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Shrinkage Elimination in Casting of GG30 Grade Cast Iron Impellor by using Pro-cast Software& Finite Elemental Analysis by Meshcast Software

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Abstract: There are 100+ submersible pump manufacturers in Rajkot Engineering Cluster. So, there are 100 plus foundry engaged in casting of cast iron impellor for submersible pump. They face shrinkage defect after casting and about 10 % rejection is because of shrinkage.[1] So in order to reduce this defect casting simulation software is very helpful. By using Pro-Cast simulation software mould of impellor is imported in Pro-Cast software and by applying sand mould condition, pouring temperature, pouring time etc. are put into the software, and finally result shows the areas of impellor where shrinkage chances are more.

Keywords: Pro-Cast, Cast Iron, Submersible pump

I. INTRODUCTION

Casting is old and important production process in manufacturing sector. Where mould cavity form by using sand mould, and molten metal is poured into the mould and after solidification done, as cast product can be produced.[2]

II. LITERATURE REVIEW

Guidelines for effective implementation and the best practices for efficient use of casting simulation technologyare presented here. These are based on a comprehensive review of about 200 industrial projects carried out bysimulation consultants associated with IIT Bombay. The projects are of two types: (a) quality or yield improvementof existing castings, and (b) rapid development of new castings. The guidelines cover all major metals and processes,and deal with five stages of simulation projects: data gathering, methods design, numerical simulation, methodsoptimization, and project closure. Major concerns: how to obtain accurate results, reduce total lead time, andensure data security are addressed, and illustrated with industrial examples [3]. Casting defects are usually easy to characterize but toeradicate them can be a difficult task. Defects are caused bycombined effect of different factors, whose dentification isoften difficult. casting process involves complex interactionsamong various parameters and operations related to metalcomposition, methods process, melting, pouring, machining.Presence of these defects exposes foundries to contribute over70% of total quality costs. Foundries try to reduce rejectionsby experimenting with process parameters (like alloycomposition, mould coating and pouring temperature). Whenthese measures are ineffective, then methods design (gatingand feeding) is modified.[4].Computer simulation technique and design of experiment used for casting defects analysis. In the firstpart using casting simulation technique analysis for shrinkage porosity defect is performed and new gating system designed.Number of iterations performed using simulation software to achieve optimum design. With new gating system reduction inshrinkage by (about 2.85 %) and yield improvement by (about 9.85 %) is observed. In the second part DOE used for castingdefects analysis so sand related and pouring practices related parameters considered are moisture content, sand particle size,mould hardness and pouring temperature. Taguchi based L9 orthogonal array was used for the experimental purpose andanalysis was carried out using Minitab software for analysis of variance (ANOVA).[5].Casting defects can be defined as the departure from conformance to customer requirements, with respect to (i) geometry: ex. mismatch and swell, (ii) integrity: ex. porosity and inclusions, and (iii) property: ex. segregation and hard spots. The resulting loss of foundry productivity and customer confidence is a heavy price to pay. Jobbing foundries encounter a higher level of defective castings, averaging 8-15%. Even production foundries have overall 3-6% defective castings [6],[7] Metal casting is one of the direct methods of manufacturing the desired geometry of component. The method is also called as *near net shape process*. It is one of the primary processes for several years and one of important process even today in the 21st century. Early applications of casting are in making jewelry items and golden idols. Today, casting applications include automotive components, spacecraft components and many industrial & domestic components, apart from the art and jewelry items. [8],[9].Solidification of metal is the process phase transformation of the liquid phase to solid phase with the liberationism of latent heat of fusion.

Metal solidification phenomenon is the great interest to casting engineers, metallurgist and software developers. It influences directly the quality of casting, production cycle time and utilization of materials (yield of casting). During this phase transformation process, it developed casting defects like shrinkage, hot tears, and porosity. To minimize these defects, the accuracy of proper design of casting and gating system is the basic necessity. We can predict those defects with casting design by means of numerical optimization (simulation) of casting solidification. In this paper, by using Auto cast –X simulation software we made modification in gating system and develop casting free from defect, in particular, shrinkage defect.

III. METHODOLOGY

The experimental work carried out at small scale unit engaged in casting of cast iron impellor.. When casting defect inspection was completed on casting major shrinkage defect was found. Due shrinkage defect, due to shrinkage defect cast iron impellor were rejected and 10 to 12 % rejection is observed during ultrasonic testing. Simulation is the process of imitating a real phenomenon using a set of mathematical equations implemented in a computer program.

In casting numerical simulation, the activity like, filling of molten metal into the mould and solidification process analysis is done with the help of algorithm or program based on vector element based, the simulation used to identify the hot spots and defects like shrinkage porosities, hot tears, cracks, etc. The casting solid 3D model has to be created using a solid modeling system e.g. solid works and imported into the simulation software, further analysis. B.ravi [11] has suggested casting simulation and optimization methodology.

IV. EXPERIMENTAL DATA FOR IMPELLER

The component for casting process is impellor for the centrifugal pump made of gray iron material. The required grade for the casting is as per GG30 grade by sand casting process. The pouring temperature, pouring time, runner weight and riser weight all the details cover under following table 1 as shown below.

Table 1: Specification of impellor

Sr. No.	Parameter	Value
1	Pouring temp	1440^0C
2	Composition of casting	C-2.50%, Si-2.61%, Mn-0.39%,
		Si-2.90%, P-0.033%
3	Part No.	R34
4	Material	C.I GG-20
5	Weight	5 Kg
6	Bath Metal	C-2.9 to 3.76,Si-1.56 to 1.75,Extra add Mn-250gms
7	Runner riser total weight	6 kg
8	Pouring Time	5.0 Sec
10	Density	7000 kg m^-3
11	Co. of Thermal exp.	1.1e-005 C^-1
12	Specific Heat	447 J/kg C
13	Thermal Conductivity	52 W/m C
14	Resistivity	9.6 e-008 ohm m
15	Mould size	228.6 X 330.2 mm

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V. MODELING AND FINITE ELEMENT ANALYSIS OF IMPELLER USING PROCAST

A. Modelling of Impeller is Performed using SOLID Works 2009

Figure1 shows Impeller 3D Model. In Impeller Casting Process, two impellers are cast in single mould. Therefore, we have to prepare assembly of two impellers with actual runner and riser. It is shown in fig. 1

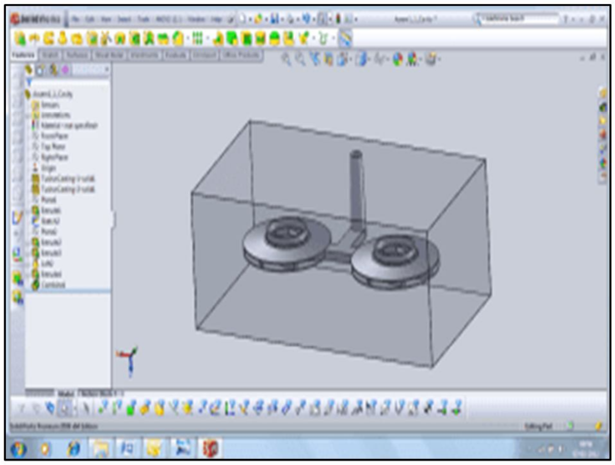

Fig 1. 3D Model of Impeller mould.

1) Apply Mould material as Silica Sand&Apply interface between mould and Casting

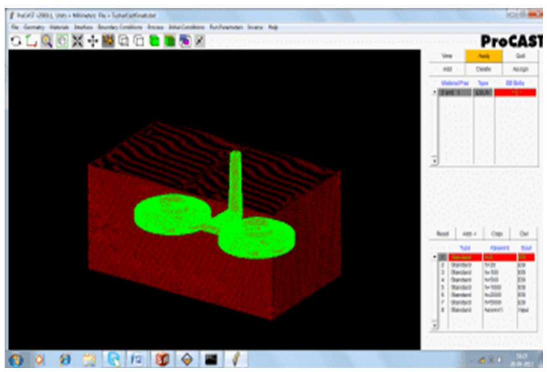

Figure 2Interfaces between Mould and Casting

2) Applying initial conditions for casting and run parameter for impeller simulation.

B. Post Processing Results in VIEW CAST

Obtain the temperature contour in different steps viz. 0, 10, 15,20,25,35 steps and up to 150 steps.

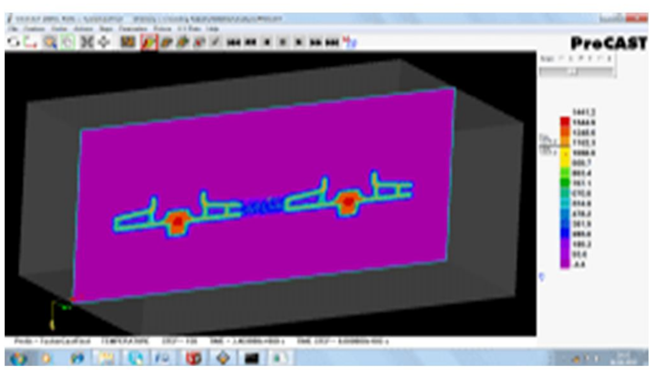

Fig.3. Temperature contour at 150 step

C. Fraction Solid

Fraction of solid is obtained after temperature contour at 150 step, and fig 4 shows fraction of solid

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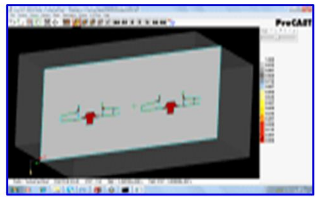

Fig.4. Fraction solid

Above Fraction Solid Figure Shows that after completion of Mould Filling there is a possibility of uneven solidification because metal in the middle portion of the casting(impeller Hub) are in the liquid stage while outside of the hub it has been cooled.

D. Shrinkage Porosity

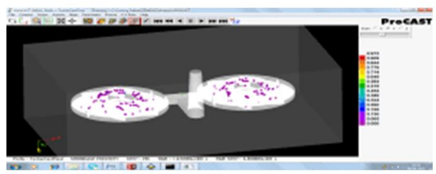

Fig.5 shrinkage porosity

VI. FINITE ELEMENT ANALYSIS OF IMPELLER IN PROCAST

A. Meshing of impeller in MESHCAST

It is important to note that working with MeshCAST always begins by opening a file. After the file has been loaded, you begin working at the corresponding work step in the process. From this entry point to the final generation of the tetra mesh, the steps you follow and the MeshCAST tools you use will be the same regardless of the type of input file used.

VII. COMPARISON OF RESULT OF SIMULATION AND FEM

By comparing both the results as shown in following figure the shrinkage chances is as shown by pink dots and to eliminate shrinkage now we increase runner and riser size, in order to eliminate shrinkage defect.

A. Comparison of Experimental and FE Analysis Results

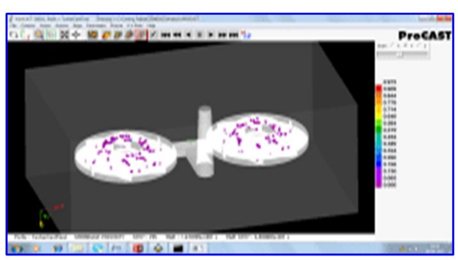

Fig.6.Location of Shrinkage Defect

Fig.7.Location of Shrinkage Porosity

As shown in fig. 6 and fig. 7above FE analysis done by software and actual location of porosity exists at the same region.

VIII. CONCLUSION

From above Experimental and Analytical Results We can say that FE Analysis Results Fairly matches with Experimental Results So FE Analysis are a good tool to replace costly experimental and time consuming costly experimental Work.

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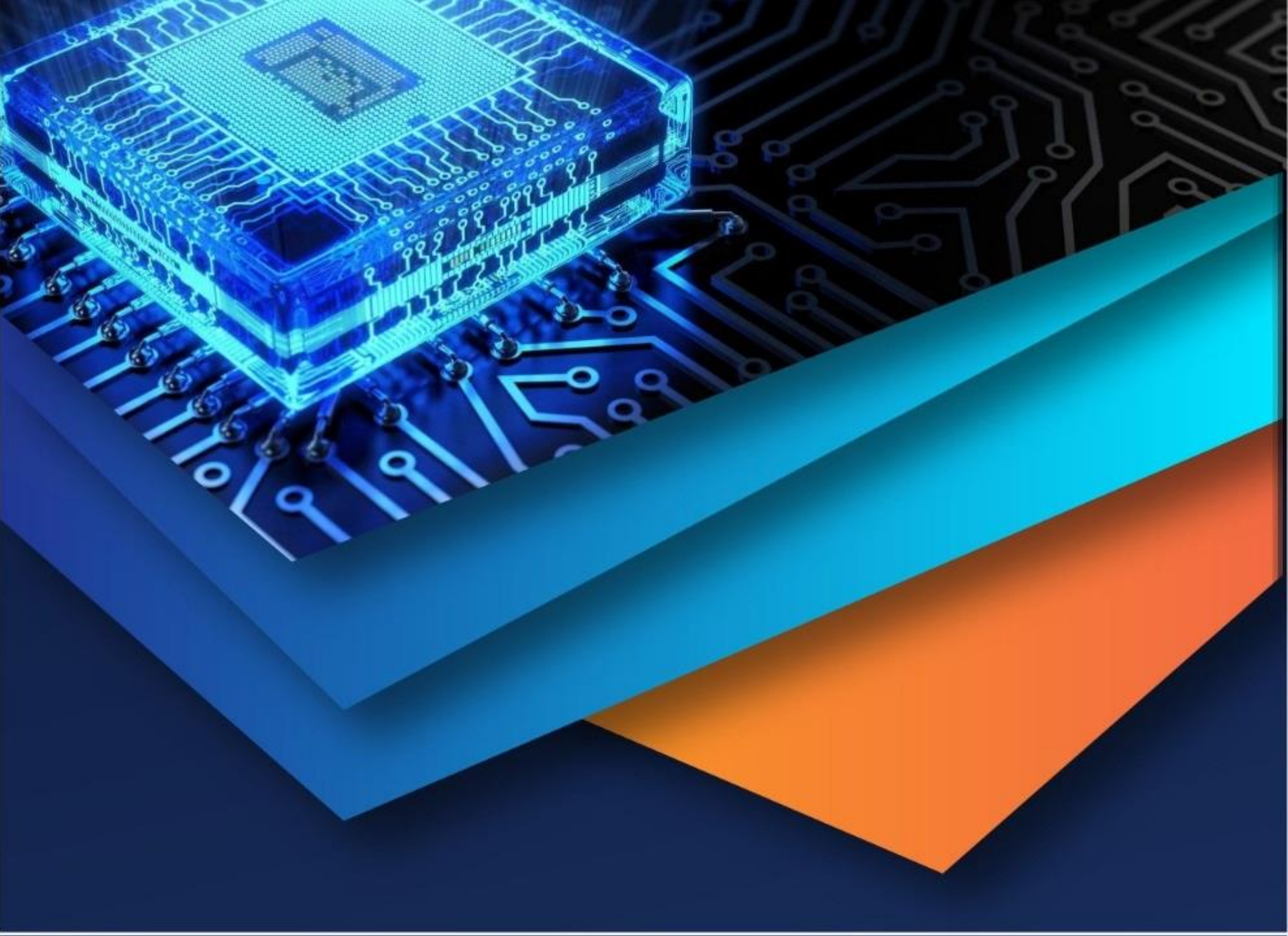

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