Design, simulation and analysis of disc rotor using anycasting software

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Keywords: AnyCasting; solidification time; casting defects

ABSTRACT – This project describes about the design and simulation of disc rotor in sand casting by using AnyCasting software. The analysis of this study is filling time, solidification time and defects on the three mold designs. The selected design in this study is design 2 referring the present defect that happened on the riser part. The filling time for design 2 is 7.6648 seconds and solidification time is 1452.6 seconds.

1. INTRODUCTION

Foundry sand is often used in the industry to make parts consisting of iron, bronze, copper and aluminum as well. The metal is poured into the mold cavity that formed by the sand when the metal melted in the furnace. The process is relatively simple and inexpensive, and this process had been applied in many industries. However, the weakness of sand casting is commonly in parts of cast sand and it can affect the properties of casting materials [1].

Gray cast iron is one of the most important casting materials and has many industrial applications because of its good castability properties and large variation in mechanical properties. Kumar and Kumar [2] stated that the variation of mechanical properties depends on the microstructure. The quality of the casting parts is depending on the percentage of the porosity in the product; the smaller percentage will lead to the better design.

The objective of the project is to analyze the casting defects on gray cast iron disc brake in AnyCasting software.

2. METHODOLOGY

2.1 Part selection

The part selection for an obsolete automotive part in this project was made based on several criteria. The part focused with produced by sand casting method. The chosen part is disc rotor. Disc rotor is a device is used for slowing or stopping the rotation of the tire wheels in automotive fields [3].

2.2 Design CAD

The CAD software that is used in this project was SolidWorks software. From this, the 3D CAD data of the disc rotor and the mold design of the sand casting can be generated. There are three molds are designed as shown in Figure 1 based on four criteria of parameters which are gating system, runner system, riser system and the position of sprue.

2.3 AnyPRE (Pre-processing)

In this stage, it is function to generate meshes by analyzing the CAD data. A fix mesh, which is hexahedron was used in simulation. The total mesh for design 1, design 2 and design 3 are 1164800, 931190, and 6349500, respectively. Materials properties and temperature condition were selected. The setting parameters gate conditions is to determine the pouring temperature and velocity of the molten metal.

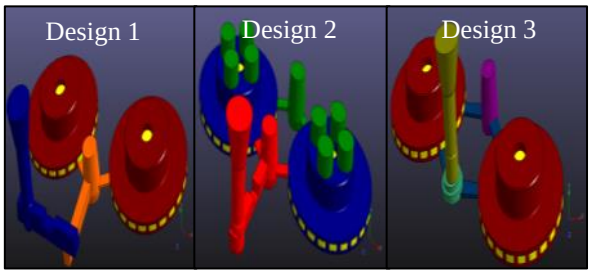

Figure 1 Three designs of sand casting mold.

2.4 AnySOLVER

Simulates the flow and temperature fields of the design proces. The solidification of the molten metal need to be starts when the casting completely filling with the molten metal.

2.5 AnyPOST (Post-processing)

Graphics function for analyzing the simulation results. The results that will be considered in this simulation are filling time, solidification time, and defects.

3. RESULTS AND DISCUSSION

The filling times for three designs were analyzed as shown in Figure 2. The velocity condition during filling for all designs are 45 cm/s while the pouring temperature is 1420 °C for gray cast iron. The longest filling time is 7.6648 seconds which is observed from Design 2 while Design 3 has the shortest filling time which is 1.5559 seconds. The solidification time as shown in Figure 3 for the molten metal of Design 2 to solidify is high, 1452.6 seconds while Design 1 is the shortest time to solidify which is 1172.8 seconds. The defects occur as shown in simulation was happened on product and mold for Design 1 and Design 3, while the

defects occur only on the riser of mold for Design 2 as shown in Figure 4. Thus, the product of the casting is not affected and the part product still in good castability shape for Design 2.

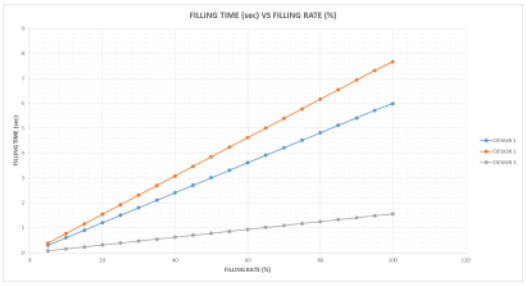

Figure 2 Filling time vs filling rate for three different of mold designs.

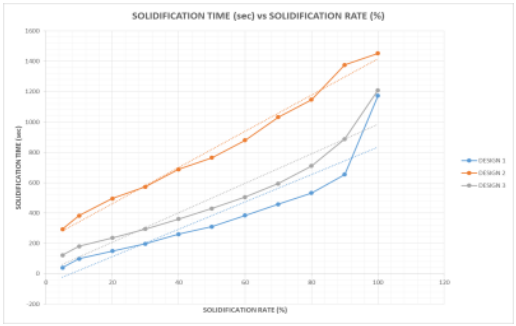

Figure 3 Solidification time vs solidification rate for three different of mold designs.

Shrinkage cavity will form when a large isolated region of liquid phase remains within solid and with it surrounding. Based on the feature of retained melt modulus for three designs, the formation and location of the defect of shrinkage cavity as shown in Figure 4.

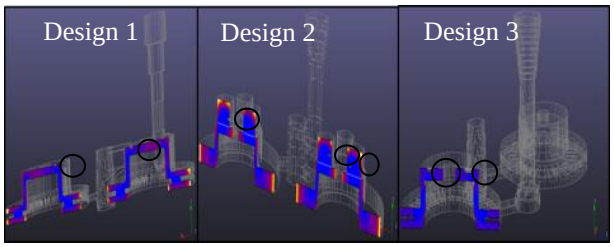

Figure 4 The defects of shrinkage cavity for three designs.

Component of disc rotor that has been analyzed and the value is shown in Table 1 for their retained melt volume. Retain Melt Volume indicates the volume of the residual melt for each grid when it reaches the critical solid rate. The increasing of retained melt volume, it will lead to better area for solidification and reducing the defect formation.

Table 1 Data analysis of retained melt volume.

Design	**Retained melt volume, cm^3**
Design 1	5456.8066
Design 2	6486.7300
Design 3	5236.6099

Figure 5 shows the turblence occur at circles area due to the designs of the runner at the side of the cavity and the area of the top riser.

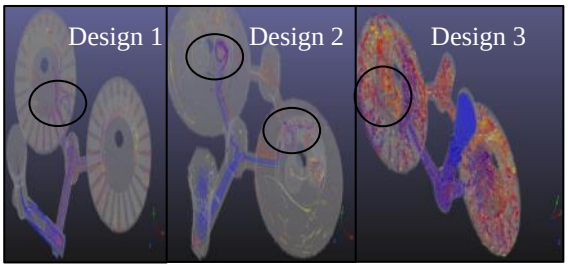

Figure 5 Analysis of particle tracing and position of turbulance for three designs.

Figure 6 shows the cooling curve for three designs and the pouring temperature state is at 1420°C. It is started to cooling until it is reached the freezing point and starting to become a semi-solid. After it reached the freezing point, it starting to become a solid state and the total time taken for deformation of solid state for design 1 is 1172.8 seconds, design 2 is 1452.6 seconds, and design 3 is 1209.3 seconds.

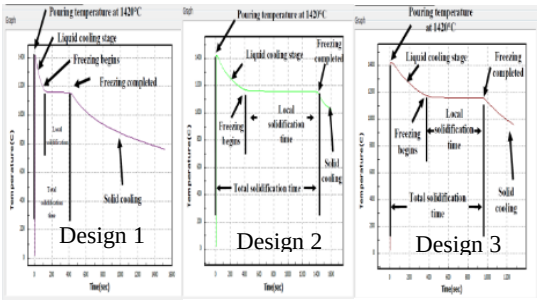

Figure 6 The cooling curve for three designs.

4. CONCLUSION

In a conclusion, the best design that have been selected is design 2. The design 1 and 3 have a defect of unfilling at the product. Eventhough the design 2 has the longest filling time that is 7.6648 seconds, the overall results from the simulation shows that the defects are happened on the mold and at the machining part for wheel stud only. For the solidification, it takes about 1452.6 seconds but the defects of casting as shown in analysis are occurs at the mold. The objective of this project is to analyze the simulation of sand casting and to find the optimum parameters based on quality reponse is successfully achieved.

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