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CLASIFICATION OF CASTING DEFECTS : A REVIEW

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ABSTRACT

Casting is a age old production technique wherein cavities are formed by a pattern into a porous and refractive material, usually sand, and then liquid metal is poured into the cavity so that it takes up the shape of the cavity, thus forming the required metal product. Green sand casting process involves many process parameters which affect the quality of the casting produced. Defect in casting are observed and hence casting process is also known as process of uncertainty which challenges explanation about the cause of casting defects. In order to identify the casting defect and problem related to casting, the study is aimed in the research work. This will be beneficial in enhancing the yield of casting.

Keywords: *Casting; defects in casting; Classification of casting defects; Causes and remedies for casting defects.*

1. INTRODUCTION

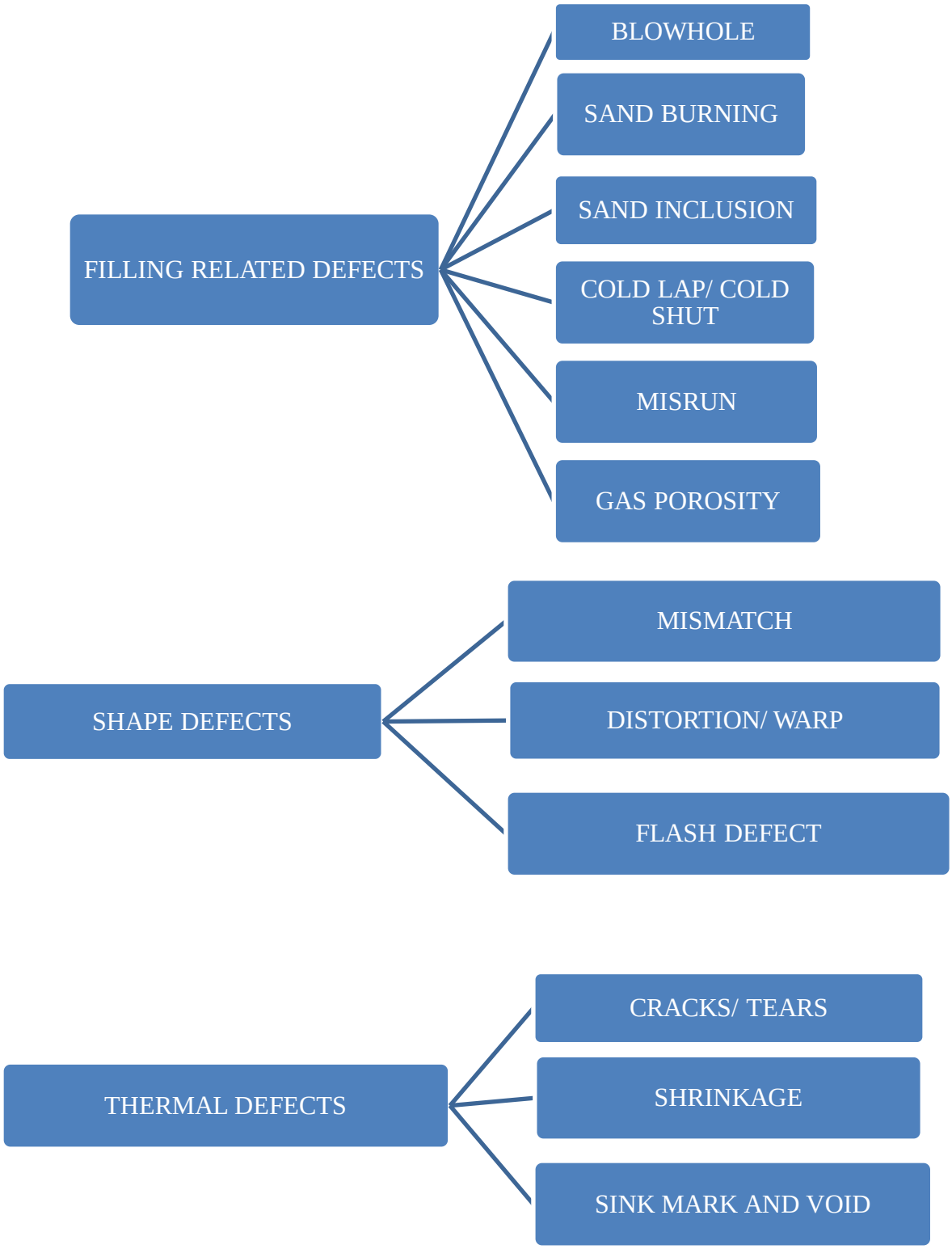
Casting process is the most widely used process in manufacturing industries especially in automotive products. Production of casting involves various processes like pattern making, molding, and core making and melting. A casting defect is an undesired irregularity in a metal casting process. Some defects can be tolerated while others can be repaired, otherwise they must be eliminated. Foundry industries in developing countries suffer from poor quality and productivity due to involvement of number of process parameter. Even in completely controlled process, defect in casting are observed and hence casting process is also known as process of uncertainty which challenges explanation about the cause of casting defects.

1.1 Defects may be because of the following reasons:

1. Improper pattern/tool design or lack of allowances,
2. Improper mould and core constituents,
3. Improper melting practice,
4. Improper pouring practice
5. Because of molding and core making materials.
6. Improper gating - risering system along with lack of feedaids.
7. Improper metal composition
8. Inadequate melting temp and rate of pouring.
9. Unskilled post melting treatment like shakeout, fettling etc.

Casting defect analysis is the process of finding root causes of occurrence of defects in the rejection of casting and taking necessary step to reduce the defects and to improve the casting yield.

2. CLASSIFICATION OF DEFECTS:



2.1 BLOWHOLE :

Blowhole is a kind of cavities defect, which is also divided into pinhole and subsurface blowhole. Pinhole is very tiny hole. Subsurface blowhole only can be seen after machining. Gases entrapped by solidifying metal on the surface of the casting, which results in a rounded or oval blowhole as a cavity. Frequently associated with slags or oxides the defects are nearly always located in the cope part of the mould in poorly vented pockets and undercuts.

FIG 2.1

2.1.2 POSSIBLE CAUSES:

- Inadequate core venting
- Excessive release of gas from core
- Excessive moisture absorption by the cores
- Low gas permeability of the core sand

2.1.3 REMEDIES:

- Reduce moisture content of sand.
- Improve gas permeability
- Reduce betonies content. Use betonies with a high montmorillonite content, high specific binding.

2.2 SAND BURNING

Burning-on defect is also called as sand burning, which includes chemical burn-on, and metal penetration. Thin sand crusts firmly adhering to the casting. The defect occurs to a greater extent in the case of thick-walled castings and at high temperatures. In addition, the always present iron oxides combine with the low-melting-point silicates to form iron silicates, thereby further reducing the sinter point of the sand.

FIG 2.2

2.2.1 CAUSES

- Lustrous carbon content too low
- Uneven mould compaction.
- Uneven distribution of inflowing metal with resultant over-heating
- Temperature of liquid metal too high.

2.2.2 REMEDIES

- Increase proportion of lustrous carbon producer.
- Reduce dust content.
- Ensure uniform compaction. If necessary, increase heat removal from the moulds.

2.3 SAND INCLUSION

Sand inclusion and slag inclusion are also called as scab or blacking scab. They are inclusion defects. Looks like there is slag inside of metal castings. Irregularly formed sand inclusions, close to the casting surface, combined with metallic protuberances at other points. Sand inclusion is one of the most frequent causes of casting rejection.

FIG 2.3

2.3.1 CAUSES

- Break-up of mould sections during stripping of patterns, core setting or assembling of moulding Flasks.
- High content of inert material.
- Lustrous carbon producer content higher.
- Low core strength.
- High compaction at some places.
- Low content of betonies.
- Pouring rate too high and long.

2.3.2 REMEDIES

- Pressure marks should be checked for moulds and for better results insert pressure pads.
- Mould cavities should be blown out carefully.
- Improve pattern plates, increase pattern tapers and radii. Heat pattern plates and, if necessary, use release agent.
- Automate core setting.
- Mould compaction should be uniform.
- Increase the compatibility and plasticity of sand.
- Reduce inert dust content. Decreasing the dust content re-duces lumps in the sand.
- To increase the strength of cores use high proportion of binders.
- Avoid core mismatching.
- Shorten the pouring times thus improving the distribution of gates.

2.4 COLD LAP/ COLD SHUT

Cold lap or also called as cold shut. It is a crack with round edges. Cold lap is because of low melting temperature or poor gating system. When the metal is unable to fill the mould cavity completely and thus leaving unfilled portion called misrun. A cold shunt is called when two metal streams do not fuse together properly.

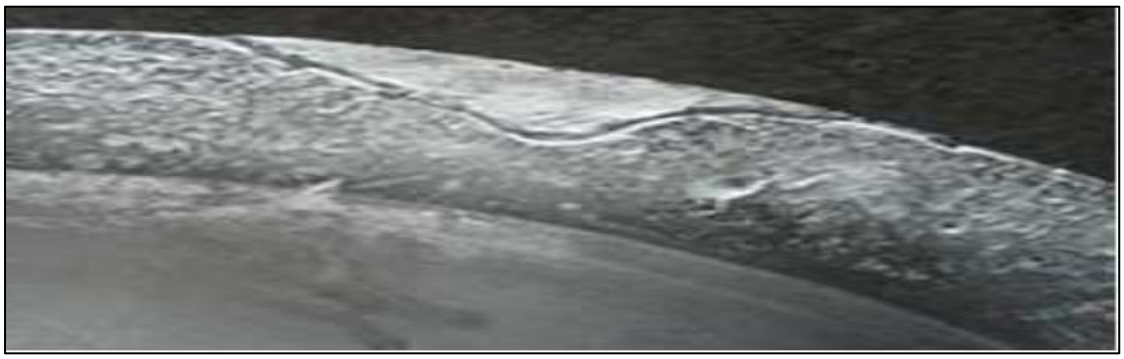


FIG 2.4

2.4.1 CAUSES

- Lack of fluidity in molten metal.
- Faulty design and gating.

2.4.2 REMEDIES

- Pouring temperature need to be adjusted.
- Modify design and gating system.

2.5 MISRUN

Misrun defect is a kind of incomplete casting defect, which causes the casting uncompleted. The edge of defect is round and smooth. When the metal is unable to fill the mould cavity completely and thus leaving unfilled portion called misrun. A cold shunt is called when two metal streams do not fuse together properly.

FIG 2.5

2.5.1 CAUSES

- Lack of fluidity in molten metal.
- Faulty design and gating.

2.5.2 REMEDIES

- Pouring temperature need to be adjusted.
- Modify design and gating system.

2.6 GAS POROSITY

The gas can be from trapped air, hydrogen dissolved in aluminium alloys, moisture from water based die lubricants or steam from cracked cooling lines. Air is present in the cavity before the shot. It can easily be trapped as the metal starts to fill the cavity. The air is then compressed as more and more metal streams into the cavity and the pressure rises. When the cavity is full it becomes dispersed as small spheres of high pressure air. The swirling flow can cause them to become elongated.

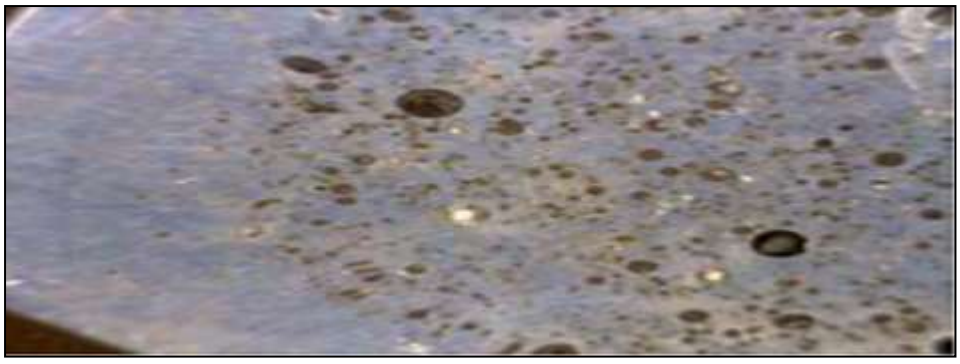


FIG 2.6

2.6.1 CAUSES

- Metal pouring temperature too low.
- Insufficient metal fluidity e.g. carbon equivalent too low.
- Pouring too slow.
- Slag on the metal surface.
- Interruption to pouring during filling of the mould.
- Metal section too thin.
- Inadequately pre-heated metallic moulds.

2.6.2 REMEDIES

- Increase metal pouring temperature.
- Pour metal as rapidly as possible without interruption. Improve mould filling by modification to running and gating system.
- Adequate venting of moulds and cores.
- Eliminate lustrous carbon where applicable.
- Ensure metal moulds are adequately pre-heated and use insulating coatings

2.7 MISMATCH DEFECT

Mismatch in mold defect is because of the shifting molding flashes. It will cause the dislocation at the parting line.

FIG 2.7

2.7.1 CAUSES

- A mismatch is caused by the cope and drag parts of the mould not remaining in their proper position.
- This is caused by loose box pins, inaccurate pattern dowel pins or carelessness in placing the cope on the drag.

2.7.2 REMEDIES

- Check pattern mounting on match plate and Rectify, correct dowels.
- Use proper moulding box and closing pins.

2.8 DISTORTION / WARP

FIG 2.8

2.8.1 CAUSES

- Distortion due to warp age can occur over time in a casting that partially or completely liberates residual stresses.

2.8.2 REMEDIES

- Common practice in iron casting is normalizing heat treatment to remove residual stress. In aluminium casting, a straightening between quench and aging might be required.

2.9 FLASH SET

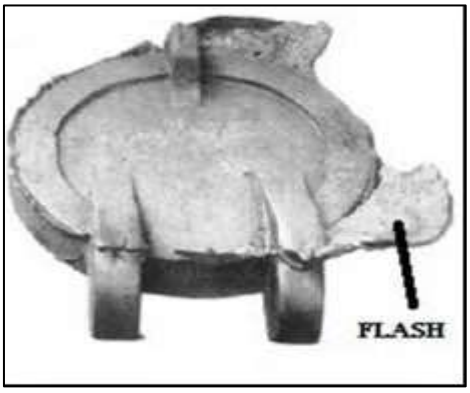


FIG 2.9

Flash can be described as any unwanted, excess metal which comes out of the die attached to the cavity or runner. Typically it forms a thin sheet of metal at the parting faces. There are a number of different causes of flash and the amount and severity can vary from a minor inconvenience to a major quality issue. At the very least, flash is waste material, which mainly turns into dross when re-melted, and therefore is a hidden cost to the business.

2.9.1 CAUSES

- Damage to die faces and die components
- Parts of the die have insufficient strength
- Bending, crowning of stretching of dies
- Cavities offset from centre of platen
- Insufficient machine clamp-up
- Pressure spikes at the end of cavity fill
- Excessive intensification pressure
- Incorrect intensification timing
- Damage, or wear, in toggle mechanisms
- Machine hydraulic malfunction
- Hydraulic valve or seal leaks

2.9.2 REMEDIES

- If your sprue is very tall and the casting covers a wide area of the mold face, it's very possible for the mold to actually be forced up by the hydrostatic pressure of the metal. The seriousness of this depends density of the metal (aluminum is very light, but be careful with a bronze pour!) and the weight of the mold fighting it. The solution here is very simple: weight down the mold.

2.10 CRACKS / HOT TEARS

Cracks can appear in die castings from a number of causes. Some cracks are very obvious and can easily be seen with the naked eye. Other cracks are very difficult to see without magnification.

2.10.1 CAUSES

- Shrinkage of the casting within the die
- Undercuts or damage in die cavities
- Uneven, or excessive, ejection forces
- Thermal imbalance in the die
- Insufficient draft in sections of the die
- Excessive porosity in critical regions of the part
- Product design not matched to the process
- Inadequate die design

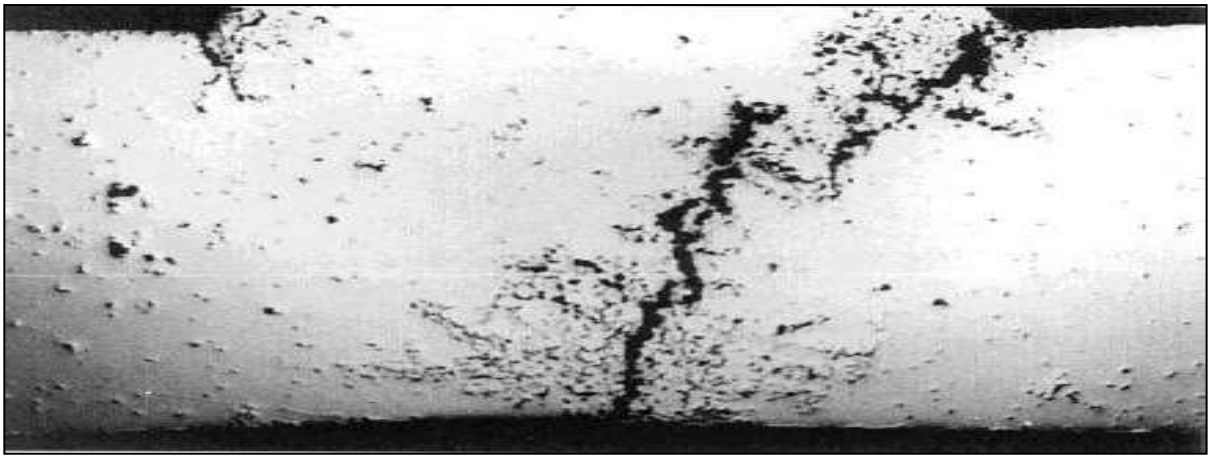


FIG 2.10

2.10.2 REMEDIES

- Improvement in casting design
- Proper metallurgical control and chilling practices

2.11 SHRINKAGE

Shrinkage defect occurring during the solidification of the casting. Open shrinkage defects are open to the atmosphere, therefore as the shrinkage cavity forms air compensates. There are two types of open air defects: pipes and caved surfaces. Pipes form at the surface of the casting and burrow into the casting, while caved surfaces are shallow cavities that form across the surface of the casting. Closed shrinkage defects, also known as shrinkage porosity, are defects that form within the casting.

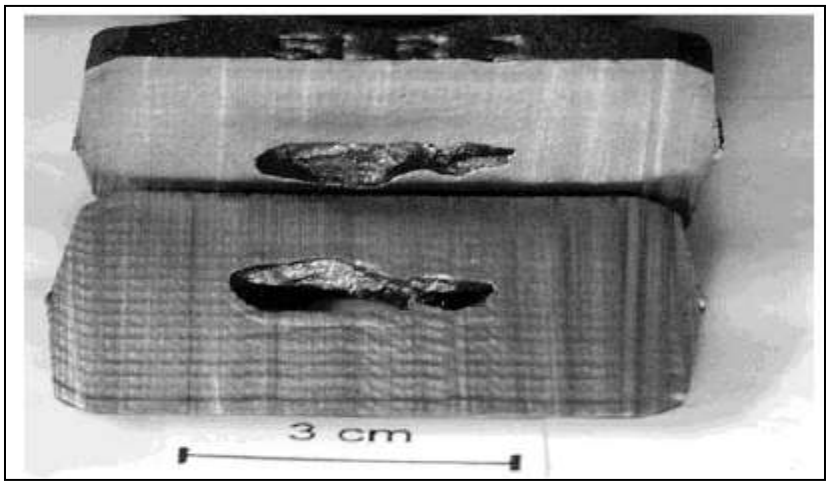


FIG 2.11

2.11.1 CAUSES

- Volumetric contraction both in liquid and solid state.
- Poor casting design. Low strength at high temperature.
- Shrinkage of the casting within the die
- Undercuts or damage in die cavities
- Uneven, or excessive, ejection forces

2.11.2 REMEDIES

- Proper feeding of liquid metal is required .
- Proper casting design. Avoid superheating of metal
- The general technique for eliminating shrinkage porosity is to ensure that liquid metal under pressure continues to flow into the voids as they form.

2.12 SINK MARK

Sink marks and voids both result from localized shrinkage of the material at thick sections without sufficient compensation. Sink marks appear as depressions on the surface of a molded part. These depressions are typically very small; however they are often quite visible, because they reflect light in different directions to the part. The visibility of sink marks is a function of the color of the part as well as its surface texture so depth is only one criterion. Although sink marks do not affect part strength or function, they are perceived to be severe quality defects. Voids are holes enclosed inside a part. These can be a single hole or a group of smaller holes. Voids are caused when the outer skin of the part is stiff enough to resist the shrinkage forces thus preventing a surface depression. Instead, the material core will shrink, creating voids inside the part. Voids may have severe impact on the structural performance of the part. moldings sink mark and void.

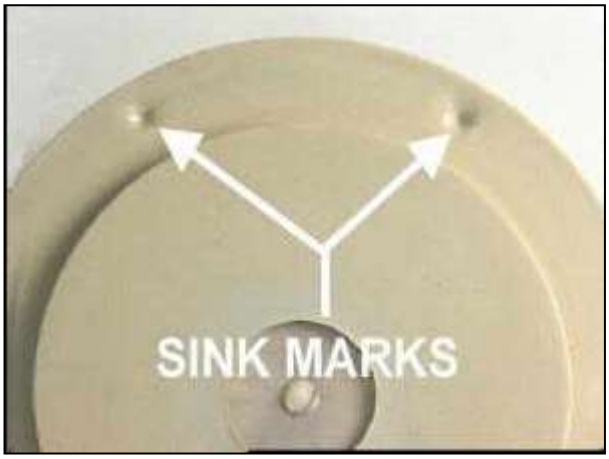


FIG 2.12

2.12.1 CAUSES

- High volumetric shrinkage
- Insufficient material compensation
- Early gate freeze-off or low packing pressure may not pack the cavity properly.
- Short packing or cooling time
- High melt and/or mold temperatures

2.12.2 REMEDIES

- As sink marks occur during packing, the most effective way to reduce or eliminate them is to control the packing pressure correctly. To determine the effects of packing on sink marks, use a simulation package such as Mold flow Plastics Insight.
- Alter part design to avoid thick sections and reduce the thickness of any features that intersect with the main surface.
- Relocate gates to problem areas This allows these sections to be packed before the thinner sections between the gate and the problem areas freeze.
- Restrictive runner system design can result in premature gate freeze-off.

3. DEFECTS BY APPEARANCE

3.1 METALLIC PROJECTION

FIG 3.1

Flat projection of irregular thickness, often with lacy edges, perpendicular to one of the faces of the casting. It occurs along the joint or parting line of the mold, at a core print, or wherever two elements of the mold intersect.

3.2 INCOMPLETE CASTING

Poured short. The upper portion of the casting is missing. The edges adjacent to the missing section are slightly rounded; all other contours conform to the pattern. The spree, risers and lateral vents are filled only to the same height above the parting line, as is the casting.

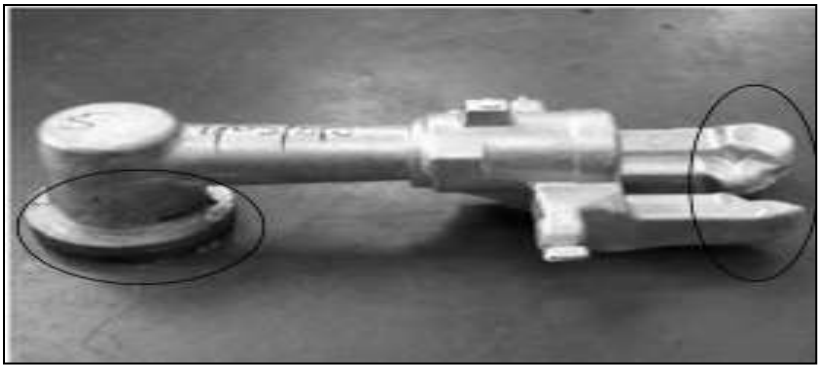


FIG 3.2

3.3 RAT TAIL / BUCKLES

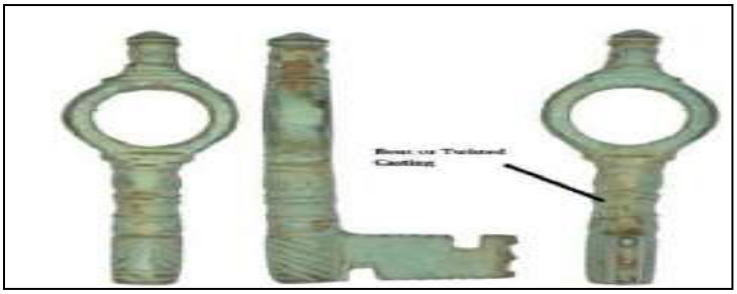


FIG 3.3

Rat tails and buckles are caused by the expansion of a thin outer layer of moulding sand on the surface of the mould cavity due to metal heat.

CONCLUSION

In this research work different casting defects are studied. By referring different research papers causes and their remedies are listed. These will help to quality control department of casting industries for analysis of casting defect. This study will definitely be helpful in improving the productivity and yield of the casting. Rejections of the casting on the basis of the casting defect should be as minimized and all the above research is heading in the same direction.

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