ISSN 2395-1621

Design, Development and Improvement of Gating System for Lord Vitthal Idol

[#1]Mr. Samadhan Jalindar Shinde, [#2]Prof. N. D. Misal

[1]sjshinde@coe.sveri.ac.in
[2]ndmisal@coe.sveri.ac.in

[#1]Student M.E. Mech CAD/CAM Engg,Department of Mechanical Engineering
SVERI'S, COE, Pandharpur, Maharashtra, India.

[#2]Professor, Department of Mechanical Engineering
SVERI'S, COE, Pandharpur, Maharashtra, India.

ABSTRACT

The production of shaped articles by pouring molten metal into moulds is called casting.Now days for better performance, defect proof and lower cost of the manufacturing of the casting product can be achieved by using advanced techniques like CAD/CAM/CAE. The development of new casting is an iterative process which includes mould design and analysis of proper position of the gates and risers. The shrinkage porosity defect is one of the most common solidification defect of sand casting process.It occurs in the thickest sections of the casting which is possessing last freezing point.The defects like shrinkage cavity, porosity, scab, dirt and misrun can be minimized by designing an appropriate feeding system to ensure directional solidification in the casting, leading to feeder design. Major parameters of a feeding system include: feeder location, feeder shape and size and feed aids. Selecting the correct set of parameters that lead to the desired quality and yield, is important but difficult to achieve.There is a need for computer aided optimal feeder design coupled with solidification simulation to reduce the number of shop floor trials and obtain enhanced yield and high quality, in minimal possible time. In this work a new approach for feeding system évaluation and its optimization alongwith surface finish is presented here for lord Vitthal idol.

Keywords—design, simulation, defect, analysis, optimization, finishing.

ARTICLE INFO

Article History :

Received:2nd November 2015

Received in revised form:

4th November 2015

Accepted : 5th November 2015

I. INTRODUCTION

Casting is one of the oldest manufacturing processes. Basically it involves the introduction of a molten metal into a mold cavity, where upon after solidification, the metal takes the shape of the mold cavity. Simple and complicated shapes can be made from any metal that can be melted. Though this process is widely used in industrial sectors it has certain limitations like dimensional accuracy and poor surface finish. Also in casting process various defects may occur such as blow hole, misrun, shrinkage cavity and porosity, hot tears etc. occurs during or as a result of solidification phenomenon of the molten metal. These defects can be minimized by appropriate changes in feeding parameters, such as feeder location, feeder shape and size, feeder neck shape and size. While manufacturing lord Vitthal idol by casting process it was observed that final casting product formed is not retaining its shape for more than 5-6 castings. Also idol formed from conventional processes are mostly defective and deformed in shape. Also finished casting product is having rough surface finish. Hence, it was necessary to redesign and redevelop the component. In this paper, an attempt has been made to carry out the entire methoding, simulation and optimization in AutoCAST X1 software along with surface finish of casting. Hence in order to satisfy said purpose a random component is selected. The component geometry is created using AutoCAD 2015 software.Then same component is imported to AutoCAST X1 software and gating system for lord Vitthal idol is designed.

The casting solidification simulation enables us to predict and prevent potential problems like blow hole, misrun, shrinkage cavity and porosity, hot tears etc. Hence this approach provides immediate tangible benefits such as shorter lead time, higher productivity with good surface finish and lower rejections, and long-term intangible benefits like better image, higher confidence to produce large number of components.

I. LITERATURE REVIEW

From the existing literature, it is found that numerical simulations of solidification have received considerable attention from researchers in the past. Prof. C. M. Choudhari [1] has demonstrated casting design and simulation of cover plate using AutoCAST-X software for defect minimization with experimental validation and designed feeders with improvement in yield by 15 % of cover plate. Also Prof. C. M. Choudhari [2] has discussed methoding and simulation of LM 6 sand casting for defect minimization with its experimental validation and found experimental results were confirmed with simulation results. Prof. Harshil Bhatt[3] has used AutoCAST software for design optimization of feeding system and solidification simulation for cast iron and found that Solidification simulation provides iterative means of designing or modifying the feeding system. This reduces the overall cost of developing the method for new casting by minimizing the time as well as labour involved in it. According to B. Ravi (2003) [4] Shrinkage porosity continues to be a major problem in aluminium alloy castings, produced in sand as well as permanent moulds. In short freezing range alloys, especially those poured in permanent moulds, the shrinkage tends to concentrate at the hot spots. In long freezing range alloys, especially those poured in sand moulds, the shrinkage tends to be distributed all over the casting, though more of it still appears around hot spots. The location and extent of shrinkage porosity can be predicted by identifying regions of high temperature (hot spots) and low gradients (short feeding distance). Unfortunately, castings can be of complex shapes, and the heat transfer from all faces of the mould may not be uniform. Other factors, such as air gap formation at the metal-mould interface, convection in liquid metal, application of feed aids, and presence of cores, gating system design and pouring parameters also affect the location of shrinkage porosity. Maria Jose Marques [5] has demonstrated the application of the CAEsoftware. Simulation resulted in gating system and moulding changes that reduced the weight of the total casting from 59 kg down to 46 kg. Maintaining casting quality the yield has increased by 9 %.Some experiments were carried out under foundry conditions to compare the results. M. R. Barkhudarov [6] has discussed basic approach to numerical modeling of liquid metal flow and heat transfer followed by number of casting simulation, examples These examples demonstrate how numerical modeling can be used for simulation of metal flow in casting operation he had used commercial CAE packages such as CFD & Flow3D. M. Sirvio, M. Wos [7] has used FLOW3D software, for simulation of pattern less casting techniques originally conceived at VTT technical research center of finland. Also he had discussed advantages of FLOW 3D software; he shows flow3D can be used to simulate surface defects, air entrainment, filters, core gas problems and even a cavitations. R. Monroe [8] has discussed controlling porosity depends on understanding its sources and causes. Significant improvements in product quality, component performance, and design reliability can be achieved if porosity in castings can be controlled or eliminated.Porosity in castings is due to bubbles being trapped during solidification. Porosity sources include entrapped air during filling, centerline shrinkage that occurs during the final solidification, blowholes from unvented cores, reactions at the mold wall, dissolved gases from melting and dross or slag containing gas porosity.Behera et al[9] (2011) has suggested that the application of computer aided methoding, and casting simulation in foundries can minimize the bottlenecks and non-value added time in casting development, as it reduces the number of trial casting required on the shop floor.

II. MODELLING AND SIMULATION

Solid model of the casting is created in AutoCAD 2015 version as shown in Fig. 1.

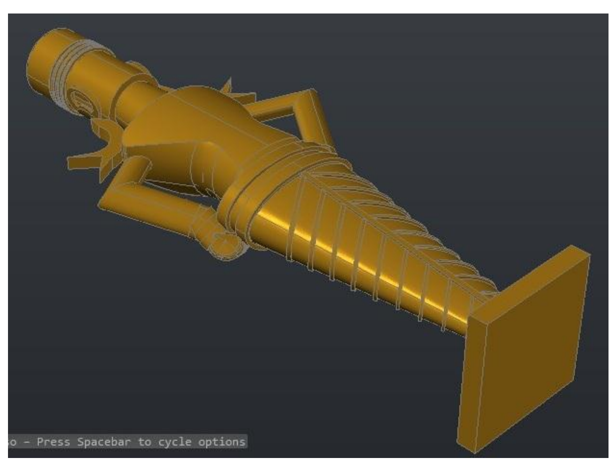

Fig. 1 Modelling of Lord Vitthal Idol

This model is then imported in AutoCAST X1 software for simulation purpose. Various parameters like casting material, mold size for casting process also specified initially.

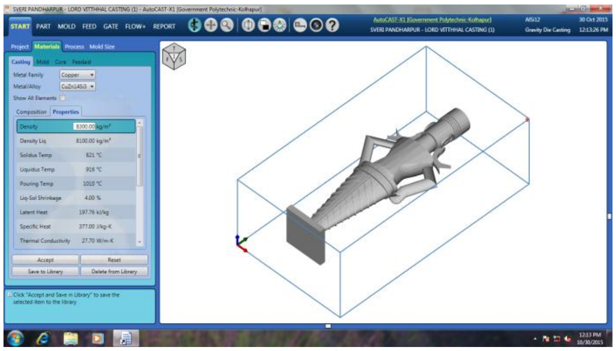

Fig. 2 Material used for casting

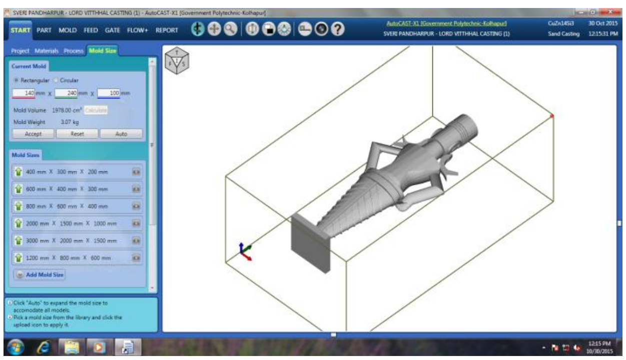

Fig.3 Mould box size for casting process

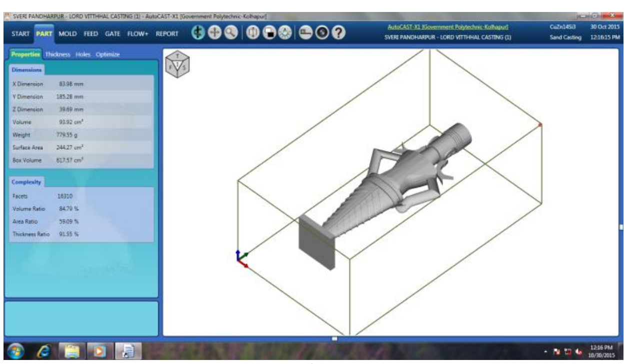

Fig. 4 Part dimensions for casting process

After simulation of casting various designed parameters of feeder are as follows:

Table 1 Design parameters of Feeder

Sr. No.	Name of Parameter	Dimensions
1	Feeder Height	42.91mm
2	Feeder Top Diameter	28.61 mm
3	Feeder Bottom Diameter	28.61 mm
4	Modulus	6.13 mm
5	Feeder Neck Distance	3.58 mm
6	Feeder Neck Length at Part	22.48 mm
7	Feeder Neck Width at Part	22.48 mm
8	Feeder Neck Radius	2.25 mm
9	Feeder Neck Modulus	2.19 mm
10	Length of Sprue	44.15mm

After simulation of casting various designed parameters of gating system are as follows:

Table 2 Design parameters of gating system

Sr. No.	Name of Parameter	Dimensions
1	Pouring Basin Height	23.81 mm
2	Pouring Basin Length	23.81 mm
3	Pouring Basin Width	23.81 mm
4	Pouring Basin Fillet	4.56 mm
5	Sprue Height	44.15 mm
6	Sprue Top Diameter	21.21 mm
7	Sprue Bottom Diameter	16.97 mm
8	Sprue Well Diameter	22.22 mm
9	Sprue Well Height	7.94 mm
10	Runner Width	7.07 mm
11	Runner Height	7.07 mm
12	Runner Length	15.77 mm
13	Gate Width	4.09 mm
14	Gate Height	5.06 mm
15	Gate Length	6.04 mm

III. RESULT AND DISCUSSION

In this study, it was found that solidification casting simulation enables us to visualise the progress of solidification of molten metal inside a casting and identification of the last freezing regions or hot spots. Hence by proper placement of feeder at the last solidifying regions will not shift the hot spot completely into the feeder. Hence, an exothermic sleeve is attached to the feeder, which has completely shifted the hot spot in the feeder and there by eliminated shrinkage defect problem. This facilitated the optimized placement and design of feeders with improvement in yield of casting while ensuring casting soundness without expensive and time-consuming trial runs. Also this approach has helped in minimizing the solidification related defects like blow holes, misrun etc, thereby providing a defect free casting. Also analysis of flow is done by taking various thermocouples on XY plane at various places as shown in figure 5.

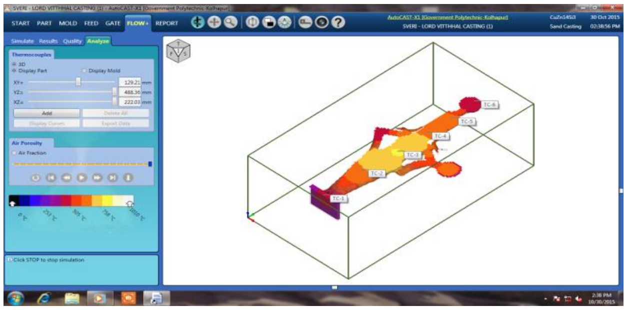

Fig. 5 Various thermocouples on XY plane

Lastly AutoCAST cooling curve was generated as shown in figure 6.

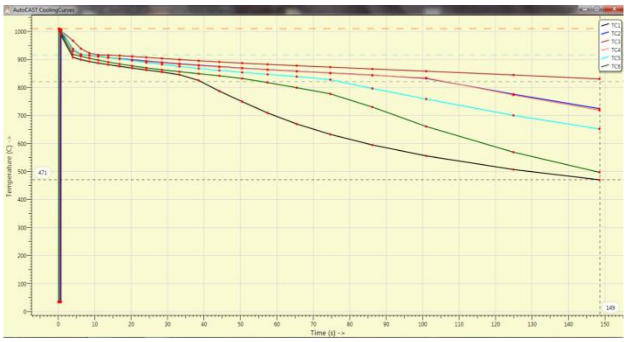

Fig. 6 Graph of temp Vs time

IV. CONCLUSION

Traditional gating system design approach for developing a new casting part involves manual method design of the 2D drawings of the cast part. This is followed by fabrication of tools, conducting trials and inspection. Sometime method layout needs to be modified in case of defective casting components. Then in this case entire process is to be repeated till defect free casting components is to be obtained. In this case each repetitive process will takes up several days and it will affect regular production.

On the other hand, casting simulation using AutoCAST software is based on trial and it will not involve wastage of material, energy and labour, and also do not hold up regular production. Computer simulation provides a clear understanding of the casting phenomena to identify the location and extent of internal defects, ensuring defect-free castings. Thus, numerical simulation of casting can be considered as an important method to make casting technique change from experience test to science guidance.

REFRENCES

1. Prof. C. M. Choudhari ‘Casting Design and Simulation of Cover Plate using AutoCAST-X Software for Defect Minimization with Experimental Validation’ 3rd International Conference on Materials Processing and Characterization (ICMPC 2014).

2. Prof. C. M. Choudhari ‘Methoding and Simulation of LM 6 Sand Casting for Defect Minimization with its Experimental Validation’ 12th GLOBAL CONGRESS ON MANUFACTURING AND MANAGEMENT, GCMM 2014.

3. Prof. Harshil Bhatt ‘Design Optimization of Feeding System and Solidification Simulation for Cast Iron’ 2nd International Conference on Innovations in Automation and Mechatronics Engineering, ICIAME 2014.

4. Prof. B Ravi ‘Computer-Aided Design And Analysis For Zero Defects’ International Conference on Aluminum (ALUCAST 2000)

5. Maria Jose ‘Marques CAE Techniques for Casting Optimization’

6. M. R. Barkhudarov ‘Advanced Simulation of the Flow and Heat Transfer Processes in Simultaneous Engineering’

7. M. Sirvio, M. Wos ‘Casting directly from a computer model by using advanced simulation software FLOW-3D Cast

8. R. Monroe ‘Porosity in Castings’

9. Behera ‘Application of computer aided methoding, and casting simulation in foundries can minimize the bottlenecks and non-value added time’

