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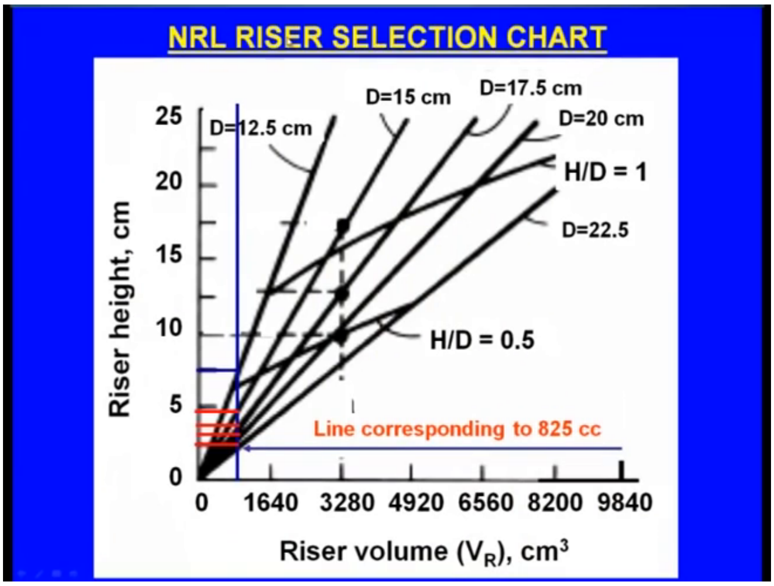

Now, so this is the volume we got volume of the riser is 825 cubic centimeters. Now here we can see on the x axis we see the riser volume and in the on the y axis we see the riser height. Now, the riser volume is 825 cc cubic centimeters. So, we have to identify 825 cc on the x axis. So, this is the place we have approximated 825 cc. So, from here we have to draw a line vertically like this. Now, so these are all the different riser lines. This is the line corresponding to diameter 12.5, this line. This line is the one which corresponds to diameter 15, this is the line which corresponds to diameter 17.5 and this is the line which corresponds to diameter 20 and this is the line which corresponds to diameter 22.5.

Now, we have to draw line upwards from this 825 riser volume. Then in this process that line will be intersecting all these riser lines, you see all these riser lines are what say intersected by this line you see. At this point it is intersecting at this point is intersecting at this point at this point. Also finally, at this point this vertical line is intersecting the different riser lines.

Now, what happens we have a rule that the diameter or the height by what say diameter ratio should be between 0.5 to 1, means the H by D ratio should not be less than 0.5. Similarly, the H by D ratio should not be more than 1. Now, you see here we this line has intersected the five riser lines here here here here and here. Now all these four lines are in all these cases the H by D ratio is less than 0.5.We see as we come down the H by D ratio will be less than 0.5. Only in this case the H by D ratio is above 0.5 and less than 1.

So, though we get the five values for the riser height only one is feasible this one. So, all these four are to be discarded. Now, what is the riser height in this case it is 7.5 you see this is 5 and 10. So, this is 7.5. So finally, only this value will be choosing now we get only one case that is the diameter is you see the diameter is for this line the diameter is 12.5, 12.5 and this is the height that is 7.5. So, the case one only one case 12.5 centimeters diameter and 7.5 centimeters height and remember we have considered only half of the casting. For half of the casting this is the require what say riser required for this remaining half of the casting one more riser is required. So, two such risers are required.

So, friends in this lecture we have learnt how to design the riser and risering systems using NRL method we will continue in the next lecture.

Thank you.