Principles of Casting Technology
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Lecture – 21
Riser Design
Introduction

Welcome to the lecture on Risering Design. So, we will discuss about the riser, in this lecture, we will have the introduction of the riser, its function, its types and other issues related to risers. So, why a riser is required in a casting?

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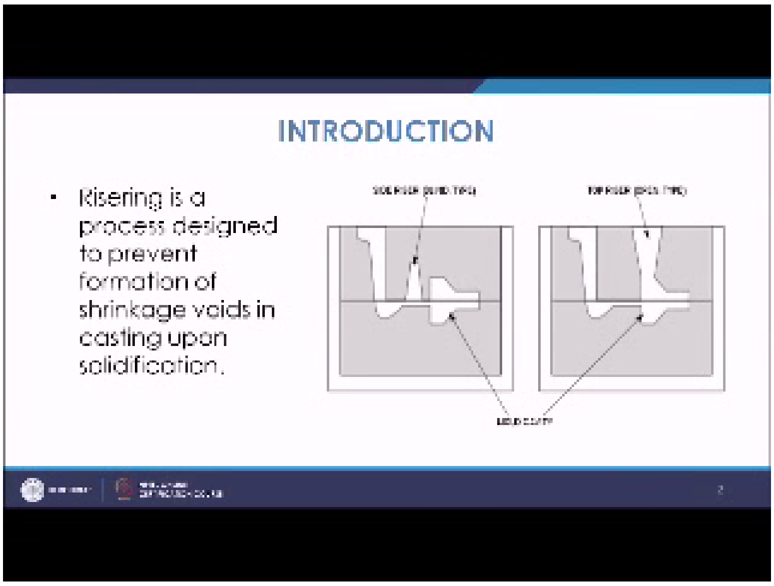

Risering is a process designed to prevent formation of shrinkage voids in casting upon solidification. So, when the casting get solidified, at that time there is possibility of shrinkage in the casting and this shrinkage has to be compensated by the riser. So that is why in the casting suppose, this is a mould cavity and riser is placed in such a manner that it should be able to supply the molten metal in case of shrinkages. So, the main purpose of the riser is to supply that liquid metal when it is required. It is also known as head or sometimes also known as feeder because it is serving the purpose of feeding the molten metal which is required by the casting during its solidification. So why there is the requirement of riser, why there is need of the riser to feed the molten metal?

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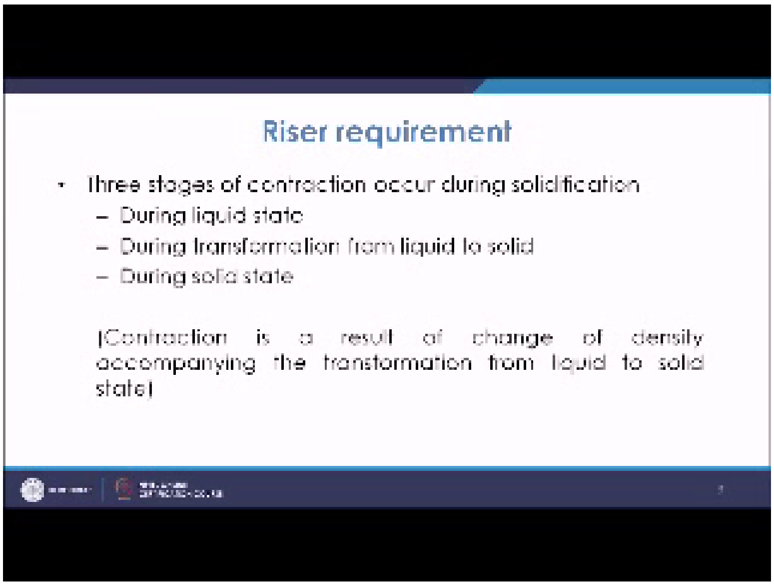

Now, for that we must know that there are basically 3 stages of contraction during the solidification. So, these stages are during the liquid state, during transformation from liquid to solid state and during the solid state which can be understood with the help of the cooling curve if you try to draw a cooling curve for a pure metal.

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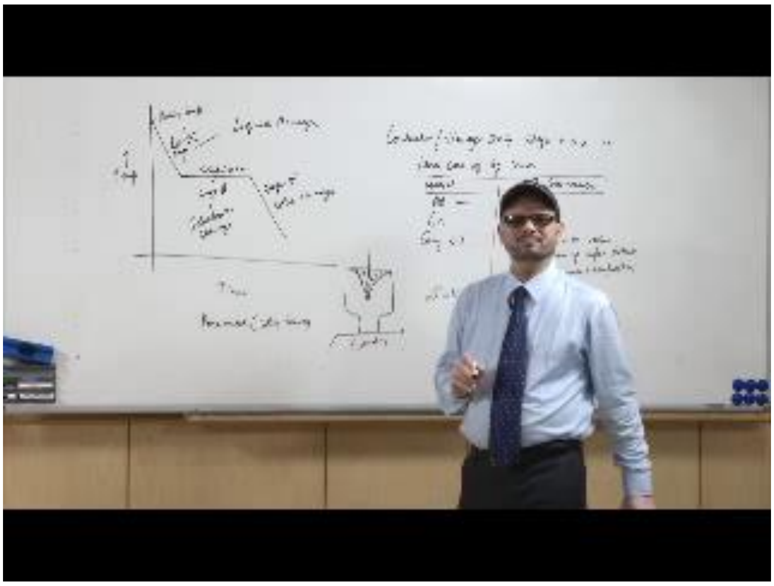

Then in that case, you can see this is the temperature and this is the time. So, if this is the cooling curve for a pure metal, in that case, when the temperature is this temperature is something like the pouring temperature. So, here you have pouring temperature now at pouring temperature when you are pouring the molten metal in the cavity then it will start losing its super heat.

Because when pouring is done, it is done at a certain temperature higher than the melting or the metal because the metal has to be transported from one place or the place where the metal is melted to the place where the mould is placed. So, during that time it must have enough of the super heat so that when it reaches the temperature should not go below the equilibrium temperature or melting temperature because once the temperature goes below this equilibrium or melting temperature then there is onset of nucleation and growth process that leads to solidification process.

So this temperature differential here from here up to here this temperature differential will cause certain contraction and this contraction the contraction which occurs in this stage, this is the first stage of contraction and this is, that is why first stage contraction is known as the liquid contraction. Similarly this is the second stage contraction this is the process of solidification. So, during this process as we have already understood when the metal reaches to this temperature with small degree of under cooling the onset of nucleation is there and then after that with the mechanism of nucleation and growth the solidification starts at certain points and that point certainly will be governed by the conditions of free energy and others. So, then when there is onset of solidification then certainly during this process you have the release of heat the metal tries to release the latent heat during the process of solidification, but during this process for basically pure metals. So, this is for metal. So, during this process although temperature does not change for pure metals, but it takes time to completely solidified and reaches at this point.

During this process also there will be some contraction in the metal and this contraction is this is stage 2 contractions. So, this is the stage 2 that is during the transformation from liquid to solid state. So, when the liquid state is changing to solid state then that contraction is known as the stage 2 contraction that is solidification shrinkage. So, this is liquid shrinkage and this is, so this is known as liquid shrinkage and this stage is known as solidification shrinkage.

Then once the solidification has finished at this point, the metal is at its solidest temperature now in this case certainly it is at that temperature only and after that there is temperature drop and the metal virtually comes down to a temperature at the room temperature and that is why, this is the stage 3 of the contraction because of the temperature difference there will be change in the dimension all the material there will contraction further. So, that is known as the shrinkage in the third stage and this is known as solid shrinkage.

All these 3 stages of contraction is there now let us see these 2 stages involve the liquid in this case we have pure liquid and you are coming to at a liquid state here also. So, there is liquid contraction and then in this case liquid is slowly converting to solid. So, basically in most of the cases you have change of density. So, when the liquid is changing to solid in most of the cases except only few the density in the solid state becomes more. So, once the density becomes more the mass being the same the volume goes on decreasing. So, because of that basically there will be change in the volume then the decrease of the volume that is contraction.

Normally if you take for plain carbon steel it is somewhere close to 1.6 percent or so, similarly in the second stage it will be close to 3 percent. So, something like this and once you go in the solid shrinkage stage it will be somewhere close to seven percent. So, for such materials like typical carbon steel medium carbon steel materials if you look at the shrinkage during these 2 stages it will be somewhere close to 4.5. So, this 4.5 percentage of shrinkage, in case of that particular material has to be compensated. So, stage 1 and the stage 2 when the material is still in liquid state some part is there in the liquid state that time the contraction can be overcome or that basically can be balanced by feeding the extra metal and that metal can be supplied only in the liquid form. So, this liquid metal which has to be supplied in extra that is done by the riser. So contraction or shrinkage during stage 1 and 2 is taken care of by riser.

This is the function or the riser it takes care of the shrinkage which occurs in the first 2 stages, the third stage shrinkage because it happens when the material has got the solid state. So, then it is basically because of the solid cooling and this is being taken care of by providing the shrinkage allowance on the pattern because at that time you cannot provide the extra liquid metal for changing its dimension. So, its dimension cannot be changed you will have to have the extra material on the sides. So, that when it shrinks. So, then you can get the exact dimension of the material. So, that is how it goes. Now contraction, so we have studied that contraction is a result of change of density accompanying the transformation from liquid to solid state.

Function of riser. So, what do we have? Seen that the function of riser is to feed the molten metal during the first and second stage of the contraction riser requirement depends considerably on type of metal being put. Now the thing is we had seen that you have 2 types, you have 1 type like for medium carbon steel that was 1.6 and this was somewhere goes to 3 percent of the contraction during these 2 stages. So, it is somewhere close to 4.5. So, for different materials like for suppose aluminum the volumetric shrinkage will depend upon the metal being cast. So, if you take material different materials and if you find they are volumetric material shrinkage in that case, for aluminum, it is somewhere close to 6.9. If you take the copper it will be somewhere close to 4.9 if you take somewhere of the grey cast iron it will be somewhere close to 1.52 even negative value depending upon extent of graphitization and composition. On the other hand, if you take white cast iron, it will be somewhere close to 4.5 to 5.

So, basically it depends upon the material, which is being cast, how much is the volumetric shrinkage basically that much amount to minimum has to be supplied by the riser. So, we can see that for certain material it is quite low value whereas; for certain material it is higher. So, when it is higher you need to provide large extra material for compensating that volumetric shrinkage.

Now, in this case its decreasing it has a very less value because of its composition and because of the face which is formed after solidification. So, in this case what happens in the case of grey cast iron? The transformation to this graphite basically that leads to expansion process. So, basically it expands and formation of this graphite basically and because it expands the volume basically increases. So, that is why this is very small and sometimes even it is negative value. So, may be sometimes we go for certain cases known as riser less design the riser is not required. So, grey cast iron is such component where rather requirement is very less because of the graphitization which takes place in the case of grey cast iron.

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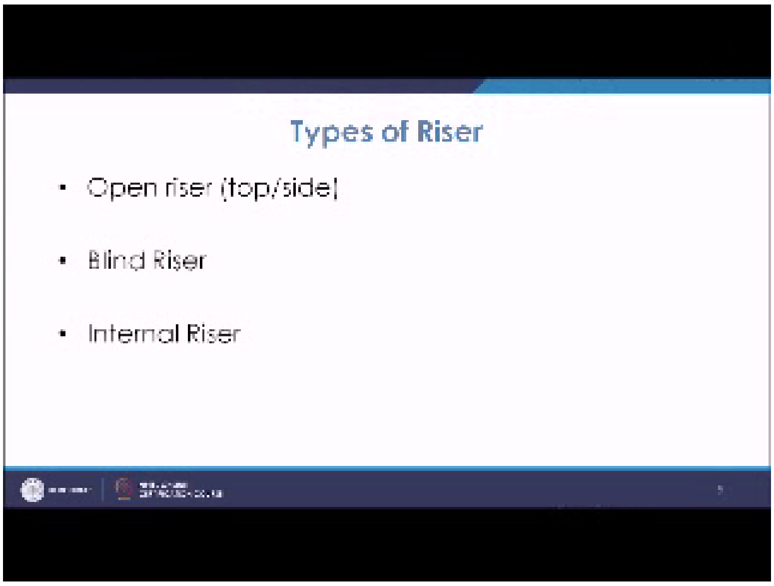

Types of risers, now you have the riser as we have seen in our first slide that you have to place the riser and it should be attached to the casting so that it should be able to supply the liquid metal to the casting whenever it is required. Now the type of riser is, one is open riser then open riser means the riser is open to atmosphere, the top part of the riser is open to atmosphere and there are 2 types of forces which are acting on this riser to feed the molten metal to the cavity.

Now, the 2 forces are one is the atmospheric pressure. So, once it is open to atmosphere and there will be atmospheric pressure acting on the liquid metal at the top surface then because of that pressure, it will be in a position to feed the metal towards the casting another is force of gravity. So, under gravity basically metal goes inside the cavity.

Now, if your top riser is there and in that if the top portion is basically not in the liquid state, it get solidified. In that case this atmospheric pressure will not work and even by because of the gravity the liquid metal will be pushed towards the casting a vacuum will be created. So, it will be further difficult to feed the metal. So, in the top risers you have to be careful that we have to see that the top surface is normally open to the atmosphere it remains in liquid state so that the forces act on it considerably so that the metal can be fed into the cavity in a proper manner, one more thing is which is required to be known suppose this is a top riser.

The top riser is normally placed to the casting. So, this is the surface which is open to the atmosphere now in when the liquid metal is getting the pressure from the top and also because of the gravity force the metal is supplied and it goes like this. So, this way your metal is this much metal is basically fed. So, this is basically the amount of shrinkage which is occurring inside the casting and this much metal is basically supplied by the riser to the casting.

You must know that this is also a casting; the riser is also a casting because it also get solidified. So, it will solidify from this part and basically once it is in liquid state it will be coming down like these and this is known as a pipe. So, this is something like a piping type of riser where you see the pipe and by measuring this amount of liquid metal in that pipe you can calculate that, what is the amount of shrinkage which has been experienced by the casting? So, you have this way the formation of risers now in that case the top riser basically is attached to the co portion of the casting it does not extend till the drag portions.

Whereas there is side riser, side riser normally will go at the parting plane of the casting. So, side riser is placed on the side of the casting and it will have a connection at the parting plane.

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Side riser will have like this. So, once you have a cylindrical riser and then from here you have something like this and then this is your casting. So, this may be your casting and this is the riser. So, if it is on the side then it is known as a side riser. So, normally it is on the parting plane of the riser and from the side you try to provide the liquid metal through certain connections. So, that the molten metal is fed from the riser to the casting.

Least type of riser is the blind riser. So, blind riser basically. So, as we have understood in the case of open type of riser the riser is open to the atmosphere and the atmospheric pressure as well as the gravity force acts on it, but at the same time, the riser being open to the atmosphere, loses its heat to surroundings. So, it is like a casting which is on the surface or at outside. So, it will lose its heat and its portions will solidify with time. So, only of the central portion you can feed to compensate for the shrinkage now in that in that case the sizes of these top risers or side risers which are open they are open risers it will be larger.

Now, to compensate for that sometimes the riser is basically surrounded from all the sides by or it is covered from all the sides or it is inside, it is not open to the atmosphere, it is basically inside if from all the sides, it is covered with the molding material. So, inside the mould it is kept. So, in that case, its surface is not very much exposed to the atmosphere and you that type of riser is known as a blind riser.

Now, in that blind riser, your atmospheric pressure does not work, but it has for feeding, you need to because the gravity effect is not that much dominant because is not at a very high height. So, the gravity force which otherwise would have been instrumental in feeding the liquid metal to the casting that is not the case, in the case of blind riser. So, in the case of blind riser, what we do is and that too if its surface is solidified then the absence of these 2 forces will make the feeding of the metal into the casting difficult. So, in that case what we do is inside when we have a blind riser this is a blind riser and attached to certain casting.

In the blind riser, what we do is this blind riser is basically you provide some core inserts. So, that it is open to the atmosphere and the atmospheric pressure still acts. So, that is sometimes known as a special type of core which is there and this basically helps in providing that environment because of which is able to feed the liquid metal and since it is covered. So, this is molding material on all this sides the sizes of this blind risers are basically small.

There is another verity of riser that is internal riser. So, this internal riser it is basically a riser where in some cases the riser is surrounded from all the sides by the casting itself. So, those kinds of risers are known as the internal risers.

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What happens, you have a riser and basically this is surrounded and on this side you have casting. So, this is a riser and this is a casting, casting on the sides and riser is here in between them. So, it is enveloped by the casting.

What happens in this case, the riser being here since it is surrounded by the casting on all the sides the heat lost by the casting it reaches to this riser and keeps this riser hot for longer duration of time this riser being hot for longer duration of time. So, the advantage is that you can have a smaller size of the riser had it been a riser somewhere else the riser will also solidify in that case the riser size has to be larger, but in this case, since it is getting the heat from all the sides by the casting itself. So, these risers which are in between them, the castings mostly in case of circular or cylindrical castings, they basically it is there in that casting itself. So, from all the sides you have in that in the middle of the circular or the cylindrical casting sometimes you keep it. So, in those cases, the advantages as we have discussed is that the riser will be hot for longer duration of time and that is why you need the small volume of the riser as compared to that when you can use the riser somewhere else or in other cases. So, these are the different types of risers which are normally practiced.

Step and size of riser, now this is important because what should be the size of the riser first of all as we have understood the size of the riser has to be that one so that it is able to feed the amount of shrinkage which occurs in the case of solidification. So, size has to be adequate suppose the volumetric contraction is four percent. So, the contraction amount that is during the liquid and the solidification stage the contraction will be four percent of the volume now that much amount has to be supplied by the riser. So, the size has to be obtained from there you have to take the size of a riser you should be able to feed that much of liquid metal in case of shrinkages that much value of that much volume of metal is required otherwise there will be shrinkage cavities.

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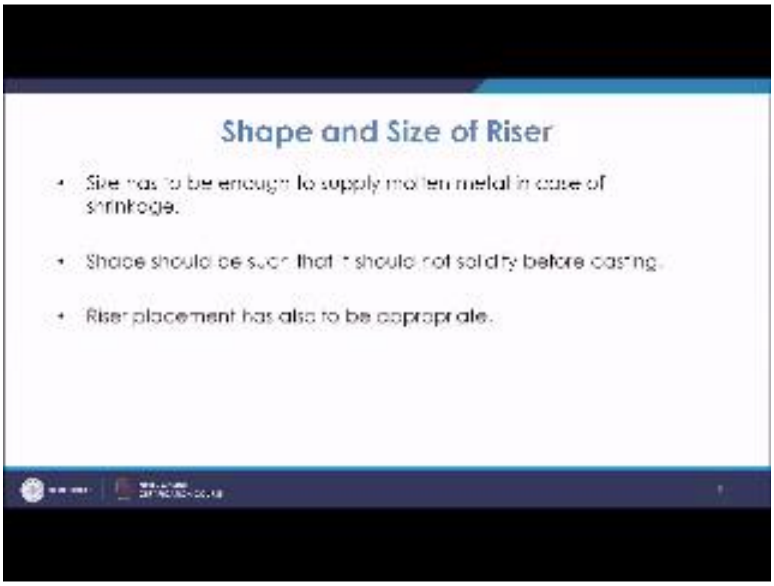

The size should be such that it is able to feed that much of liquid metal. Next comes the shape of the riser, the shape of the riser should be search that it should not solidify before casting you know that the riser is the one which supplies the liquid metal to the casting. So, a riser should not solidify till the casting completely solidifies. So, you have to take a shape for which the solidification time is larger than that of the casting. Now we know, using the sovereign of rule t is proportional to v by a square volume by area square. So, it means this v by a, is a parameter which talks about the freezing time.

Now, freezing time of the riser and freezing time of the casting. So, among the 2 freezing time of the riser must be greater than the freezing time of the casting. So, you must take a shape for which the freezing time is greater or the same amount of volume of the liquid metal you have different shapes and freezing time for the shape which has maximum value that shape will be preferred as a riser shape. So, it has been seen that you have different shapes, you may have a spherical shape, you may have cylindrical shape, you may have cubical shape, but in among these 3 shapes, the spherical shape has the maximum v by a for a particular volume or for typical size, the spherical has the minimum amount of volume. In that case, the spherical size is the ideal one, but practically the sphere shape cannot be taken on that account because the sphere portion spherical shape will have the hottest metal in the code and you cannot have access to the core portion of the sphere. That is why this practically it is not possible.

So, the next step is cylindrical and this is the preferred choice for a riser shape. So, normally we take the cylindrical riser, but we also take the cylindrical riser and sometimes we have the hemispherical top that we put. So, that the freezing time is further having maximum value on the top you have minimum surface area there. So, in that case, a riser is taken as cylindrical, but with hemispherical top or without hemispherical top riser placement also is needs to be seen because where the riser should be placed riser should be placed at such a position that it should be able to feed the molten metal to those areas which is more prone to shrinkage and normally the chunky part of the casting is more prone to shrinkage. So, normally riser will be placed at a place near which there is chunky part or thick part because that will solidify late.

And in the later part, there may be requirement of the liquid metal. So that is why riser placement is also important and you have to see adequately, you have to place the risers at different positions that any part of the casting is not feeling isolated is not like a isolated reason which you may if requires liquid metal, it should be supplied by the riser at appropriate place with appropriate shape and size.

Thank you.