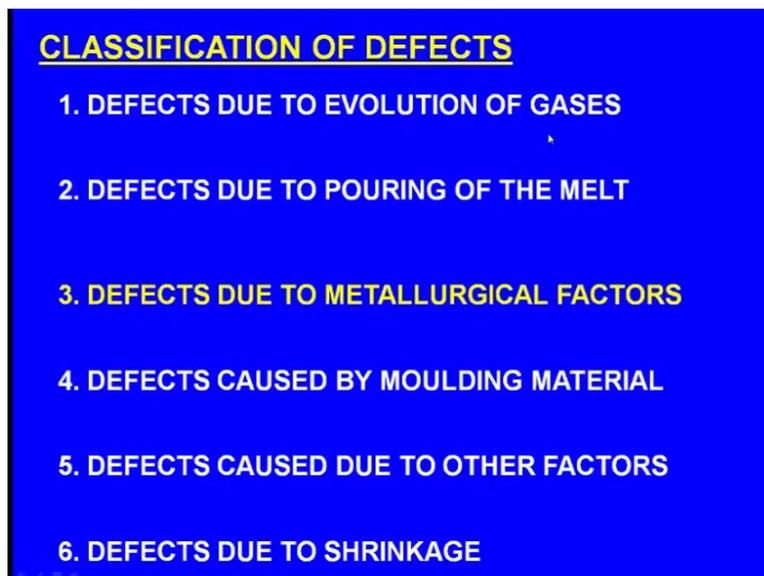


Metal Casting
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Module - 02
Sand Casting Process
Lecture - 17
Sand Casting Defects –II

Welcome back friends. In the previous class we have seen the casting defects and its classifications. We have seen that casting defects are broadly classified into six categories.

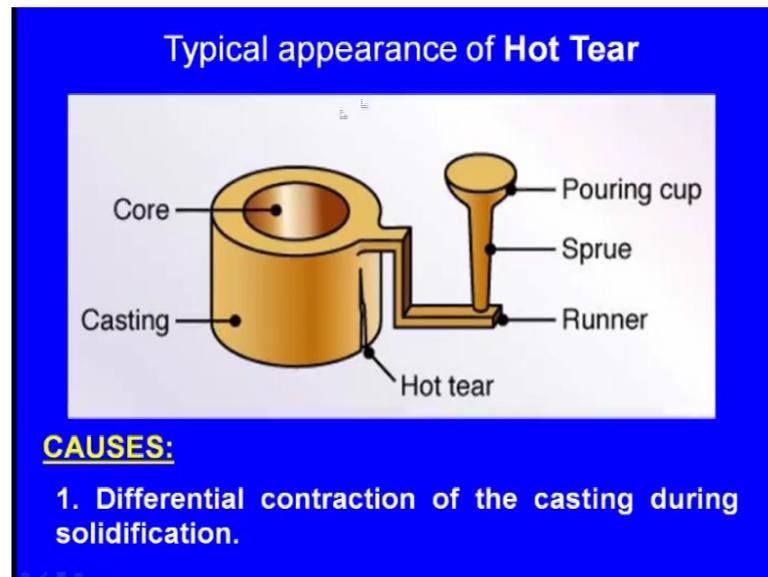
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One is defects due to evolution of gases, second one defect due to the pouring of the melt. Next one defect due to metallurgical factors defects caused by the moulding material defects caused due to other factors and finally, defects due to shrinkage. In the previous class we have learnt about defects due to evolution of gases and defects due to pouring of the melt.

Now, in this class let us learn about defects due to metallurgical factors. Now under these metallurgical factors there is a defect called hot tear, what is this hot tear this is the typical appearance of a hot tear.

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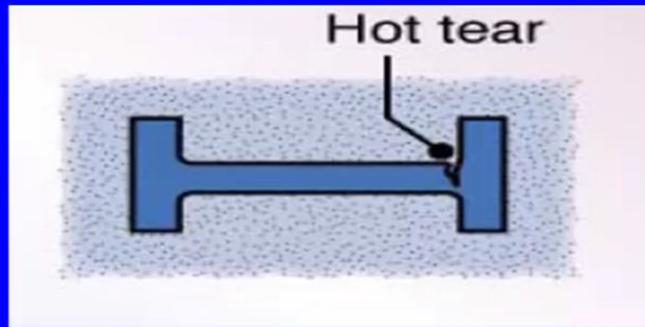


This is the casting, now this is the pouring cup the molten metal is poured through the pouring cup and it passes through the sprue, and this is the runner and it enters into the cavity, and here there is a core a very hard core is there. Now during final stage of the solidification a crack will be developed that happens during the final stage of solidification, this crack is known as the hot tear.

Now, what are the reasons for hot tear one is differential contraction of the casting during solidification, means this is a ring like casting ring type of casting and to there is a hollow cavity inside to get this hollow cavity inside we are placing a core mostly this will be a metallic core. Now as the what say contraction is going on the casting wants to undergo shrinkage and its size becomes smaller, where there is a core inside it to what say objects the contraction that is how this crack can take place this is the hot tear.

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Typical appearance of Hot Tear



CAUSES:

2. The casting could not undergo shrinkage freely during solidification, due to casting design.

There is another reason why this hot tear can occur the casting could not undergoes Shrinkage freely during solidification due to casting design here, we can see another casting you see the casting has got three different sections, and here one section, and here one section, and here one section.

Now, what happens is the middle section undergoes freezing early and it wants to contract, where as the two members they are objecting the contraction, that is how this middle portion could not undergo shrinkage freely because of the neighboring elements, that is how a crack can takes place here, so this is the hot tear.

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OTHER FACTORS INFLUENCING HOT TEARS

3. Chemical composition – High Sulphur content promotes hot tearing.
4. Long freezing range and decreased quantity of EUTECTIC influence hot tearing.

Al-10%Sn, Al-20%Sn, Al-30%Sn and Al-40%Sn are the most important alloys used in bearings.

Al freezes at 660 °C

Sn freezes at 232 °C

The third reason is chemical composition. In the cast iron and the steels sulphur is present, very small proportion of sulphur maybe 0.06 percent of sulphur is present in cast iron and in most of the steels. This sulphur enables machinability at the same time if the proportion of the sulphur is not controlled properly, this can induce cracking in the casting. So, chemical composition is another factor responsible for hot tear.

Next reason is the long freezing range and decreased quantity of eutectic right. So this is another reason which influences hot tearing long freezing range means what there will be generally we cast alloys means, two or more metals will be there in the melt for example, let us take aluminum and 10 percent tin aluminum freezes at 660 degree centigrade, where as tin freezes at 232 degree centigrade.

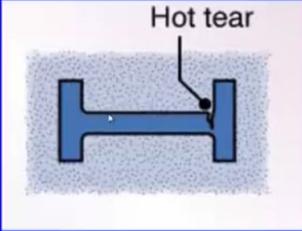
Now, what happens because of this what say difference in the freezing point, the freezing range is very longer for example, you consider let us consider say four types of compositions aluminum 10 percent tin, aluminum 20 percent tin, aluminum 30 percent tin, and aluminum 40 percent tin. Now let us take aluminum 10 percent tin, and we pour it about to say 700 degree centigrade, and say aluminum starts somewhere about say 600 degree centigrade it is starts freezing.

Now, what happens the tin will be there as the aluminum previous the tin will be it will be filling the gap that happens right, in the case of the aluminum 40 percent tin case there will be more tin will be there right. So, this tin because of what say reason the tin will be replacing the gap.

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REMEDIAL MEASURES FOR HOT TEARS

1. Use exothermic pads.
2. Control the composition – minimize Sulphur content in the liquid metal.
3. Use grain refiners (Eg. Al-8B, Al-3B, Al-3Ti-0.15C, Al-5Ti-1B, etc.).
4. Exploit the benefits of residual and alloying elements.



The diagram shows a cross-section of a cast metal component, likely a T-joint or a similar structure. A vertical crack is visible in the center of the horizontal section, labeled 'Hot tear'. The crack is filled with a darker material, possibly a repair or a byproduct of the casting process. The surrounding metal has a grainy texture, indicating a cast structure.

So, that is how the long freezing range is responsible for the hot tearing, how to prevent hot tearing one is use exothermic pads. Now here is the one portion which is what say undergoing shrinkage very quickly we place a exothermic pads. So, that it is freezing, and it is cooling will be delayed that is how we can prevent hot tearing.

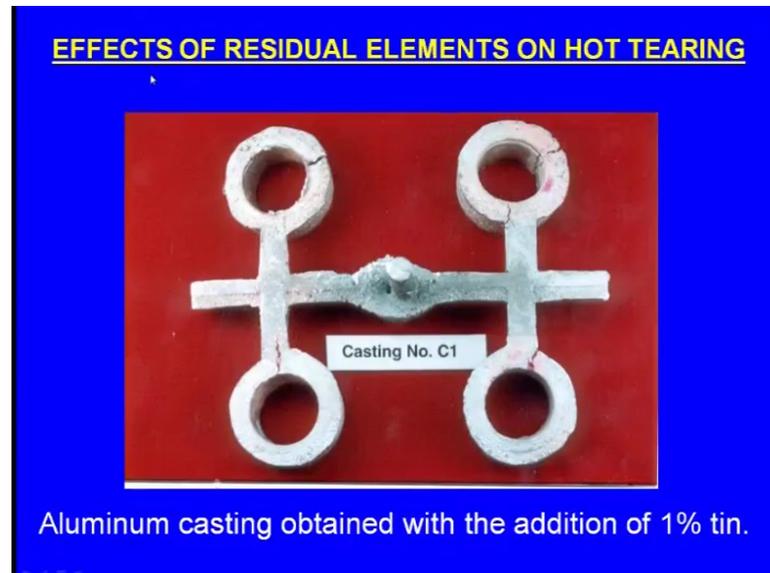
Next one control the composition minimize the sulphur content in the liquid metal, we have seen that the sulphur enables for us and it improves the machinability at the same time if the sulphur content is more it induces hot tearing, that is why we have to carefully control the sulphur content. Next one use grain refiners, when we use the grain refiners the grain structure of the cast component becomes finer and finer, when the grain structure becomes finer the possibility of hot tearing will be lesser.

So, there are different types of grain refiners or there aluminum 8 boron, aluminum 3 boron, aluminum 3 titanium, and 0.15 carbon, aluminum 5 titanium one boron, and many more grain refiners are there we have to choose a an appropriate grain refiner. So, that we can refine the cast structure and which ultimately reduces hot tearing.

Next one exploit the benefit is of residual and alloying elements, what are the residual elements. If we take the what say what say pure commercial aluminum do not think that the aluminum is 100 percent aluminum, in that there will be small amount of iron will be there which comes what say without our knowledge about say 0.5 percent iron, this is

known as the residual element it is an example. Now sometimes these kinds of elements help us to prevent hot tearing.

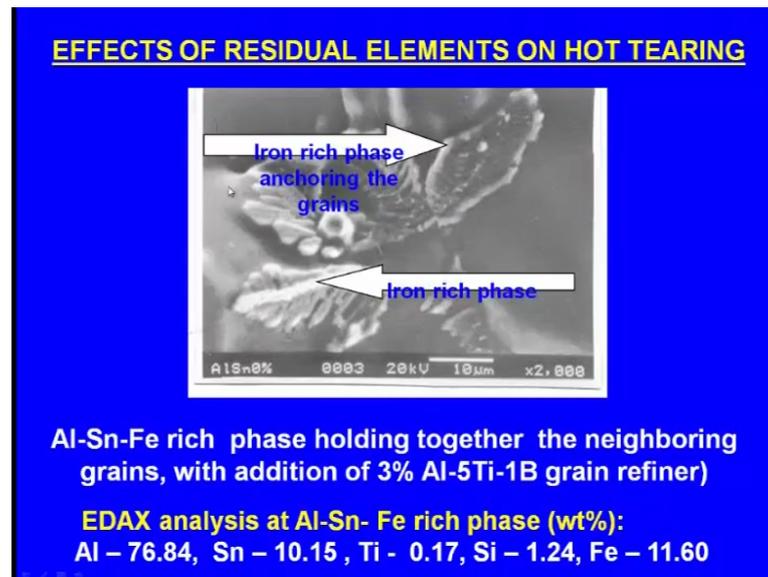
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Now, in a research it was found that iron which is the residual element in commercial aluminum can reduce and even prevent hot tearing in the aluminum castings for example, let us consider this casting. So, this is the casting obtained right with the addition of 1 percent tin castings freezing point is say aluminum freezing point is 660 degree centigrade, and the till's freezing point is 232 degree centigrade.

Now, because of the long freezing range and here we can see everywhere there are cracks are there. Now what happened is iron was added intentionally right, iron was added and 1 percent of tin, you can see and 3 percent of the grain refiner, and 6 percent of aluminum 30 iron master alloy. Now the cracking has completely gone there is no hot cracking, with the addition of iron in the aluminum melt hot tearing was totally prevented.

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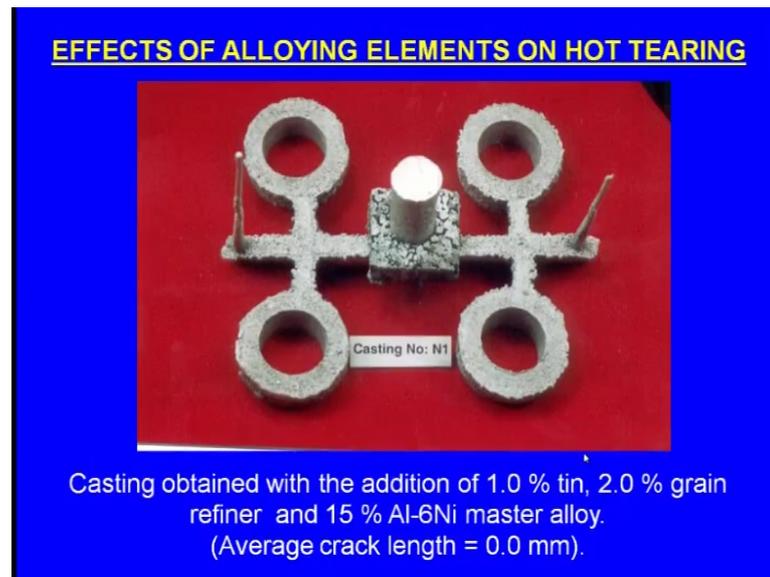


Why it was prevented this is the SEM examination. If we see that so, here are the grains and here we can see a leaf like structure. So, this is the aluminum tin iron rich phase.

So, this has frozen much earlier than the remaining grains. So this has become hard and strong and it was able to catch the neighboring grains, that is how they residual element like iron has prevented hot tearing in the aluminum tin casting, and here we can see a magnified view. So, here we can see that leaf like structure has become hard and strong much before the neighboring grains and it is catching the neighboring grains that is how the hot hearing is prevented.

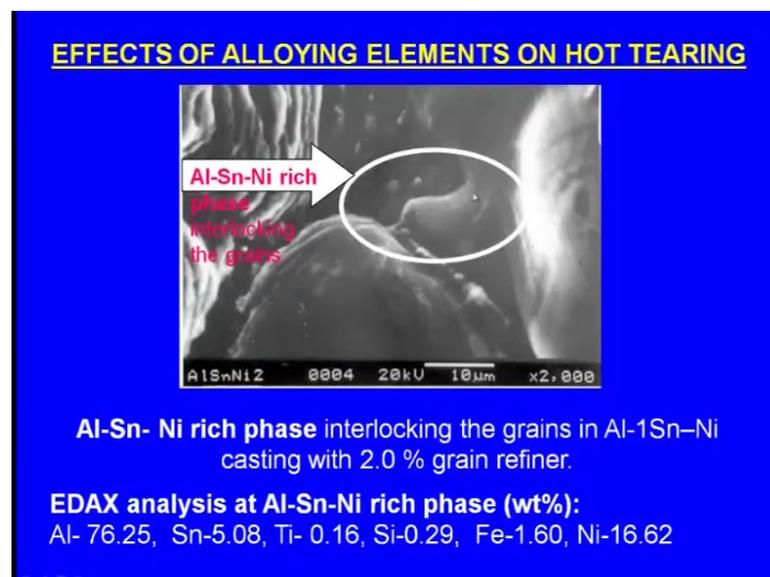
Now effects of alloying elements on hot tearing nickel is one of the common alloying elements in aluminum castings. Now here nickel is added intentionally, we can see here casting obtained with the addition of 1 percent tin, 2 percent grain refiner and 15 percent aluminum 6 nickel master alloy, again the hot tearing has completely gone.

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Hot tearing was completely prevented, with the addition of nickel which is the common alloy increment in aluminum again SEM was conducted here, we can see these are the neighboring grains these grains are captured by the somewhat say here this reason.

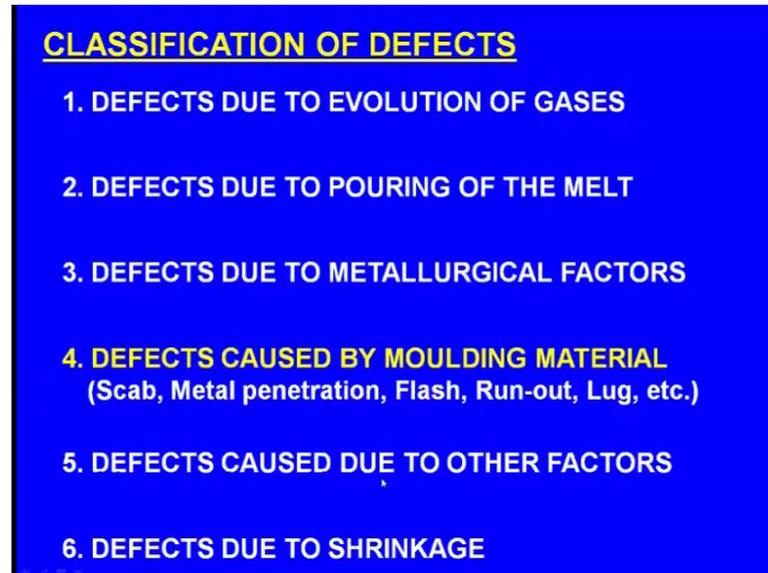
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We can see this is the aluminum tin nickel rich phase this rich phase was interlocking the neighboring grains, again this aluminum tin nickel rich phase has frozen much earlier than the neighboring grains that is how hot tearing in the in this casting was prevented.

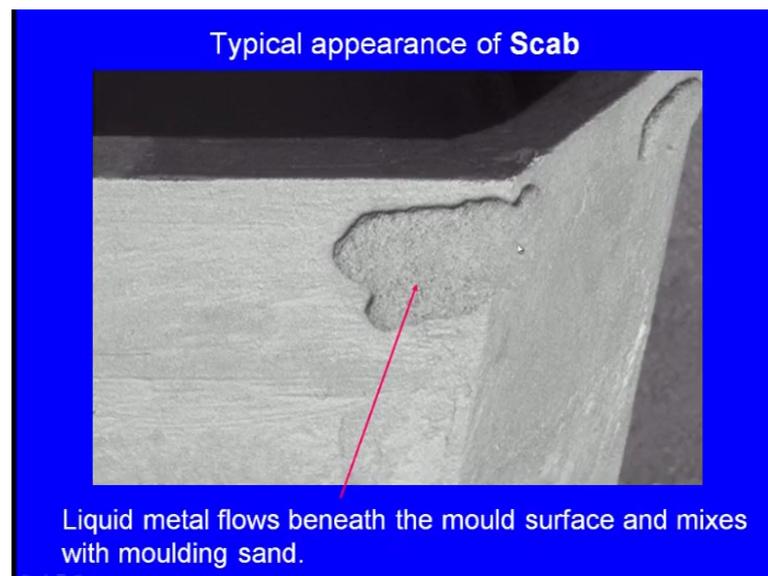
Now, let us see the defects caused by the moulding material; moulding material, means the moulding sand. In the moulding sand something is wrong that is how these defects are occurring.

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Under this we have scab metal penetration, flash, run out, lug first let us see this scab. Now what is a scab.

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So, this is the casting you can see this is the typical appearance of scab, what is this liquid metal flows beneath the mould surface and mixes with moulding sand. The

moulding sand is loosely compacted around the what say pattern maybe the moisture content is not enough maybe the clay content is not enough, that is how the molten metal is able to take away certain sand grains, and molten metal, and sand grains are mixed together and they are occupying a place above the casting, this becomes a ceramic and it is very difficult to machine it and to remove it. So this is the scab. Now what are the reasons, what are the factors responsible for scab?

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SCAB

CAUSES:

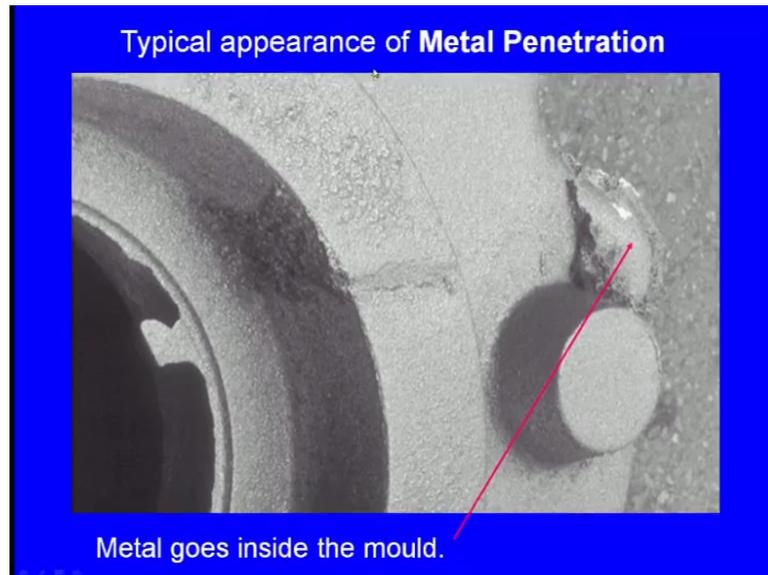
1. Low moisture content in the moulding sand (below 3 %).
2. Insufficient clay in the moulding sand.



Typical appearance of a
Scab

Low moisture content in the moulding sand, when the moisture content is below 3 percent this can happen are insufficient clay, and they clay is not sufficient the time also this defect can happen. Now how to prevent this defect proper moisture and clay contents are to be taken, that is how we can prevent this defect scab. Next one let us see the metal penetration.

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Now you can see here this is the casting this is the casting, but this is not part of the casting here we can see unwanted projection above the casting. In fact the molten metal has penetrated into the mould unnecessarily and it is causing unnecessary projection.

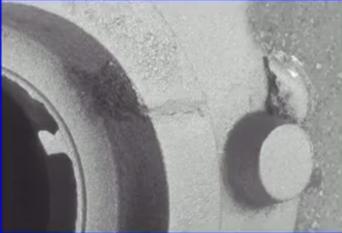
So, this is known as metal penetration. What are the factors responsible for metal penetration larger sand grains, the mould is made up of sand grains are the moulding sand which contains the base sand clay water and the additives. The base sand it contains the sand grains, if the sand grains are too larger between the neighboring sand grains there will be gap and the molten metal can penetrate into the gap and cause this kind of projection.

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METAL PENETRATION

CAUSES:

1. Larger sand grains.
2. Insufficient compaction of sand.



Typical appearance of
Metal Penetration

So, when the sand grains are very larger this penetration defect can occur, there is another reason insufficient compaction of the sand if the moulding sand is not compacted around the pattern sufficiently, then also this defect can occur. What are the remedial measures? use fine sand grains it does not mean that the sand should be very fine, then in such a case the permeability will be very poor, it should not be too fine the sand should not be too coarser. Next one reduce casting temperature, when the casting temperature is very high it can penetrate.

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METAL PENETRATION

REMEDIAL MEASURES:

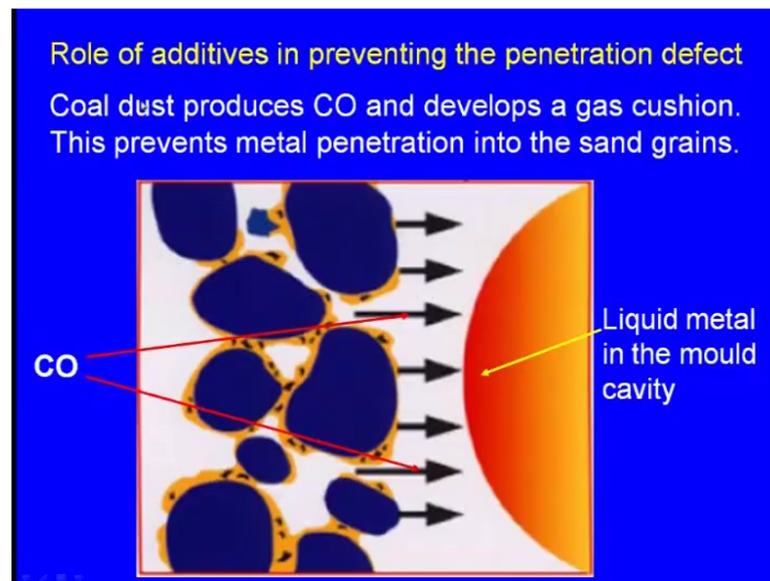
1. Use fine sand grains.
2. Reduce casting temperature.
3. Apply sufficient compaction of mould.
4. Use additives in the moulding sand.



Typical appearance of
Metal Penetration

Next one apply sufficient compaction of the mould, next one use additives in the moulding sand, we have seen that the ingredients of the grains and are the base and clay additives and the moisture. Now these additives they help us to prevent the metal penetration defect.

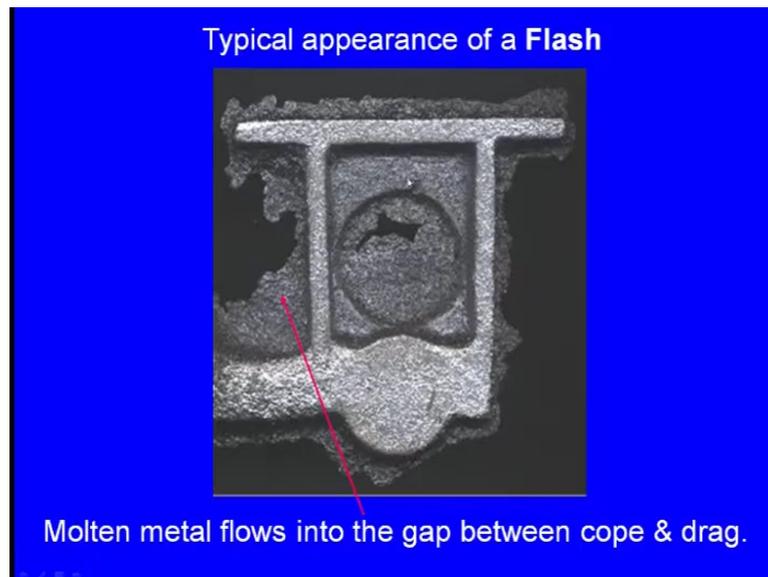
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Now let us see how it is possible, now one coal dust is one of the additives. Now when we mix the coal dust with the mouldings sand what happens it produces carbon monoxide, now here we can see these are the sand grains.

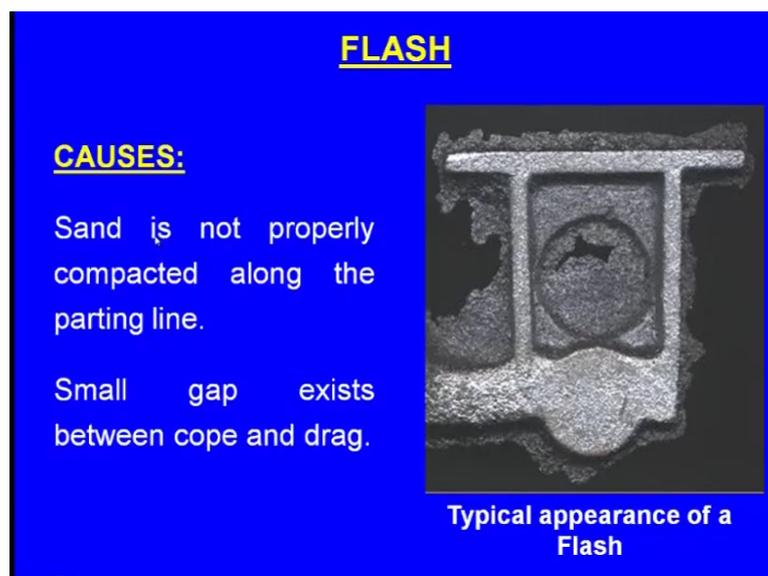
Now, this is the liquid metal, now there a definitely there is a gap between the neighboring sand grains. The molten metal can penetrate this way and it was above to penetrate into the gap of the neighboring sand grains, but before the molten metal can penetrate into the this gap this carbon monoxide which is generated due to the mixing of coal dust is pushing the molten metal in the opposite direction, that is how this penetration defect can be prevented and minimized. Next one let us see the flash now here we can see this is the casting.

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Now, one is this is the casting one is this is the casting, but here we can see this is the unwanted material or unwanted flash, here we can see unwanted flash, and here we can see unwanted flash, here we can see unwanted flash, means metal molten metal flows into the gap between cope and drag. The mould is made up of cope and drag, and these two are separated by the parting line along the parting line sometimes if there is a small gap the molten metal penetrates into that small gap, that is how this flash will occur.

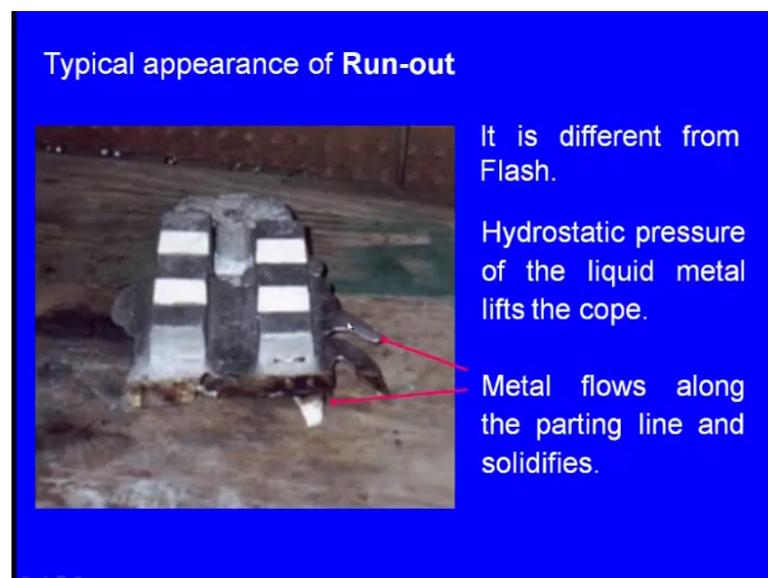
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Causes, sand is not properly compacted along the parting line small gap exists between cope and drag. Now, what the remedial measures moulding sand should be leveled properly along the parting line after the compaction is over it must be leveled properly, this not be any depression along the parting line neither on the drag nor on the cope, then only we can prevent this flash defect.

Next one let us see the run out, now you we can see this is the casting, and here we can see this is an unwanted projection and this is an unwanted projection.

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This is similar to the previous defect which is known as the flash, but it is not the same as the flash defect there is a difference. In the previous case the flash occurred due to gap between cope and drag, because there was unwanted and unnecessary gap between cope and drag molten metal has penetrated into that gap that is how the flash has occurred, but here even if there is no gap between cope and drag this run out can happen.

So, that way it is different from flash, then why does it occur hydrostatic pressure of the liquid metal lift the cope, the liquid metal has got hydrostatic pressure as we keep pouring the molten metal inside the mould, because of the hydrostatic pressure of the liquid metal the cope can lift up that time again, there is a gap between cope and drag that time the molten metal flows between this gap, that is the run out.

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RUN-OUT

CAUSES:

1. The cope rises up during pouring of the metal, due to hydrostatic pressure of the poured metal.
2. Insufficient weight of the cope.



Typical appearance of a Run-out

So, that way it is different from flash right, cope rises up during pouring of the metal due to hydrostatic pressure of the liquid metal. Sometimes even the insufficient weight of the cope you can be another reason for run out. Now how to prevent this defect run out this is the remedial measure.

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RUN-OUT

REMEDIAL MEASURES:

Place some weight over the cope before pouring of molten metal.



Place some weight over the cope before pouring of the molten metal right. So, this is the drag this is the cope, and here we have placed some weights here you see because of this weights the cope cannot lift up due to the hydrostatic pressure of the molten metal a fine,

when we place weights on the cope it cannot rise up and this run out defect cannot occur, that is how we can prevent the run out defect.

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Next one let us see the lug, now here you can this is the typical appearance of a lug, here we can see this is the casting, this is not part of the casting, this is not part of the casting, means metal solidifies in unwanted cavities surrounding the mould, somehow some unwanted cavities have the occurred have developed around the mould; molten metal flows, even into these unwanted cavities and forms unwanted projections. This is the a lug.

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LUG

CAUSES:

Some portions of the cast contour are broken off in the mould area (after withdrawal of pattern).



Typical appearance of a Lug

Causes, some portions of the cast contours are broken off in the mould area after withdrawal of the pattern. Some portions of the what say cast control are broken maybe due to what say poor handling of the mould are it is a mechanical breakage of the mould cavity. in such times this lug can happen remedial measures check for pressure points and broken off edges before pouring.

After withdrawal of the pattern, we have to check the cavity whether it is perfect or not. Whether it is broken somewhere due to what say miss handling of the mould.

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LUG

REMEDIAL MEASURES:

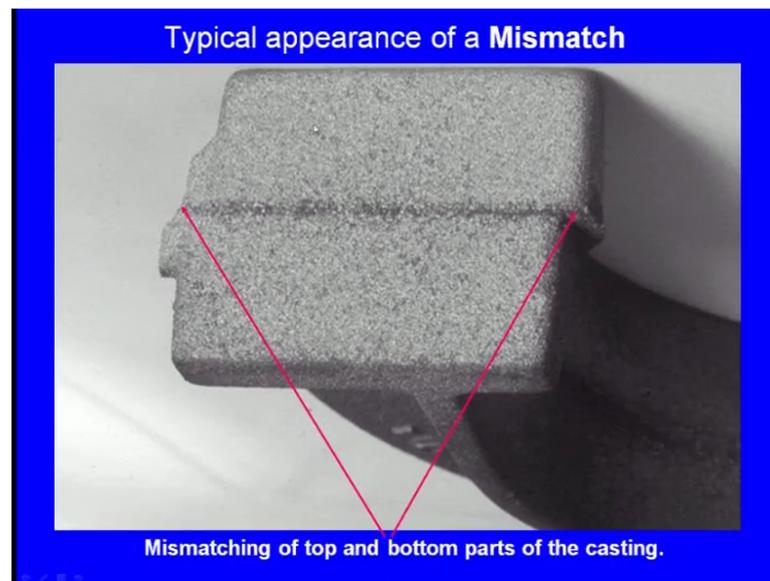
Check for pressure points and broken off edges before pouring.



Typical appearance of a Lug

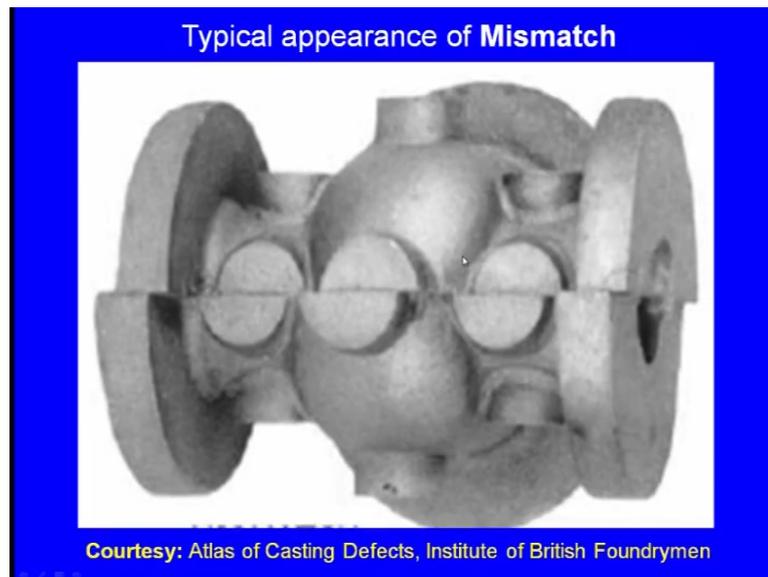
Are due to mechanical Breakage, if there is any unwanted cavities we need to check if that be the case we have to repair the mould cavity, then only we have to pour the molten metal, and that is how we can prevent this defect lug. Next one defects caused due to other factors. Under this we have mismatch and hot cracks, first let us see the mismatch.

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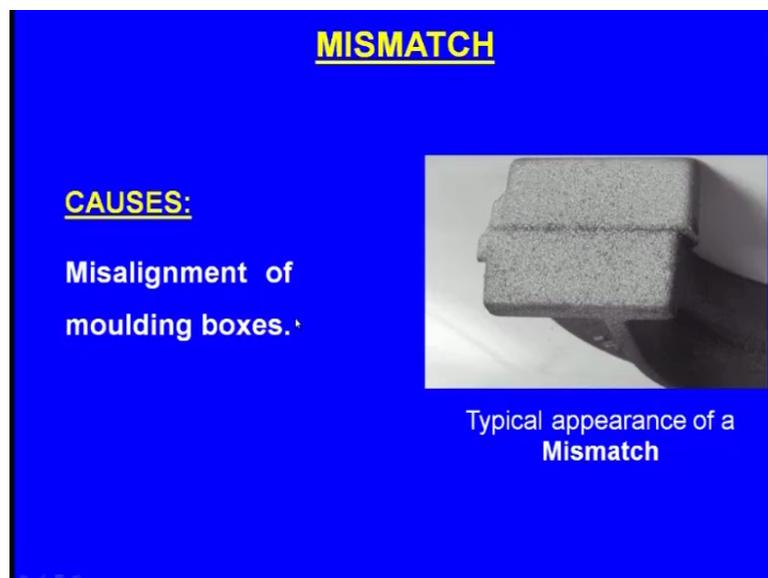
Now we can see here this is a casting, now here we can see this portion was what says compacted in drag, and this portion was compacted in cope. Now there is a shift between these two portions and this defect is known as mismatch means, mismatching of top and bottom parts of the mould or the casting. Now what are the reasons for mismatch?

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Again we can see another casting this is the casting, again we can see there is a mismatch causes misalignment of moulding boxes.

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Now the cope will be there and drag will be there. Now after withdrawal of the pattern again we place the cope over the drag, and we place the dovetail pins for the proper alignment, sometimes what can happens due to repeated use of these dovetail pins, they may wear out and the they dimensions becomes smaller, and that is how they can be

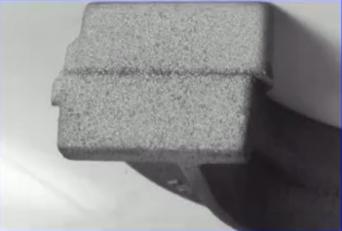
some displacement between the cope and drag are they can be misalignment between cope and drag.

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MISMATCH

REMEDIAL MEASURES:

1. Ensure proper alignment of moulding boxes.
2. Replace worn-out dovetail pins by new ones.

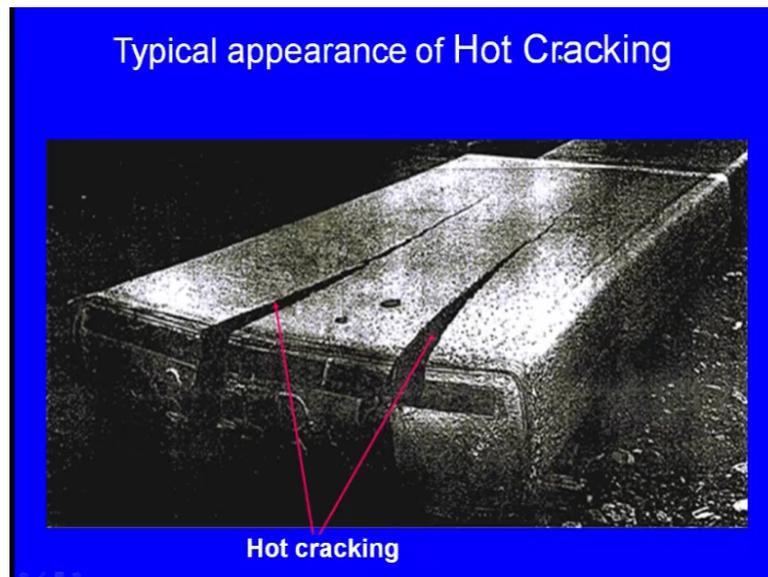


Typical appearance of a
Mismatch

Remedial measures ensure proper alignment of the moulding boxes, while we are placing the cope box over the drag box we have to ensure that it is perfectly resting over the drag.

Next one replace worn out to dovetail pins by new ones, they should they should not be worn out if that be the case even if you place the dovetail pins there can always be a shift, or there can always be a mismatch between the drag and cope. Next one hot cracks, this is another what say defect which comes under the defects caused due to other factors. Now previously we have seen a similar defect under the metallurgical factors that was the hot tearing or hot tear, now this is hot crack. So, these two are different.

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Now, you can see here this is the typical appearance of hot cracking, now this is a big casting, now here there is a crack and here there is a crack the hot tearing defect occurred during the final stage of the solidification, whereas this defect hot cracking occurs after the solidification is completely over during the solid cooling this can occur, that way hot tearing and hot cracking are different. It is different from hot tearing that we have already seen.

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HOT CRACKING

It is different from Hot Tearing.

HOT CRACKS MAY OCCUR:

- During cooling in the mould
- During knocking out
- During cooling after knock-out
- During a heat treatment cycle



Typical appearance of Hot Cracking

HOT CRACKS MAY OCCUR:

- Due to uneven cooling conditions
- Differential contraction

Now hot cracks may occur due to the following reasons right or in the following cases during cooling in the mould. After the solidification is completely over, when it is cooling down to the room temperature that time this defect can occur during cooling inside the mould are during knock out after the casting is completely solidified we break the mould, and take the casting outside. This process is known as the knock out, that time this can happen.

During cooling after knock out may not be after during what say knockout after; knockout, maybe the casting will be moved from one place to another place that time this defect can occur means the hot cracking are during a heat treatment cycle, after the what say solidification is over after the knockout is over we give heat treatment to improve the properties that time also this defect can occur. So, hot a hot crack may occur due to uneven cooling conditions and also due to differential contraction. These are the remedial measures, one is use chills; chills, are the what say large steel blocks which are kept close to the mould cavity. These absorb heat rapidly, so when we place the chills the possibility of hot cracking comes down.

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HOT CRACKING

REMEDIAL MEASURES:

- Use chills**
- Use fillets**
- Avoid rough handling**



Typical appearance of
Hot Cracking

Next one use fillets and avoid rough handling sometimes, because they what say casting is handled roughly the time also this defect can occur that is why rough avoid rough handling finally, we have another defect defects due to shrinkage under this we have only one defect called shrinkage cavity.

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SOLIDIFICATION SHRINKAGE

- Solidification causes a reduction in volume in almost all the metals.
- Exception: **Cast Iron** with high Carbon content
 - Graphitization during final stage of freezing causes expansion, which counteracts the volumetric shrinkage.

Solidification causes a reduction in volume in almost all the metals it is a universal fact solidification causes reduction in the volume, but there is a an exceptional case also right. Cast tearent with high carbon content what happens when it is undergoing what say is solidification it is volume will be increasing due to graphitization.

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Shrinkage cavity

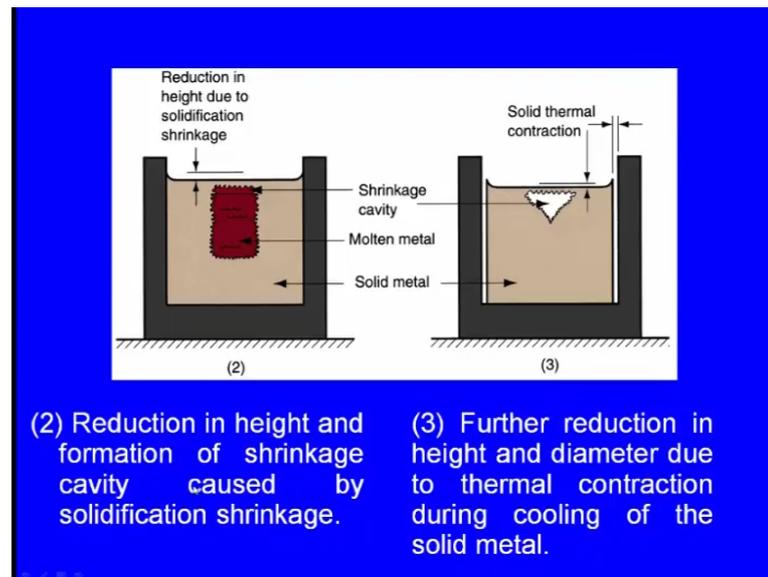
The diagram shows two cross-sections of a mold. In (0), the mold is filled with molten metal up to a certain level. In (1), the metal has cooled and contracted, causing the liquid level to drop. A thin layer of solidified metal is shown at the mold wall, and a gap (shrinkage cavity) has formed between the solidified metal and the mold wall.

(0) Starting level of molten metal immediately after pouring.

(1) Reduction in level caused by liquid contraction during cooling.

Now, here we can see this is the liquid metal, and here we can see the liquid metal is poured and say this there is a reduction in volume due to liquid cooling reduction, in liquid level caused by the liquid contraction during cooling.

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Here we can see reduction in height on formation of the shrinkage cavity caused by the solidification shrinkage.

Now, the solidification is going on that is how there will be reduction in height and also there will be formation of the shrinkage cavity. Now this what say we have we have seen two types of shrinkage is in the previous case there is liquid cooling, in because of the liquid cooling, there is a reduction in volume this will be compensated by the riser.

We always keep sufficient amount of liquid metal in the riser that is the primary function of the riser the primary function of the riser is to supply liquid metal to the casting during solidification, and also during liquid cooling, so that the volume will be same as the volume of the mould cavity.

So, this gap will be compensated by the liquid metal in the riser. Similarly here we are going to get a what say solidification shrinkage, this is also is going to be compensated by the liquid metal in the riser, that is why because of the what say liquid cooling, because of the solidification shrinkage this is shrinkage defect can occur, but when this riser are the liquid metal in the riser is what say enough this defect can be minimized.

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And here we can see there is a casting with shrinkage here, we can see because there is no riser, here for this casting no riser, here we can see no riser, that is how shrinkage defect is occurring causes insufficient rise of the riser.

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SHRINKAGE CAVITY

CAUSES:

1. Insufficient size of the riser.
2. Improper positioning of the riser.
3. Premature freezing of liquid metal in the riser.
4. Abrupt changes in the casting design.

We may use the riser, but it must be large enough to supply liquid metal to the casting during liquid cooling and also during solidification shrinkage.

Next one we may have the enough what say liquid metal in the riser, but the position of the riser may not be proper, it must be propped in the it must be positioned in the right

place. Next one premature freezing of the liquid metal in the riser, this is most unwanted situation the purpose of the riser is to feed liquid metal to the casting.

So, it must be the one which should free at the end, where as the casting must freeze before riser on the other hand due to some reasons due to the casting design of the riser design the liquid metal in the riser freezes first, then the liquid metal in the casting. Then how the riser can supply liquid metal to the casting it cannot that is why premature freezing of the liquid metal in the riser can be another reason for the casting, what say shrinkage defects, the what say size of the riser maybe enough and it is position may be good, but it is freezing in a premature way that is most unwanted situations.

Next one abrupt change in the casting design, when the casting design right because of the abrupt changes the riser liquid metal in the riser may not supply to the required location. In such a case also the cast shrinkage cavity can occur.

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SHRINKAGE CAVITY

REMEDIAL MEASURES:

1. Design the riser sufficiently large.
2. Ensure **Directional Solidification**.

Remedial measures one is design the riser sufficiently larger. We have seen that the riser supplies liquid metal during liquid cooling and solidification shrinkage, and the liquid metal in the riser must be large enough to supply the entire liquid shrinkage and solidification shrinkage. So, use of a riser is not enough it must be large enough to supply the entire liquid metal to the entire liquid cooling and solidification shrinkage.

Next one ensure directional solidification, we may have the sufficient what say riser which is large enough which is having sufficiently liquid metal to what say supplied the liquid what say cooling to compensate the liquid cooling, and solidification shrinkage, but if the direction of solidification is not there the riser may not supply are the efficiency of the riser may not be high.

Now, let us see what is this directional solidification growth of partially solid and partially liquid zone from the outside to inside is known as directional solidification, here we can see this is the and what say casting, and this is the riser. Now the directional solidification means from outside to inside. So, this directional solidification must be there, ways to achieve directional solidification locate risers away from the sections with lower volume to area ratios, so freezing occurs first in these regions.

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Ways to Achieve Directional Solidification

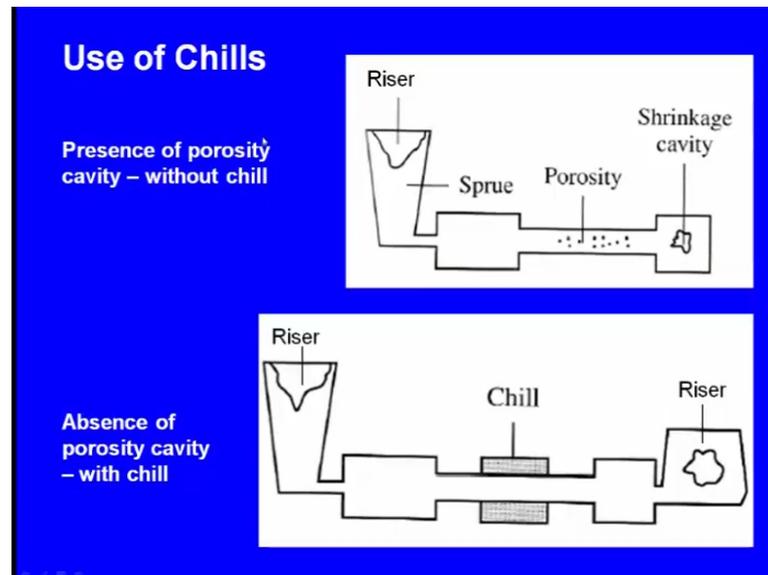
1. Locate risers away from the sections with lower V/A ratios, so freezing occurs first in these regions. ✓
2. Use chills at required locations. ✓
3. Modify the casting design such that it promotes directional solidification. ●
4. Use blind riser.
5. Use exothermic material on the top of riser.
6. Cover riser with insulating compound / pad.

Second one use chills at required locations. Next one modifies the casting design such that it promotes directional solidification.

Next one use blind riser, next one use exothermic material on the top of freezer, next one cover the riser with insulating compound or the pad. So, these of the ways to achieve directional solidification, now let us discussed this one by one. First let us see the first reason, locate the risers away from the sections with lower volume to area ratio; lower volume to area ratio means, what you can see here this volume to area ratio can be lower when this area is larger, then what will happen the solidification occurs first at this

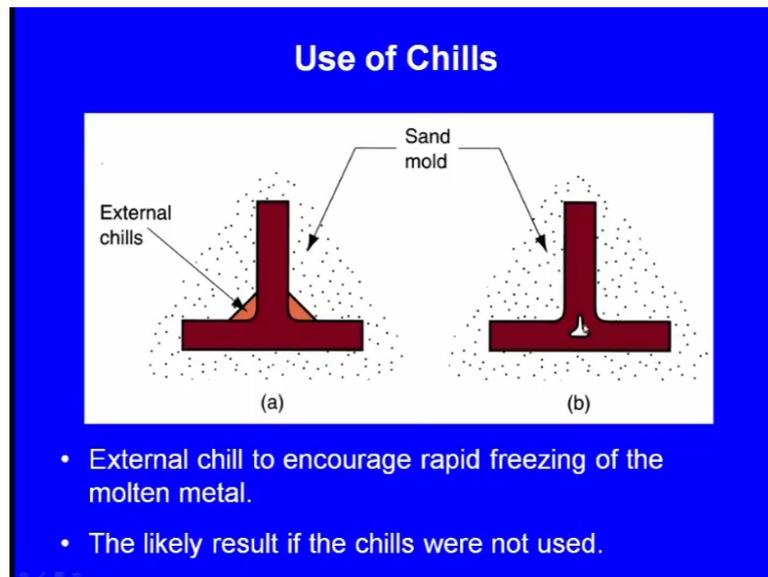
regions, then slowly the solidification will be propagating to the other regions that is why look at the riser away from the sections with lower volume to area ratios, second reason is use chills at required locations.

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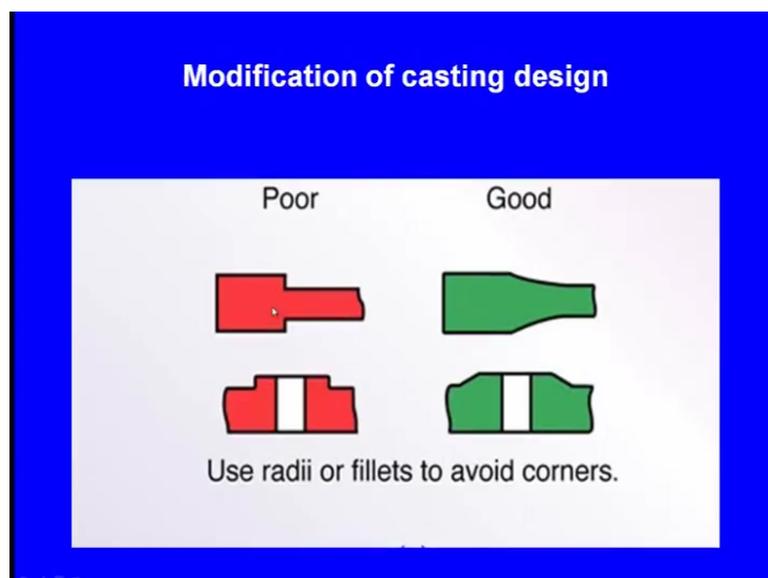
Now, these are the chills, now this is the casting where there is no chill. Now this is the casting this is the riser, now yes because there is no what say chill here we there can be porosity defect or here they can be shrinkage defect, now what we are doing is here we are placing the chill, chills are the steel blocks which are place close to the mould cavity this chill blocks rapidly absorb heat, now there cannot be porosity and even shrinkage defect cannot occur. So, use of chills can help us to prevent the shrinkage defect.

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And here we can see this is the casting this is the casting in side there is a shrinkage cavity is there you see on the other hand, here we are placing the chills, and here is one chill and here is one chill. These chills are extracting heat so, this portion will be solidifying right somewhat quickly, that is how this what say shrinkage defects cannot occur in this case.

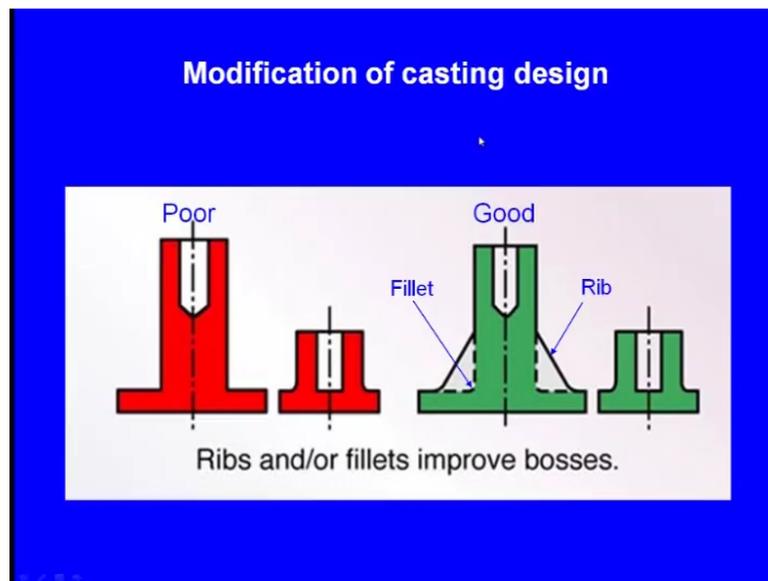
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Next one modify the casting design, such that it promotes directional solidification now you can see here, different designs are there right. So, this is the what say actual shape of

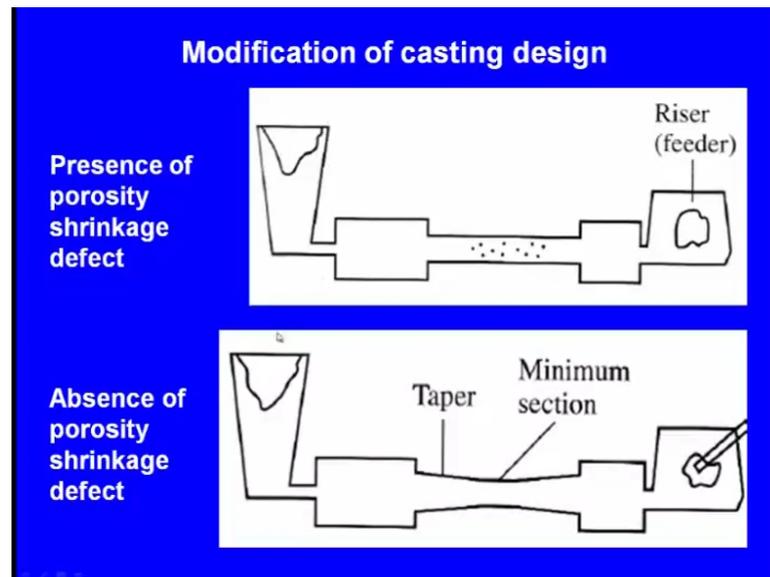
the casting, this is not so, good this design instead you modify like this maybe here, this is the shape of the casting, here we can see an abrupt change is there abrupt change in the design. Let us modify like this. So, by modifying the castings design we can minimize the hot tearing are we can achieve the directional solidification.

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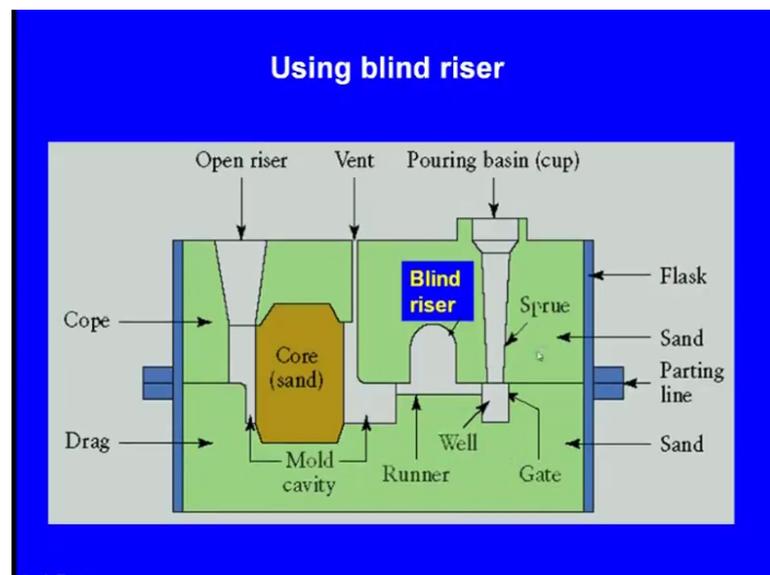
Next one modification again we can see here yes here is then a abrupt change, and here we are using fillets. So, this is poor design where as with fillet it is better design or a good design, and here we can see this is the casting here on there is no what say deviation in this portion are there is no change, but here we are making a taper, what happens when we make taper here at the central portion there is minimum thickness the portion, which has got the minimum thickness starts freezing slowly the freezing will be propagating to the other portions and finally, the freezing will come towards the riser.

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So, by placing a taper or by modifying the casting design we can achieve directional solidification. Directional solidification means the solidification has to propagate from the lower volume to area ratio to the other regions towards the riser.

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Next one use blind riser, now this is the bound, and this is the drag, this is the cope, and here we can see this is the open riser. Now the efficiency of the riser can come down

because of an open riser what happens it is exposed to the atmosphere, that is how it is what is a freeze early on the other hand there is a blind riser is there.

This blind riser is not exposed to the atmosphere it will be it will be in liquid state for a prolonged time, then what happens wherever there is a shrinkage cavity this if the open riser fails to supply liquid metal, the blind riser can definitely supply liquid metal that is how by using the blind riser we can achieve directional solidification, then we can minimize the shrinkage defect.

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Using exothermic material on the top of riser

Exothermic compounds are mixtures of metal oxides (Oxides of Ni, Co, Cu, Mn, Fe, etc.) and aluminum.

They are placed on the top of the riser.

Typical exothermic compound: **Fe₂O₃ + Aluminum**

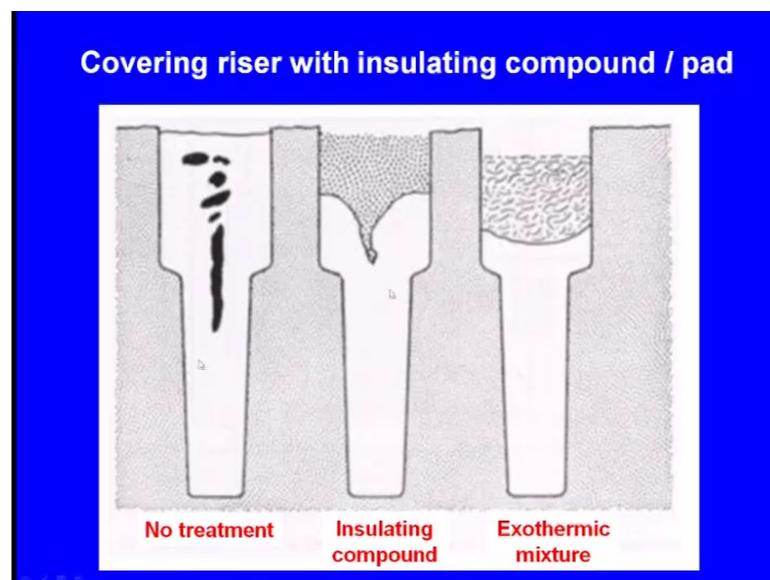
$$4 \text{Fe}_2\text{O}_3 + 8 \text{Al} \longrightarrow 4 \text{Al}_2\text{O}_3 + 8 \text{Fe} + \text{Heat (4500 }^\circ\text{C)}$$

Next one use exothermic material on the top of the riser. Now exothermic what say compounds are mixtures of metal oxides; oxides of nickel, cobalt, copper, manganese iron, and aluminum, they are placed on the top of the riser. Now a typical exothermic compound will be like this right Fe₂O₃ plus aluminum, now what happens when these two what say mixtures are what say mixed right, here we can see a Fe₂O₃ and aluminum, now there will be an exothermic reaction will be taking place and finally, lot of heat will be generated.

Now, this exothermic mixture is placed on the pump of the riser. Now when the riser is about to freeze what happens because of this exothermic reaction the material or the metal inside the riser will be in liquid state for a prolonged time. Till it supplies liquid metal to a very portion which requires liquid metal that is how by using exothermic material we can achieve the directional solidification. Directional solidification means

the solidification has to commence right, where there is minimum thickness then slowly it has to propagate towards the riser means in the direction of solidification riser should solidify at last so by placing the exothermic material we can ensure that the riser will be solidifying finally. Finally, cover the riser with insulating compound or pad, here we can see this is the riser. Now in this case we are placing or we are covering the riser with insulating compound or insulating pad what happens what is our aim first of all to achieve the directional solidification there liquid metal in the riser must be in liquid state for prolong time.

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Now, it is open to the atmosphere here, but are it is exposed to the mould wall again the mould wall what say absorbs heat rapidly. Now we are placing a insulating what say pad around the riser, now this would not allow heat to dissipate from the riser to the mould wall, that is how the liquid metal in the riser will be in liquid state for a prolong time, then what happens this can supply it can supply the liquid metal to the portion where there will be shrinkage.

Friends now in these two lectures we have seen the classification of the defects and we have seen that defects are classified into totally six types, one is the defects due to the evolution of the gases. Next one defects due to the pouring of the melt poring of the melt means molten metal or the molten alloy, next one defects due to the metallurgical factors we have seen, next one defects caused by the moulding material means the moulding

sand, next one we have seen defects caused due to the other factors finally, we have seen the defects due to the shrinkage. With this we are completing the casting defects and we will meet in the next class.

Thank you.