Analysis of Casting Defects and Yield Improvement Through Simulation

A Case of Cast Iron Straight Parallel Edges

Purvi Chauhan[1], Umang Patel, Tejas Chaudhary[2], Harshil Jani [3]
[1]Assistant Professor
[2]B.E.Students, Production Engineering Department, BVM Engineering College,Gujarat,India,
[3]B.E.Student, Mechanical Engineering Department, BVM Engineering College,Gujarat,India

Abstract
The quality in the least possible cost is need of hour in this highly competitive world. The same challenge is faced by Foundries to achieve high grade casting with minimum cost. Casting simulation is an economical step in our quest instead of individual experimental casting or small runs before mass production.
Keywords: *Quality, Minimum Cost, Casting, Foundries, Simulation*

INTRODUCTION

The increasing demand of quality has pressurized foundries to improve their casting techniques. To do this experimental casting method was chosen like individual casting or small runs before production. But this method yields high cost hence is uneconomical.

From many product of this industry one of the important product is cast iron Straight Parallel Edges. During casting process there is an unnecessary blow hole & porosity defect occurred in the product. This defect may due to certain reasons like unidirectional solidification, improper location of riser, gating design etc.

Typical Operation Process Chart

The operation process chart described below in figure 1 is made after undertaking a detailed study of various components in foundry process. Some of the major components which were observed during their processing are Bench center box angle plates, sine bar granite surface plate and many more.

During our observation we came to a conclusion that the process being followed for the manufacturing of the following castings is same. The sequence and the flow of the operations being done for manufacturing of all the products at MICRO FLAT DATUM is the same as described in the operation process chart below for the above mentioned products.

The present procedure followed in the manufacturing of the casting at MICRO FLAT DATUM is proper with appropriate number of inspection stages. This inspection stages are for constant monitoring over the process in order to find and eliminate the errors if any occurs. The operation process chart shown in figure 1.

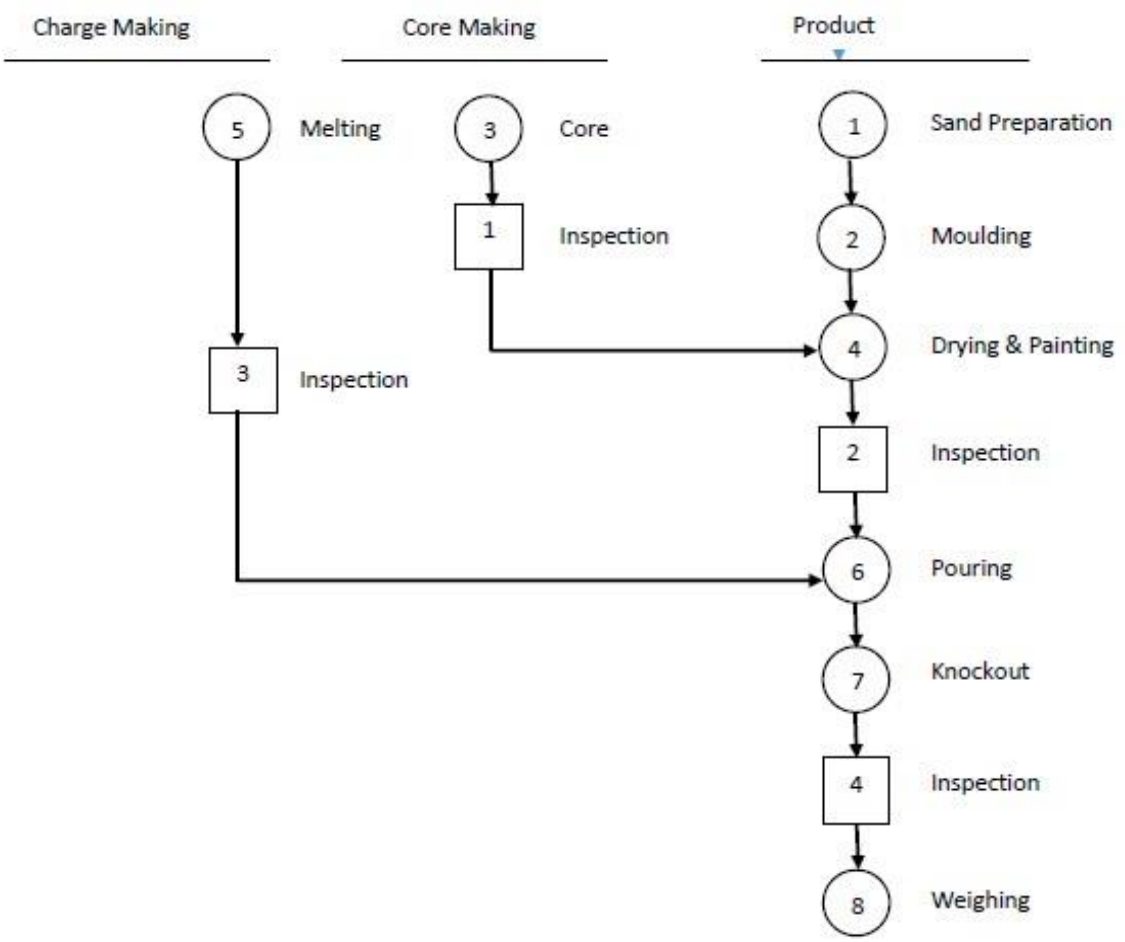
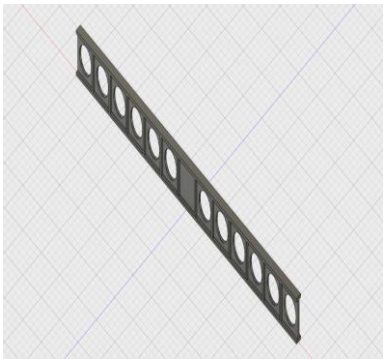


Figure – 1 Operation process chart

After analyzing the whole process of casting used in industry and finding out one major defect occurring in final product. Then reviewing literature papers related to the project and then did work on sand used in casting process and did improvement in it and then did work on gating system and made one new optimal design through simulation

PRODUCT DESCRIPTION

- Cast iron parallel straight edge
- Material: - FG 220
- Dimension:- 3000*250*60
- Product Weight: - 85.700 kg
- Density:- 2.80 kg/m^3



An angle plate is a work holding device used as a fixture in Metalworking. The angle plate is made from high quality material (generally spheroidal cast iron) that has been stabilized to prevent further movement or distortion.

Figure – 2 Cast iron Straight parallel edge

P.D. Chauhan, Mohit Anuvadiya, Vivek Chauhan proposed the methods & techniques of feeding and gating system design to increase the yield of casting[9]. Aniruddha Joshi and L. M. Jugalkar proposed the pareto principle and cause effect diagram to identify and evaluate different defects and causes for these defects responsible for rejection of components at different stages of manual metal casting operations[6]. Mr. Patil Sachin S, Prof. Naik Girish R. impacts on the quality of casting which depends on quality of sand, method of operation, quality of molten metal etc. To produce defect free casting, attention have to be given towards controlling the process parameter[7].

MAJOR DEFECTS OBSERVING IN INDUSTRY

Gas Porosity, Blow Holes, Pin Holes and Cold Shut

CAUSES:

- Blowholes and pinholes are produced because of gas entrapped in the metal during the course of solidification
- Gas Porosity generally produced due to low metal pouring temperature and Insufficient metal fluidity e.g. carbon equivalent too low.
- Excessive moisture absorption by the cores and inadequate core venting are main cause of cold shut and Blow holes.

REMEDIES:

- Make adequate provision for evacuation of air and gas from the mold cavity; Increase permeability of mould and cores
- Increase metal pouring temperature.
- Reduce amounts of gas. Use slow-reacting binder, Reduce quantity of binder. Use coarser sand if necessary.
- Apply dressing to cores, thus slowing down the rate of heating and reducing gas pressure.

SAND TEST WITH ITS ACTUAL VALUES

As by doing sand test we get the actual data and we found that it's not in proper range so it may create defects. The calculated values are shown in Table 1.

Table 1 Calculated values

Control factors	Actual Values
Moisture (%)	6
GCS (g/cm^2)	330
Permeability (nu)	115
Mold hardness (nu)	42

CAUSE EFFECT DIAGRAM OF CAST IRON STRAIGHT PARALLEL EDGES

The Cause Effect Diagram has been made after testing sand and analyzing its results. It has been found that five major causes are there which results into defective product.

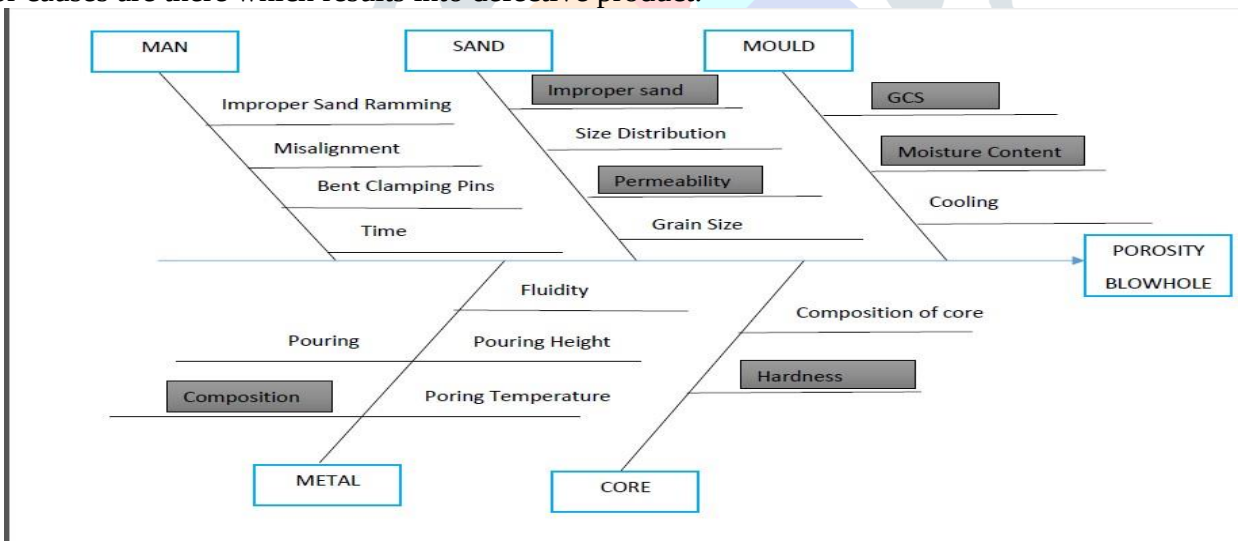


Fig 3 Cause effect diagram

After analysing cause effect diagram we did pareto analysis shown in figure 4 which shows the four parameters which is responsible for defects.

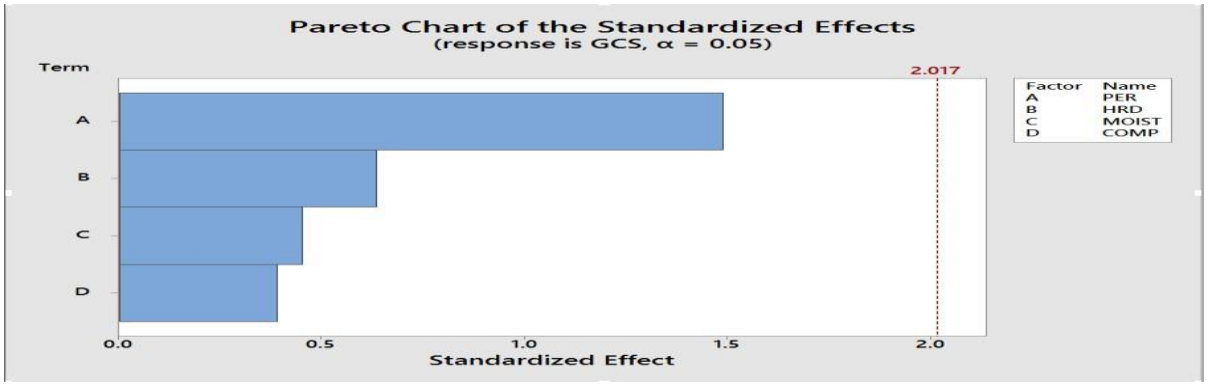


Fig 4 Pareto Chart

SIMULATION

The calculations done for new design is shown in Table 2 with data of old design.

Table 2 Calculated values for simulation

PARAMETER	CURRENT SYSTEM (in mm)	MODIFIED CALCULATION (in mm)
Ingate Height	20	20
Ingate Width	40	30
Dia of Riser	60	15
Dia of Runner	27	50

As by doing simulation we found that six risers will give optimum result. So we put six risers whose analysis are shown in figure 5 and figure 6.

Figure 5 shows the minimum temperature spots as when metal poured it will starts to solidify from these spots.

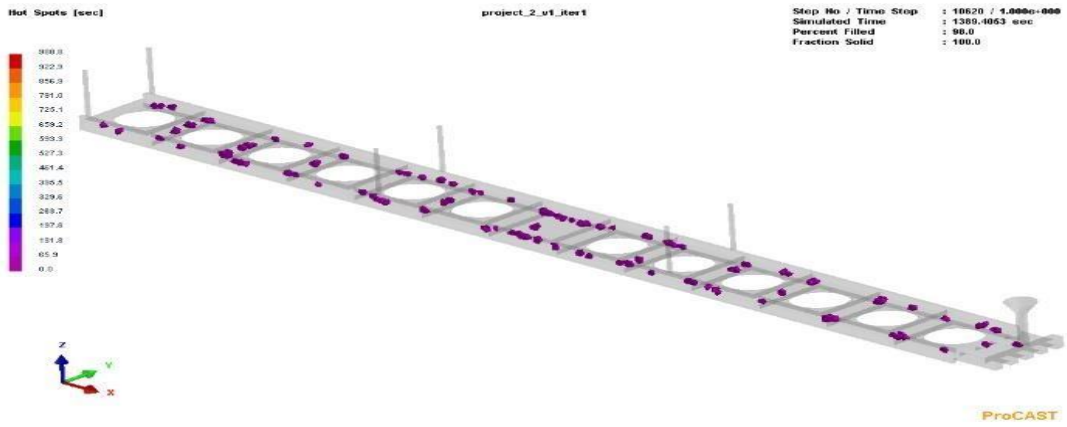


Figure –5 Spots where temperature is minimum

Figure 6 shows the directional solidification is takes place and no any spots occurs where improper temperature will occurs during solidification.

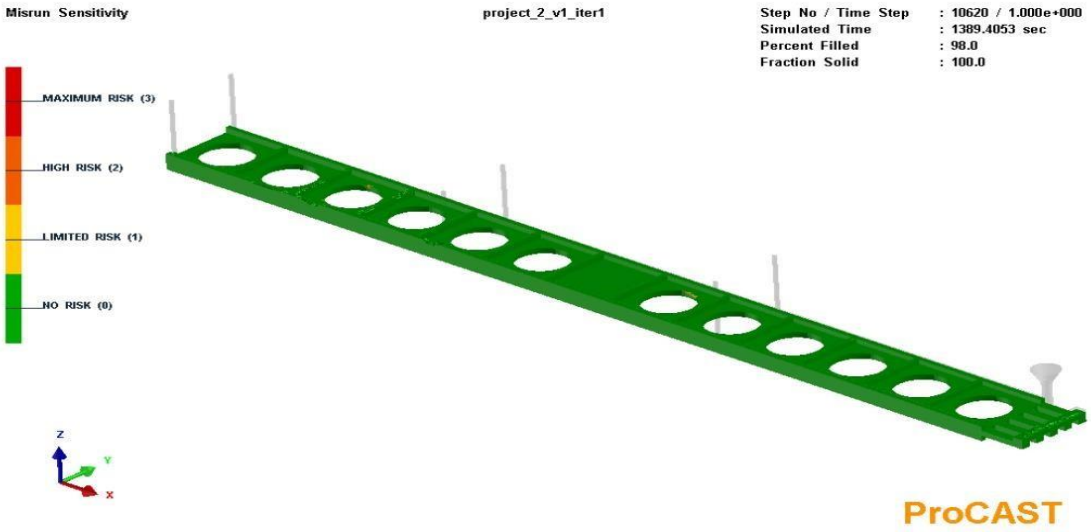


Figure – 6 proper solidification in whole edge without any risk

CONCLUSION

Based on modifications in existing gating system design of sand casting, the major problem of gas porosity, Pin Holes, Blow Holes and cold shut are reduced. The modification also resulted in the improvement of casting yield. These modifications are tested through simulations with proCAST & E Foundry and it's found to be valid while trial run production at MICROFLAT PVT.LTD.

With the help of minor changes in sand properties like GCS (Green Compressive Strength), Moisture, Mold Hardness and Permeability, we can get sound casting

ACKNOWLEDGEMENT

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