Casting Defect Identification and Its Solution by Niyama Simulation

Bhautik R. Pabani[1], Pratik R. Vyas[2], Mitesh D. Patel[3], Pratik A. Vataliya[4]

[1234]*Assistant Professor, Department of Mechanical Engineering,*
Narnarayanshastri Institute of Technology,Jetalpur

Abstract- *Increasing productivity and improve quality with reduce in cost, many foundries are exploring software packages, which help to reduce the need of trials and prototyping. However there is always a deference in actual and predicted location of defects, especially for new materials, shapes and processes.*

Casting defects caused due to evolution and entrapment of gases during casting process and many other reason. This project aims to develop a systematic approach for prediction for defect in casting based on available knowledge, experience of experts in this area and with use of mold own software like auto-cast, pro-cast. Also the final solution is given by doing experimental as well as simulation comparison The initial study will involve studying major defect in certain hardware part, principle of their formation, causes and remedies and preparing a knowledge base. The focus is on large size defect in sand casting. Mathematical equations were used for gating system for mold filling and for temperature drop of metal during mold filling. The user inputs include the 3D model of the casting (in the form of IGES _le) and relevant pouring parameters.

The layer-by-layer filling of mold cavity is simulated by Niyama criteria and display of instantaneous temperature of metal, defect developed in the mold cavity. The software result is compared with practical casting result in the future work. This enables the user to identified and gives predictable solution of sand casting defect.

Keywords: *Casting Defect, Niyama Simulation, Auto cast, Core casting, creo modeling.*

1. INTRODUCTION

Casting is a manufacturing process for making complex shapes of metal materials in mass production. There are two main consecutive stages, filling process and solidification process, in casting production. In filling process gating system composed of pouring cup, runner, sprue, sprue well and ingate, is designed to guide liquid metal filling. Casting process design is important for production quality and efficiency.

It is unavoidable that many different defects occur in casting process, such as porosity and incomplete filling. quality. Casting quality is heavily dependent on the success of gating system design, which currently is conducted mainly relied on technicians' experience. Therefore there is a need for the development of a computer-aided casting process design tool with CAD, simulation, and optimization functions to ensure the quality of casting.

2. LITERATURE REVIEW

Feng Liu et al [1] in this paper, with the aid of parametric modeling technology of runner and riser are modeledparametrically. By varying each parameter, it is easy to get different casting CAD models. These models output data populate the orthogonal matrix, which is used in the orthogonal array testing strategy to define the most suitable combinations of runners and risers parameters. After inputting the completed orthogonal matrix data and all CAD models into the simulation software the simulation result can be obtained.

Marco Aloe et al [2] observed that Gating systems, overflows, venting channels can be optimized using numerical simulation. Solidification related defects can also be predicted taking into account cooling channels and die cycling so as to accurately reproduce production conditions. ProCAST readily addresses all these issues but also includes advanced features to better assess the casting quality.

Mohammad Sadeghi et al [3] observed that ProCAST software used to simulate the fluid flow and solidification step of the part, and the results were verified by experimental measurements. By this Paper he concludesthat 1) Comparison of the experimental and simulation results indicates that defects in the pieces are placed at the predicted places by simulation. 2) If the die temperature is reduced from the optimum temperature range, probability of cold flow defects and air porosities increase. 3)

Determination of optimized places of overflows by simulation led to decrease of some casting defects such as cold shots and air porosities.

Dr. S. Shamasundar et al [4] observed that in gravity die casting of Aluminum parts, computer simulation can be a useful tool for rapid process development. Limitation of the conventional die design and gating design has been elaborated. Advantages of computer simulation based design enumerated. The procedures thus described have been demonstrated with two case studies of application of ProCAST simulation at Ennore Foundries. It is demonstrated that the foundries can derive mileage by resorting to FEM simulations of the casting process for process development and optimization.

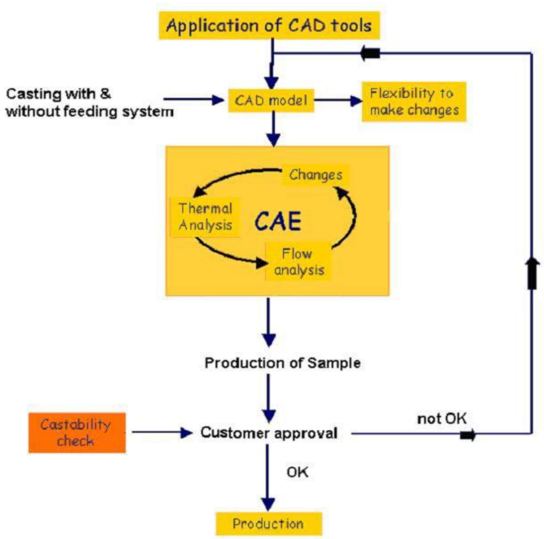

Fig. 2.1 Flow pattern of computer simulation

V. V. Mane et al [5] he focused on finding process-related causes for individual defects, and optimizing the parameter values to reduce the defects. This is not sufficient for completely eliminating the defects, since parameters related to part, tooling and methods design also affect casting quality, and these are not considered in conventional defect analysis approaches.

3. FE ANALYSIS USING PROCAST

Figure 3.1 in which 3D CAD and simulation tools are utilized to improve the systemdesign of the casting.The castings geometries presented here were meshed with MeshCAST, which requires theGeneration of a surface mesh before meshing the enclosed region with tetrahedral elements

STEP 1 3D Mode:

The model has been performed on the Creo 2.0 version and then after the analysis works has been performed on the Pro CAST 2014 version.

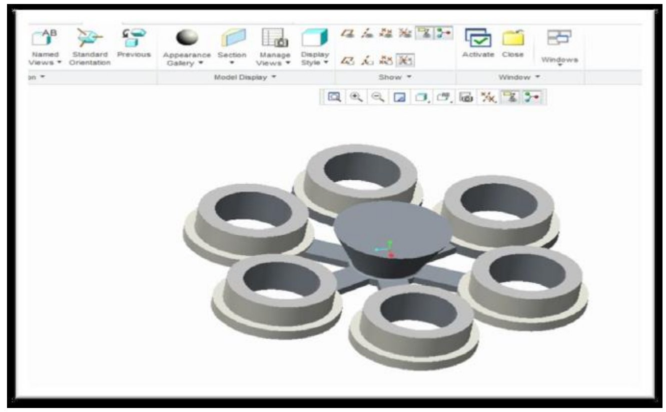

Figure 3.1 3D Model

STEP 2.Meshing with MeshCAST

Mesh CAST generates a 3-D tetrahedral mesh using the Finite Element Method . A triangular surface mesh of the object is the prerequisite for Mesh CAST's "tetrahedral mesh" generation. Mesh CAST can use the surface mesh from your CAD or CAE package as input for tetrahedral mesh generation. It is important to note that working with Mesh CAST always begins by opening a file. After the file has been loaded, we begin working at the corresponding work step in the process. From this entry point to the final generation of the tetrahedral mesh, the steps we follow and the Mesh CAST tools we use will be the same regardless of the type of input file used.

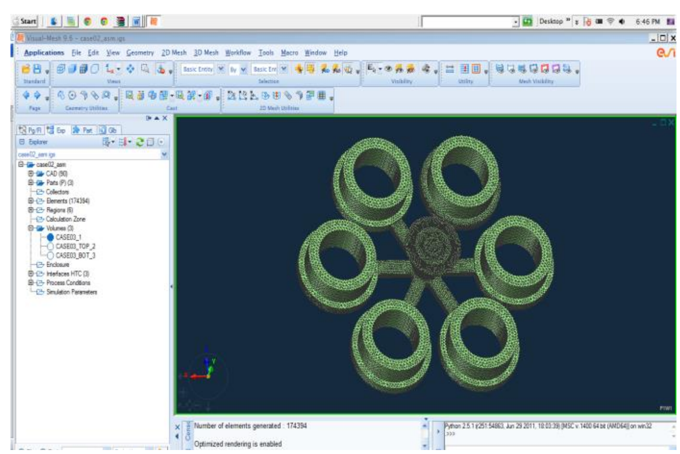

Figure 3.2 Meshing In Mesh Cast

The step by step procedure for the analysis is given below.
Step 1: Pre processing in Pre-CAST

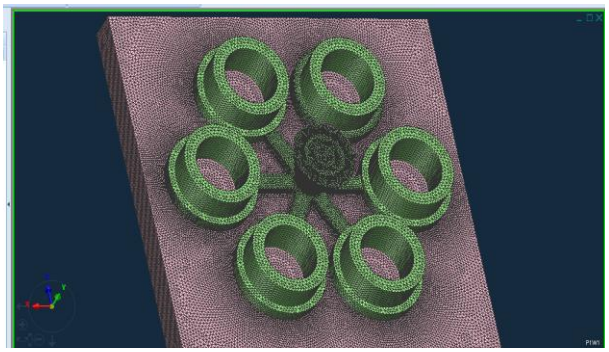

Figure 3.3 Import of Mesh File in PRE-CAST

Step 2: Selection for Mould Material
Apply Mould material as Silica Sand.

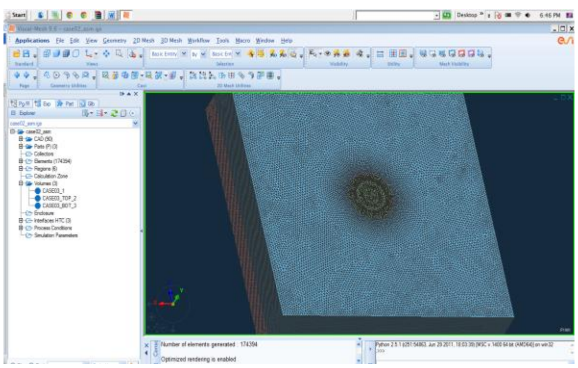

Figure 3.4 Mould body

Step 3: Apply cavity filling by molten metal
After filling molten metal in mould, the cast body ofSix part of hardware, sprueand gate are show in given below.

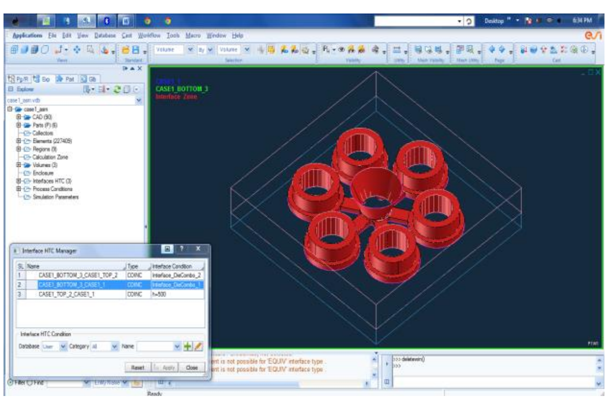

Figure 3.5 Part with Sprue& Gate inside of Mold

Step 4: Apply interface between mould and cast component

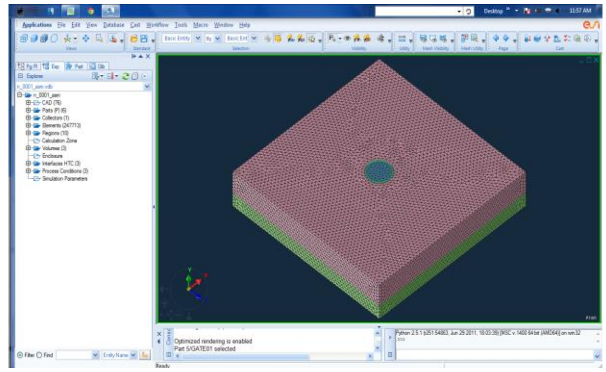

Figure 3.6 Interface between mould and cast

Step 5: Apply air cooling to all mould surfaces
Applying air cooling to the all mould surfaces as soon as beginning of pouring of molten metal into mould.

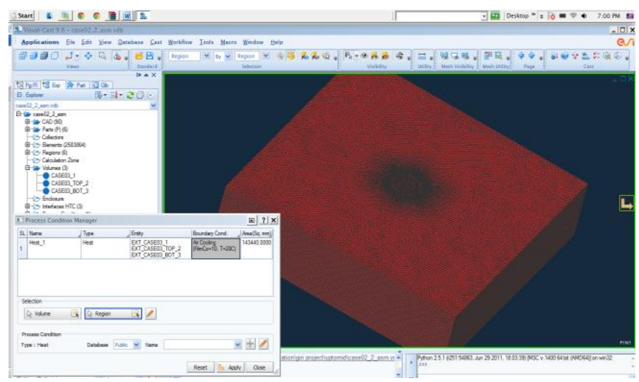

Figure 3.7 Air cooling to all mould surfaces

Step 6: Apply inlet velocity to pouring cup
Apply inlet velocity of 8.5 mm/s to the pouring cup.

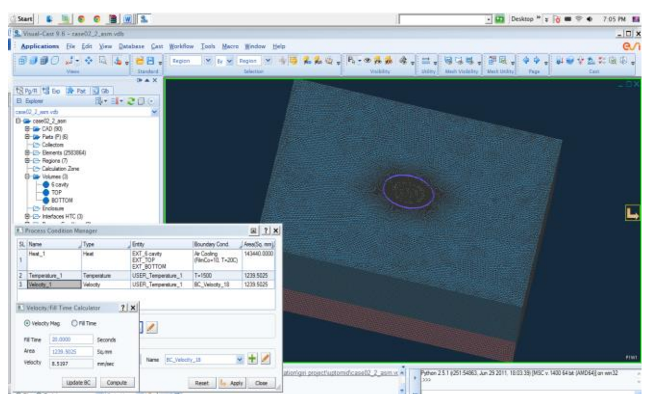

Figure 3.8 Inlet velocity to pouring cup

Step 7: Apply inlet temperature to pouring cup

The actual pouring temperature is in the range of 1400-1550 °C. So, select 1500 °C as inlet temperature to pouring cup

Step 8: Define Process for Filling

Define gravity filling as process for filling. The molten metal from ladle is poured into the mould cavity under the action of gravity force only.

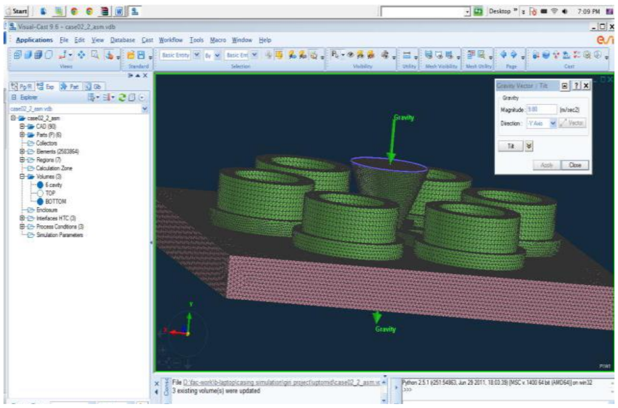

Figure 3.9 Selecting gravity filling process

Step 9: Define Run Parameter

Apply run parameter for Hardwear part.

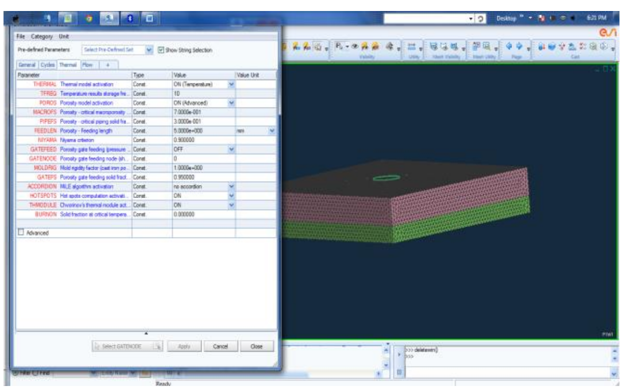

Figure 3.10 Defining run parameter

Step 10: Post Processing Results in View CAST

We have temperature distribution at section taken on Y-Y plane. A color zone in the cavity indicates the temperature distribution of poured metal at different time interval.

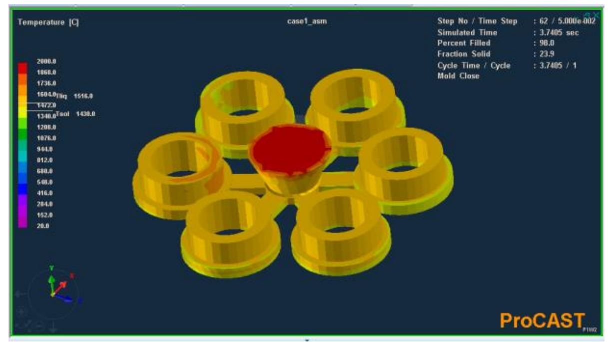

Figure 3.11 Post Processing Results in View CAST

Step 11: Output result from ProCAST

Output result of shrinkage porosity is given below in figure 3.14

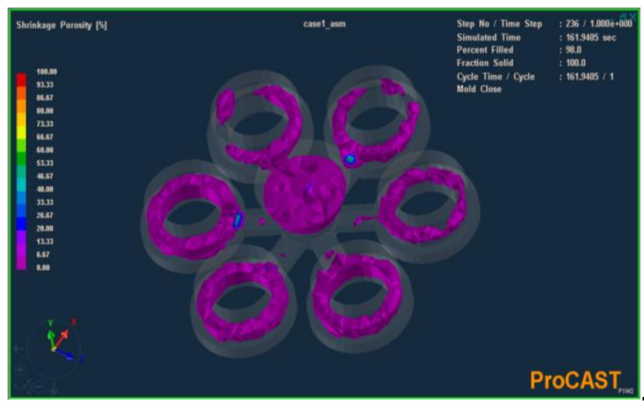

Figure 3.12 Output result form the ProCAST

Figure indicates the temperature distribution over entire part. Maximum temperature at the centre of the part so that the maximum chances of porosity occurs at that region.

4. CONCLUSION

In this study, the experimental and virtual behavior for core casting process of coupling part called Coupling Cage is validated with FEA result carried out in PRO-CAST 2014 & CREO 2.0 software. By considering two different factors as gate size, sprue size optimization for core casting process is being generated. For validation of the analysis result external source here utilize in the way of casting foundry. From combination of practical data from foundry and analysis result by software to improve the productivity of foundry shop successfully in related company. Shrinkage defect reduced the productivity at most and we target that parameter in our work and help the company for and give the new way of gating system in core casting of stainless steel material. And after all we conclude that core casting process for any complex shaped part with less productivity rate could be improved by this approach without spending more time and money.

REFERENCES

[1] Feng Liu, worcester polytechnic institute, December 2008.

[2] Marco Aloe, Calcom ESI, Switzerland Mark Samonds, ESI Software, France Lorenzo Valente, ECOTRE sas, Italy.

[3]Mohammad Sadeghi and JafarMahmoudi, HST Department, M¨Alardalen University, V¨aster˚as, Sweden.

[4] Dr.S.Shamasundar, V.Gopalakrishna, Manjunatha, BadrinathProSIM- AFTC, 326, III Stage IV Block, Basaveshwara Nagar, Bangalore 560079.

[5] M. Y. Khire, V.V.Mane, AmitSata "New Approach to Casting Defects Classification and Analysis Supported by Simulation.