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To Remove Casting Defects Analytically with the help of Pro-CAST Software

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***Abstract*: Manufacturing process is classified into many processes but in this project we are going to study about Casting process. In casting process raw material is melted at high temperature and converted in to liquid form and pour it into cavities and let it solidify. There are different types of casting process from which we are working on the Sand casting system. In this casting process most essential role is played by gating system. Although there are many new advanced technologies for metal casting, green sand casting remains one of the most widely used casting processes today due to the low cost of raw materials. We are about to use Pro-CAST Software for the analysis of the Product and to find possible solutions of the defects arising in the product.**

***Keywords*: Aluminum Casting, Pro-CAST, Sand Casting.**

1. Introduction

It is the duty of manufacturing engineer to come up with different ideas and designs into reality by proper selection of material, machine and manufacturing process. A manufacturing should possess the knowledge of manufacturing processes. He must be able to see the problems in manufacturing and production, selection of materials and tooling, plant layout, inspections and since computer automatic control system is advancing this days he should have computer based knowledge as well. Computer aided manufacturing and computer aided design are choose for large industries and companies because of advantage offered by them to remain parallel with the market because now a day high degree of accuracy in manufacturing is essential. Manufacturing process is classified into many processes but in this project we are going to study about Casting process. In casting process raw material is melted at high temperature and converted in to liquid form and pour it into cavities and let it solidify. There are different types of casting process from which we are working on the Sand casting system. It is also known as sand mould casting. In this casting process most essential role is played by gating system. Although there are many new advanced technologies for metal casting, green sand casting remains one of the most widely used casting processes today due to the low cost of raw materials.

2. Types of gates

Mainly there are four different types of gate as given bellow

- Top gate
- Bottom gate
- Parting gate
- Side gate

A. Top gate

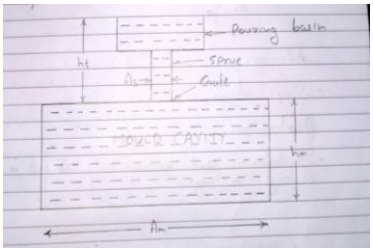

Fig. 1. Top Gate

In the top gate, molten metal is poured at the top of the mould. For the above figure
A_m = Mould cross sectional area
A_s = Gate cross sectional area
h_m = Height of Mould
h_t = Filling [pouring] height
Now, velocity of liquid metal at gate
$V_g = \sqrt{(2gh_c)}$

$$\text{Pouring time} = \frac{\text{volume of mould}}{\text{Gate cross sectional area} \times \text{velocity of matel at gate}}$$

$$= \frac{A_m - h_m}{A_s \times V_g}$$

3. Typical Gating Ratio

A. Pressurized gating system

$A_C : A_R : A_G = 1 : 1.3 : 1.1$ [For Gray Cast Iron]
$A_C : A_R : A_G = 1 : 2 : 1$ [For Aluminum]
$A_C : A_R : A_G = 1 : 2 : 1.5$ [For Steel]

B. Unpressurized gating system

$A_C : A_R : A_G = 1 : 4 : 4$ [For Gray Cast Iron]
$A_C : A_R : A_G = 1 : 3 : 3$ [For Aluminum]
$A_C : A_R : A_G = 1 : 3 : 3$ [For Steel]

Where, A_C = the cross sectional area of the Sprue Exit,
A_R = the cross sectional area of the Runner,
A_G = the cross sectional area of the Ingate

4. Typical dimensions of pouring cups

Table 1
Typical dimensions

Round outlet and round inlet			Round outlet and Square outlet		
Inlet Diameter [Top] (mm)	Outlet Diameter [bottom] (mm)	Height (mm)	Inlet Diameter [Top] (mm)	Outlet Diameter [bottom] (mm)	Height (mm)
51	25	38	78 * 90	33	117
127	64	133	105 * 134	38	127
203	76	140	140 * 159	51	152
254	102	203			

A. Problem specifications

The figure below is of one of the product which is manufactured in universal industries and as we can see there are few visible defects on the surface of the product, and some are not visible , We are going to reduce/remove those defect by changing the Methodology Universal industries is using with the help of analytical observation and solution. The below product is made of Aluminium and is moulded with the help of green sand casting.

Fig. 2. product

B. Modelling and analysis

Model below was prepared in Solid work with the help of the dimensions obtain of the actual product. Model preparation with the help of different software and analysis carried out on the Pro-CAST on basis of their application.

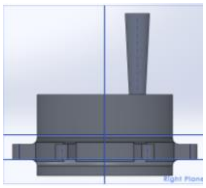

Fig. 2. Front View

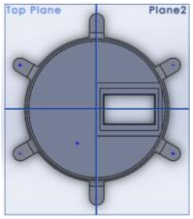

Fig. 3. Bottom View

The above figures show the Model prepared with the help of solidworks by Dassault systems, which is further used in pro-CAST by ESI Group, the dimensions are as per the existing product which we have collected from universal industries the product is the one we are studying. We have prepared this model in solid works software.

C. Implementation

As we have discussed above we were going to use the model prepared in solidwork for analysis in pro-CAST. We have implied the model in the Pro-cast and have obtained few results of our product After implementation of the model in the pro-CAST and after all the process done in the pro-CAST we have obtained few results and they are as mentioned below

D. Solidifying process

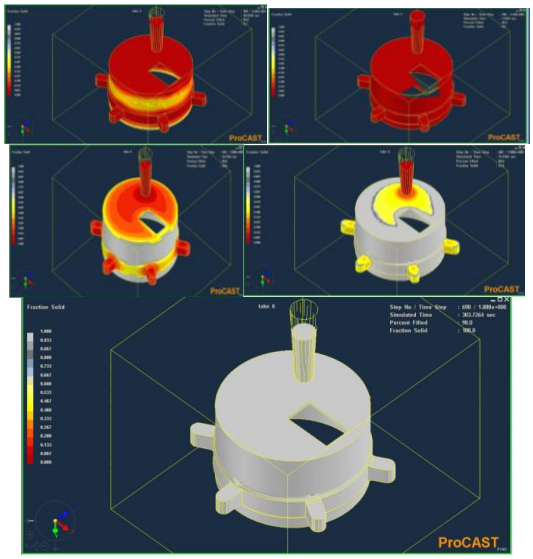

Fig. 4. Solidifying process

After simulating the model in the Pro-Cast the digital process of the solidifying was obtained as shown in the above figures with the help of this process solidifying can be done without the actual product.

E. Solidification time

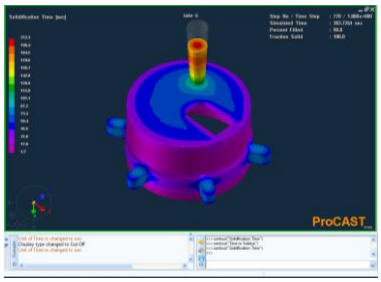

Fig. 5. Solidification Time

Time taken for solidification of the object with the help of pro-CAST. The solidification of the molten metal in the mould cavity occur as soon as it enters the cavity and the solidification begins on the edge of the casting and ends at the middle of the cavity. As we know the solidification of any material depends

on the design and dimensions of the object above object indicate the thinner area took lesser time for solidification and the maximum time taken is at the end of the inlet.

F. Hot spots

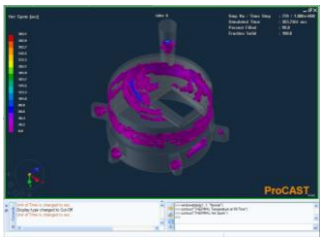

Fig. 6. Hot Spots

The above figure shows the location/positions of the Hotspots defects in our product/ object. The hotspots defects depends on the location of the riser neck and the dimensions of the riser neck the position of the hotspots defects changes if the dimensions of the riser neck changes. This defects takes place due to not proper cooling of the product so to reduce this defect properly cooling is essential.

G. Temperature at pouring time

Temperature of the molten metal is about 750 ^{0}C to 800 ^{0}C

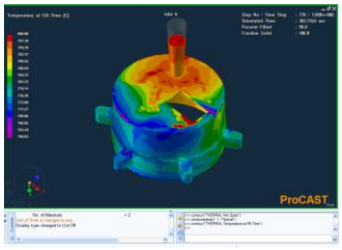

Fig. 7. Temperature at Pouring time

The Temperature of the Molten Metal at the Filling/Pouring time is about 800^0 C as informed by our Guide –Mr. Subhash Bandarkar our industrial guide. The above figure shows the temperature results we obtained with the help of Pro-CAST, As the molten metal flows down due to gravity the heat is dissipated in the Green sand and to atmosphere and the solidification takes place. The colour difference in the above figure indicate the temperature at different sections of the object

H. Total shrinkage porosity

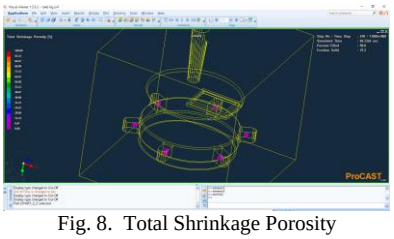

Fig. 8. Total Shrinkage Porosity

The above figure indicate the total shrinkage porosity percentage takes place in the solidification of the object it occurs due to the gasses present in the mould cavity and the gasses generated due to the burning of sand because of the molten metal

I. Voids

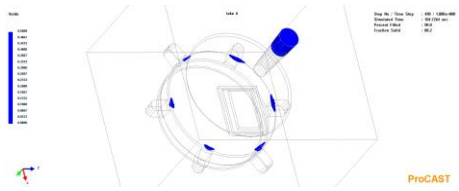

Fig. 9. Void

The above figure shows the voids occur in the product. Voids are one type of porosity defects but are very minute compare to porosity. The void takes place due to moisture present in the green sand as the molten metal is poured at high temperature in the mould cavity due to that moisture is converted into gasses

5. Conclusion

This paper presented a method to remove casting defects analytically with the help of Pro-CAST software.

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