

Casting Method Design of Gear Box Housing for Yield Improvement through Simulation: A Case Study

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Abstract

Defects occurred in a casting of Gear box housing of foundry are categorized in to two parts. Namely methoding, filling and solidification related defects such as shrinkage porosity, hot tears, etc. & sand and mould related defects such as sand drop, bad mould, etc. In the first part casting simulation technique, analysis for shrinkage, porosity defect will perform and new gating system designed. Number of iterations will be performed using simulation software to achieve optimum design. Gating system must consume less metal and the casting yield is higher, which makes the process economical. To achieve this goal, the gating should be properly designed so as to work properly and efficiently. If gating is oversized it will reduce the actual casting yield, if it is undersized or not designed properly it would result into the various flow related defects. Hence proper design of gating system is essential for sound casting with higher yield. With old gating system analysis gives shrinkage nearer to middle ingate with 83% production yield whereas modified gating shows improvement in shrinkage with 85.5% of production yield of gear box housing.

Keywords

Casting Design, Casting Defect, Simulation, Optimization and Analysis, Yield improvement, Shrinkage, Parameter optimization.

I. Introduction

Foundry deals with the process of making castings in moulds formed in either sand or some other material. Casting is an old production technique in which cavities are made into a porous and refractive material by a pattern and then liquid metal is poured in the mold to get the required product. Green sand casting is the most widely used casting process because of the wide variety of castings can be manufactured with respect to size, low cost of raw material and possibility of recycling the molding sand. Green sand casting process is a versatile process because it can be used for casting of most metals with high melting point temperatures like copper, cast iron. Several types of defects may occur during casting, considerably reducing the total output of castings. Defective castings lead to tremendous loss of productivity [1].

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. Foundries try to reduce rejections by experimenting with process parameters (like alloy composition, mold coating, and pouring temperature). When these measures are ineffective, then methods design (gating and feeding) is modified. When even this is not effective, then tooling design (part orientation, parting line, cores and cavity layout) is modified. The effect of any change in tooling, methods or process parameters is ascertained by pouring and inspecting test castings. Study show

that replacing shop-floor trials by computer simulation saves time, provides a better insight, and helps in reducing the rejections by half – from an average 8.6% before to 4.3% after, as per a survey of nearly 200 foundries carried out by IIT Bombay. This is however, still very high compared to the expectations of OEM customers. They are now beginning to share the responsibility for casting quality, by working closely with their suppliers, with the aim of reducing the rejections to near-zero level [2].

The main objective of a gating system is to lead clean molten metal poured from ladle to the casting cavity, ensuring smooth, uniform and complete filling which results into the sound defect free casting. As this is secondary component of casting, it should be minimum in volume so as it must consume less metal and the casting yield is higher, which makes the process economical. To achieve this goal, the gating should be properly designed so as to work properly and efficiently. If gating is oversized it will reduce the actual casting yield, if it is undersized or not designed properly it would result into the various flow related defects such as cold shunt, misrun, blow holes, slag and sand inclusion. Hence proper design of gating system is essential for sound casting with higher yield [3].

II. Literature review

A detailed literature review was carried out for identifying the major defects which leads to rejection of castings and to solve these defects using simulation model using advanced software is done effectively. However it was seen that a very little work has been carried out on defect reduction and yield improvement with Simulation Technique and also some researchers were gives solutions to solve the major defects during gating and feeding process in castings. A brief Review of some selected references on this topic is presented here.

Khirsariya et al. [1] studied shrinkage defects in Valve body casting. They use vector element to analyse the progress of solidification inside a 3D casting model. The gating system used in foundry to produce valve body casting, There is a possibility of shrinkage defect to arise due non-uniform solidification. To reduce the shrinkage defect in valve body casting, some modifications are done in the design of gating system. They proposed designs for reducing the shrinkage defect. One possible solution is location of ingate should be in the back side of the part as so that defects get reduced. They also commented on process to do simulation. Finally they concluded that, Modification in gating design system by changing location of Ingate at back surface of part, the shift the shrinkage from cast to gating system.

Dr. B.Ravi [2] concluded that zero defect castings can be produced by collaborative design of part, tooling, methods and process parameters using a user-friendly system. At the part design phase, thickness checks enable preliminary evaluation of part manufacturability with respect to process capability. At the tooling design phase, parting line, cores and mold cavity layout can be semi-automatically designed and analysed. The methods design includes semi-automatic design and 3D modeling of feeding and gating system, followed by mold filling and casting solidification,

to predict quality issues more accurately (compared to part design phase). A cost model enables comparing alternative designs. Finally, process optimization is carried out based on the results of shop-floor trials.

Khade and Sawant [3] Studied casting of brake disc is analysed and calculated to solve the problem of lower casting yield due to over designed gating system components. To overcome this problem gating system is redesigned based on gating rules, gating design procedure, theoretical knowledge, casting simulation and practical considerations. The various gating systems are designed for the casting and 3D CAD models of this designs are made and simulated using casting simulation program Autocast-X flow plus. After analysing the simulation results, if desired results are not obtained, then the changes are made in the design and 3D CAD model and simulated again, the procedure is repeated until the desired results are obtained so as it will give the sound quality casting with the higher casting yield, profit and productivity.

Patil and Naik [4] discussed the application of quality control tools for reducing rejection rate of gear box housing. Initial study shows that casting under study facing higher rate of rejection due to defects occurred in it namely sand inclusion, shrinkage etc. Average percentage rejection for last 6 months was found to be 13.02. High amount of revenue is lost due to these defects considering per unit cost of housing is Rs. 5000/-. This indicates there is a scope for process improvement of casting so that loss of revenue will get minimised. It has been expected that by using combined approach of simulation technique and design of experiment defects in product under study will be minimised.

Patil and Naik [5] concluded that quality of castings 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 parameters. Most of the researchers in their study used Pareto principle and hence seven quality control tools to identify and evaluate different defects and causes for these defects responsible for rejection of components. Some of also use FMEA, Six sigma, Value stream mapping to control process. Many researchers have conducted experiments on sand process parameters using Design of experiments method such as Taguchi method and proved that the reduction in casting defects due to sand process up to 6%. Also use of simulation for simulation of component, shrinkage porosity defect gets eliminated because these are method related defect.

Bose and Anilkumar [6] aimed at reducing rejection rate of castings in an Indian foundry. The overall goal of the project proposed here in is to reduce the rejection rate using simulation model in foundries. In this paper a case study on a cylinder clamp casting of Milacron product, which is having high rejection rate in an Indian foundry is taken and the defects of casting are solved using the proposed simulation model with Magma 5 software and the effective solutions for reducing rejection rate for the product is also given. By replacing the existing trial and error method with computer simulation foundries reduces rejection rate from 8.5 to 3.5 %.

Pude et al. [7] concluded from their study that value stream mapping helps an organization to identify the non-value-adding elements in a targeted process and brings a product or a group of products that use the same resources through the main flows, from raw material to the arms of customer's. Current effects of wastes on processes are observed. Process activity mapping steps are studied and wastes are identified. Different flow layouts are studied and best layout is selected that reduces the transport time. In their paper a case study in xyz foundry is carried out with current

state map and future state map after following the different steps starting from the detailed time study of mapping process from raw material to final product. The steps including waste elimination techniques with conversion of existing waste into standard wastes are described. Statistical charts are prepared for the identification of bottleneck product.

Vante and Naik [8] focuses on better control to solve the problem of dimensional variations in 3 cylinder metric block casting. Initial research shows that casting is facing higher percentage of rejection due to dimensional variations at casting wall. Average rejection percentage for last five months is 9.564. Average rejection percentage for last five years was 9.23. Revenue loss in the month of January 2015 is 10, 72,000 Rs. This indicates that there was scope for the quality improvement of casting. Quality improvement will be achieved by using quality control tools. A proper methodology is formed consisting of various quality control tools such as Pareto analysis, Ishikawa diagram (cause and effect diagram), brainstorming, why-why analysis. After implementation of this methodology a better control over the process will be obtained. Detailed analysis of root cause will result into the permanent solution to the problem. Successful implementation of the remedies results into reduced rejection rate of casting and quality improvement.

Choudhari C.M et al [9] observed that solidification simulation enables visualization of the progress of freezing inside a casting and identification of the last freezing regions or hot spots. This facilitated the optimized placement and design of feeders with improvement in yield by 15 % while ensuring casting soundness without expensive and time consuming trial runs. In this case, the thick portion of the component was subjected to shrinkage porosity. It was the root cause for the poor strength which was leading to premature failure of the component. Proper design of gating system helps in achieving the directional solidification leading towards the feeder; thereby solving the problems of premature failure due to junction solidification and incomplete fill due to sudden variations in thickness. Feeder was placed at last solidifying region using AutoCAST-X software. This approach helped in minimizing the solidification related defects, thereby providing a defect free casting. This study shows that simulation can be of great use in optimizing the feeder dimensions and increasing the feeding efficiency of the casting. Both macro-porosity and micro-porosity were identified as 4.47 cm³ with 100% quality. Quality, feeding yield and feeding efficiency obtained from software were 99.89, 84.66 and 22.82 % respectively.

Salunke et al. [10] concluded from their work as use of simulation programs saves time and reduces the costs of the casting system design. During solidification process, it induces casting defects like shrinkage, porosity and hot tears. To eradicate and eliminate these problems, accurate casting design and proper design of gating system is necessary. This can be predicted and designed by means of computer simulation of casting solidification. In this paper casting of circular disc is analysed and studied to solve the problem frequent rejections due to shrinkage observed at machining stage. Initially feeder system is designed using past experience and judgment of patternmaker. The feed system is analysed using theoretical knowledge and casting simulation. There after the feeder system for disc is redesigned based on feeding rules, conventional method and casting simulation. All the designs were simulated with Auto-Cast to ensure the completion of filling process and to see the manner of solidification of Cast Iron castings. The various models are made, then 3D CAD model of casting with these modified feeder system are simulated to analyse

effectiveness of modified feeder system. Results from simulation are used to evaluate the possibility of defects and minimize them. Analysing the various modified feeder system and the most suitable design is selected so as it will give the improved quality of casting to achieve defect free casting.

Nimbulkar and Dalu [11] worked on gating system design to know last solidifying region in casting and eliminate these defects. They simulate old gating system for productivity and defect and modified the present gating system in new gating system by using Auto-CAST X1 simulation software. They found that initial vertical gating system was not suitable for thick casting components hence proposed horizontal gating and feeding system so that molten metal flow becomes uniform, gases escape easily in to atmosphere. Feeding related defects had been reduced by 30%.

Sarath and Rathish [12] suggested new approach to produce sound FG 260 grey iron casting by computer simulation through experimental validation in a cast iron foundry. The casting process is simulated by using finite element simulation software and results were compared. A simple rectangular plate casting dimension 200*100*15 mm is produced with different combination of riser dimensions. To improve the yield and minimise defect, cylindrical riser of hemispherical bottom width $h/d=1.3$ was considered. ANSYS simulation software was used to compute solidification time and selection of optimal riser dimensions. It was proven by researchers that hemispherical bottom riser consumes 16-17% less metal than standard cylindrical side riser. Experimental verification was also done to validate results obtained by simulation.

Dabade and Bhedasgaonkar [13] proposed method of casting defect analysis by combination of design of experiment method and computer aided casting simulation technique. They aimed to find optimal setting of moulding sand and mould related parameters of green sand casting process of wheel hub casting. The optimised levels of selected process parameters obtained by Taguchi method are moisture contain-4.7%, Green compressive strength-1400gm/cm², Permeability Number-140 and Mould hardness number-85. By using this method % rejection reduced from 10% to 3.59%. Also they performed analysis of defects like shrinkage porosity by computer aided casting simulation technique. They suggest new gating system especially feeder with optimum size and two in numbers such that reduction in shrinkage porosity was observed by 15% and improvement in yield by 5%.

Bhujugade and Sabnis [14] Used computer simulation technique and design of experiment for casting defects analysis. In the first part using casting simulation technique analysis for shrinkage porosity defect is performed and new gating system designed. With new gating system reduction in shrinkage by (about 2.85%) and yield improvement by (about 9.85%) was observed. In the second part DOE used for casting defects 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 and analysis was carried out using Minitab software for analysis of variance (ANOVA). After implementation of casting simulation technique it was observed that minimization of methoding related defects such as shrinkage porosity reduced up to the 0.89% and yield improved by 9.85% with newly designed gating system. The optimized levels of selected process parameters obtained by Taguchi method is: (i): Moisture content 2-2.5% (ii): Sand Particle Size 35-40 (iii): Mould Hardness 75-80 and (iv): Pouring Temperature 1570-1585° C. With Taguchi optimization method the % rejection of casting due to sand related defects

and pouring practices related defects is reduced from 8% to a maximum up to 3.55%.

Vante and Naik [15] discussed the research carried out in the foundry to control the increased rejection. The component under study is 3 cylinder metric block. The dimensional variations in casting wall thickness are analysed as major defect contributing in rejection. Quality control tools such as Pareto analysis, cause and effect diagram, why-why analysis, are used for analysis of casting defects. Remedies to minimize the rejection are suggested and implemented. Various chaplets are tried and tested as remedies. The previously used 3 disc round chaplet is replaced by rectangular v-make chaplet. Pouring temperatures and chaplet size are optimized to lower the rejection percentage. Rejection percentage for dimensional variation at water jacket is decreased from 7 to 2.13. Reduced rejection indicates better control resulting in quality improvement of 3 cylinder metric block.

Pude G.C et al [16] Used value stream mapping tools in identifying, quantifying and minimizing major wastes in a foundry production line to quantify the variety of products generated at each manufacturing processes within the foundry line. To formulate practical means of reducing the identified major wastes by reducing excess inventory, defects and unnecessary activities. The aim of researcher is to reduce lead time for process improvement. The results of process activity mapping shows 23% waste reduction in the areas of unnecessary inventory, transportation and waiting. In their study bottleneck product is identified. The key sources for internal scraps are identified and these are analysed and improvement is carried out in these areas. Future state map revealed that about 700 castings per million are saved from defects.

Joshi and Naik [17] aimed to reduce cycle time of an operation by using Single Minute Exchange of Dies (SMED). Their Study was carried out in one of the automotive industry. Single Minute Exchange of Dies (SMED) is the approach to increase output and reduce quality losses. SMED methodology applied to prepare an optimal standard procedure for changeover operations on defined machine. A Comparison of results and achievements before and after SMED implementation were made. The results Shows that their study has achieved more than 30% of Cost reduction, 97sec can be reduced which increases the productivity.

Research Issues

In regards of use of simulation technique for minimisation of solidification related defects following issues can be summed up:

1. Number of research articles is available in the area of process parameters optimization by design of experiment for process improvement but less work has been reported in optimization of gating system for minimization of solidification defects and hence process improvement.
2. In the literature it was observed that number of virtual trials over software for defect minimization but very few explain theoretical calculations for design of gating system.
3. Virtual trials do not involve wastage of material, energy and labour, and do not hold up regular production. However, most of the simulation programs available today are not easy-to-use, take as much time as real trials, and their accuracy is affected by material properties and boundary conditions specified by users. The biggest problem is the preparation of 3D model of the casting along with mold, cores, feeders, gating, etc., which requires CAD skills.

III. Problem Definition

Gear Box Housing product of a local foundry facing a problem of Heavy rejection due to different process related defects. Process was observed for six months to analyse current practices. It was observed that the rejection rate is about 15 %. Defects occurred in housing are sand inclusion (8%), Shrinkage(4%) and other defects such as cracks, mismatch etc. (3%). The monthly production of gear box housing is approximately 1000 units. The price for one housing is Rs.5000/-. So loss of revenue due to poor quality casting is 7.5 lakhs per month approx. Organisation is facing loss of significance revenue due to cost of poor quality. Hence organisation is interested to minimise these defects to improve process with gain in production yield if any [4].

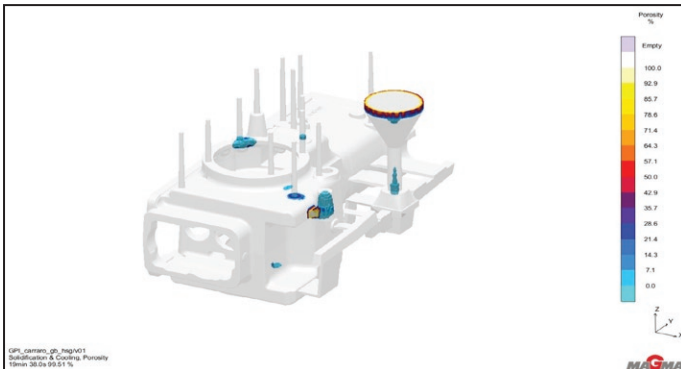


Fig 1: Simulation Image of Shrinkage Defects Observed in Casting With Existing Gating System

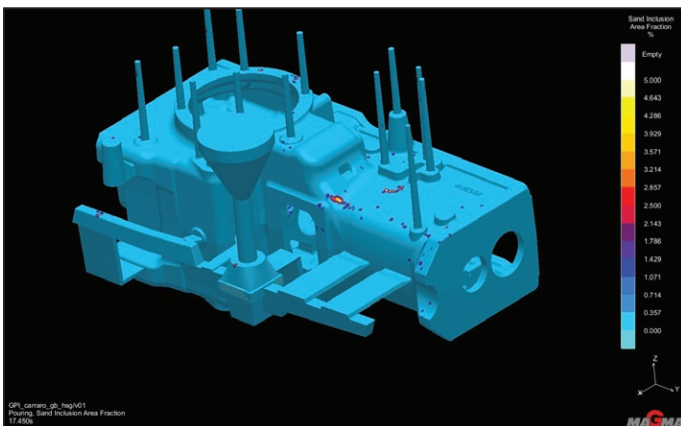


Fig 2: Simulation Image of Sand Inclusion Defects Observed in Casting With Existing Gating System

IV. Casting Process Details

Material: CAST IRON Grade: FG-260	
Iron Composition (Weight %)	
Element	Specification
Carbon	3.15- 3.35 %
Silicon	1.45- 1.65 %
Manganese	0.80- 1.00 %
Phosphorous	0.15 % Max.
Sulphur	0.15 % Max.
Chromium	0.30- 0.45 %
Copper	0.65- 1.00 %
Weight of the casting: (kg.) =195 Kg. APPROX.	
Gross weight incl. Casting + Feeder/s + gating (kg.)= 238 Kg. APPROX.	

Mold: Green sand
Molding process: High Pressure
Box size:- Cope.- 1200 x 800 x 375 ; Drag.- 1200 x 800 x 350
Sand/binder:- Bentonite
Sand / mold temperature:- 40°C- 45°C
Maximum permissible poured weight per mold: 250 kg.
Green sand molds
Water content:- 3.4-3.8%
Gas permeability:- 85-.95%
CORES – Cold Box process
Binder: Resin Part 0.85-0.95 % + Part 2- 0.85-0.95 %, Catalyst.- Amine- 0.25%
Sand: Silica Sand ; Coating: water base coating
FILTER Size:- 100X100X22
Inoculation
Inoculation alloy: Fesi.; Inoculation process: Ladle / Stream
Pouring process
Pouring temperature (°C):- 1420 ± 10 °C; Pouring time (sec.): - 17 ± 1 SEC
Type of ladle: Teapot Spout
Dia. of press pour nozzle:- Ø38 mm.

V. Design of Gating System

A. Pouring time required to fill complete casting in sec (t) -

$$t = \frac{\text{Bunch wt. (kg)}}{\text{Flow rate fixed by press pour system. (kg/s)}}$$

Bunch weight of casing = 230 kg

Flow rate fixed by press pour = 12 kg/s

$$t = 230/12$$

$$t = 19 \text{ sec.}$$

B. Sprue/Choke Area (Ac) –

$$A_c = \frac{k * \text{Bunch wt}}{\rho * t * f * \sqrt{H}}$$

where, k = thumb rule constant,

ρ = density of metal (g/cm^3),

t = pouring time (sec),

f = friction factor and

H = effective sprue height (cm).

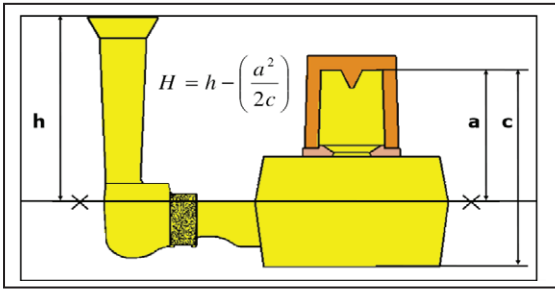
Where H is calculate as,

$$H = \frac{2h - a^2}{2c}$$

h = cope box height,

a = casting height in cope,

c = total casting height.



$$H = \frac{(2 \times 37.5) - 22^2}{2 \times 44}$$

$$H = 2814/88$$

$$H = 32 \text{ cm.}$$

Putting this value of H in above said formula to calculate choke area,

$$Ac = \frac{22.6 \times 230}{7.2 \times 19 \times 0.5 \times \sqrt{32}}$$

$$Ac = 5198/388$$

$$Ac = 1340 \text{ mm}^2$$

Sprue bar diameter (d) is calculated as,

$$Ac = \pi \times d^2/4$$

$$d^2 = 4 \times Ac/\pi$$

$$d = \sqrt{4 \times Ac/\pi}$$

$$d = \sqrt{4 \times 1340/\pi}$$

$$d = 41 \text{ mm} \sim 40 \text{ mm.}$$

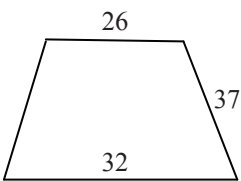
C. Total runner area (Ar)

$$= 1.4 \times \text{Sprue area (Ac)}$$

$$= 1.4 \times 1340$$

$$= 1876 \text{ mm}^2$$

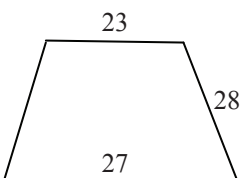
1. LHS runner area- Considered trapezoidal c/s of runner having top length 26 mm, bottom length 32 mm and height is 37 mm.



$$(Alh) = \frac{(26+32) \times 37}{2}$$

$$= 1070 \text{ mm}^2$$

2. RHS runner area- Considered trapezoidal c/s of runner having top length 23 mm, bottom length 27 mm and height is 28 mm.



$$(Arh) = \frac{(23+27) \times 28}{2}$$

$$= 700 \text{ mm}^2$$

D. Total ingate area (Ai) = 1.6 * Sprue area(Ac)

$$= 1.6 \times 1340$$

$$= 2140 \text{ mm}^2$$

1. Ingate area on LHS(3 ingates)

$$= (135+35+50) \times 6 \dots \dots (\text{length} \times \text{width})$$

$$= 1230 \text{ mm}^2$$

2. Ingate area on RHS(2 ingates)

$$= (70+65) \times 6 \dots \dots (\text{length} \times \text{width})$$

$$= 810 \text{ mm}^2$$

E. Riser Neck Modulus Calculation

Casting modulus is 1.4 cm (from simulation software)

So, neck modulus required is half of casting modulus i.e. 0.7 cm

Existing riser have neck cross section (3cm*2cm)

$$\text{Modulus of neck} = \frac{\text{length} \times \text{width}}{2(\text{length} + \text{width})}$$

$$\text{Modulus of neck} = \frac{3 \times 2}{2(3+2)}$$

$$\text{Modulus of neck} = 6/10$$

$$\text{Modulus of neck} = 0.6 \text{ cm}$$

Modified riser has neck cross section (3.5cm*2.5cm)

With this as a cross section of riser neck neck modulus is modified & it is now 0.7 cm.

VI. Simulation Results

Fig. 3 describes existing gating system of casting under study. It clearly indicates that number of ingates associated with the casting is six. Out of these six ingates two ingates are on the right side of sprue where are three ingates on left side of it and central ingate in front of sprue as seen in figure below. This figure also visible numbers of runners are two.

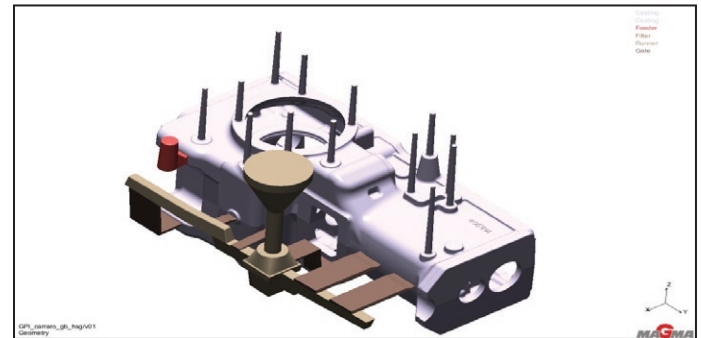


Fig. 3: Casting With Old Gating Design

Fig. 4 shows modified gating system of casting with the help of design calculations as explained above. In this gating system it is designed in such a way that it will helps in minimising shrinkage and inclusion defect of casting. In this design of gating, keeping number of runners are same as that of old gating system numbers of ingates incorporated are five out of which two ingates are on the right side of sprue and three ingates on left side of it and central ingate is removed as seen in figure.

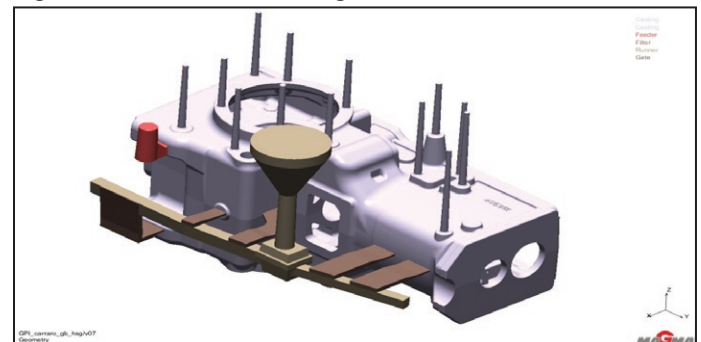
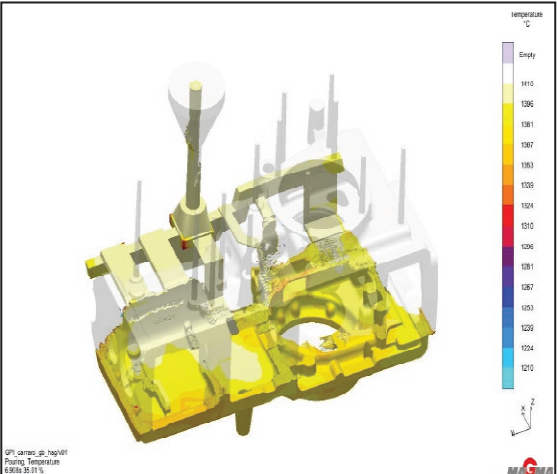
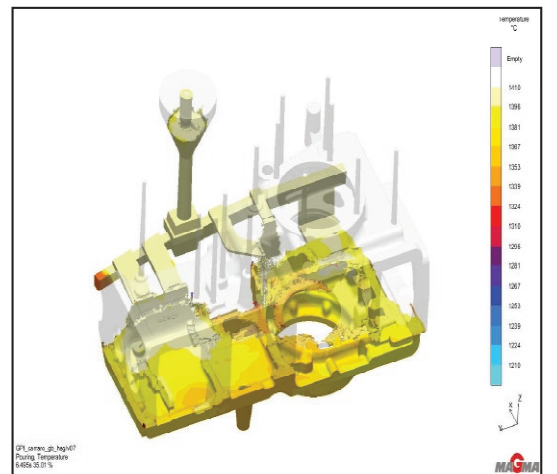
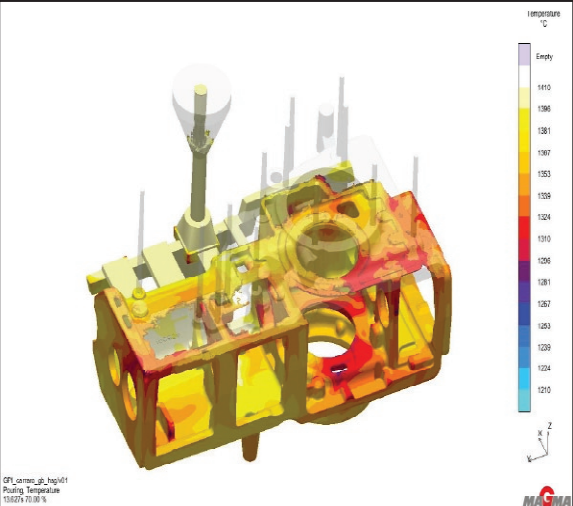
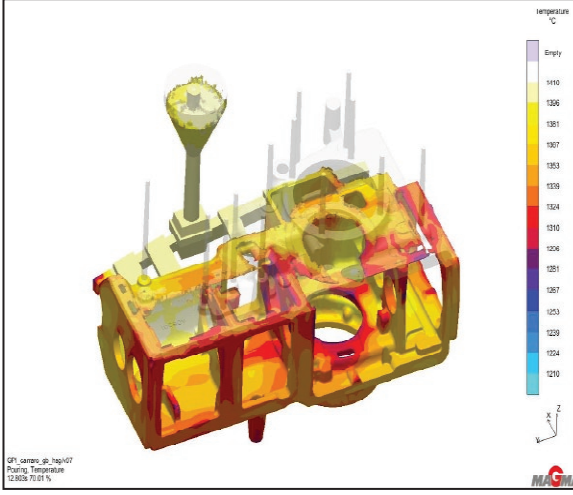
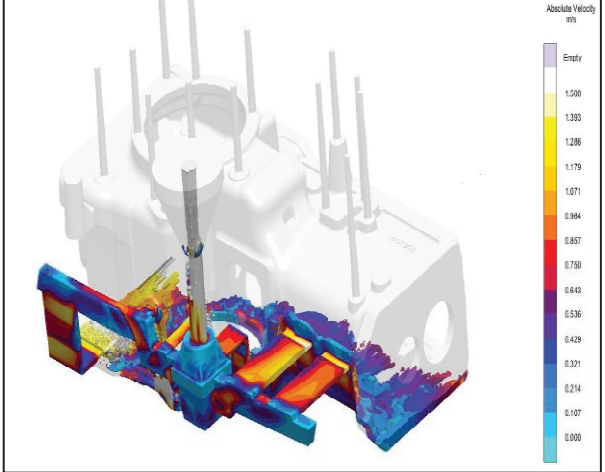
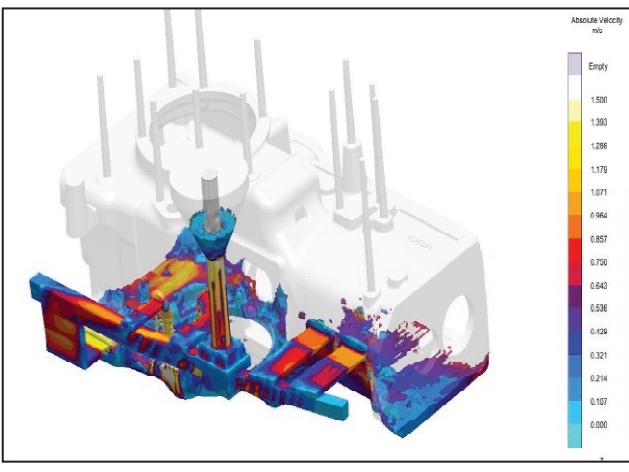
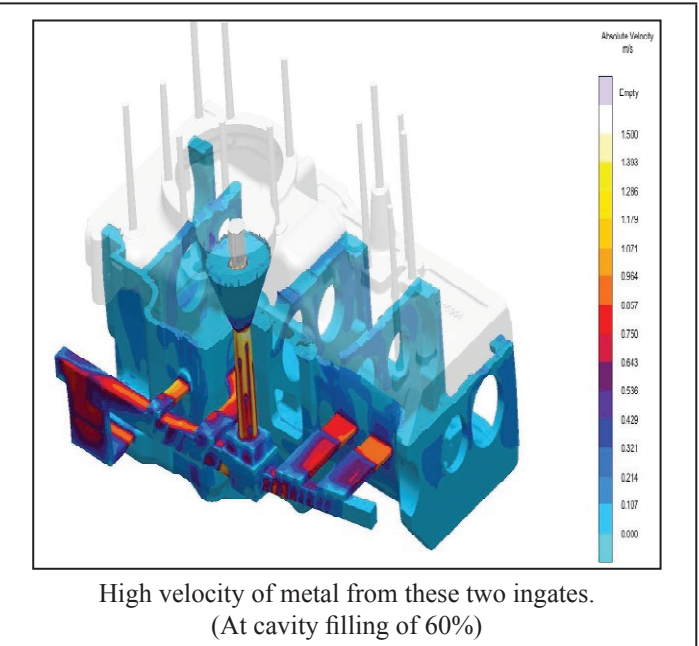
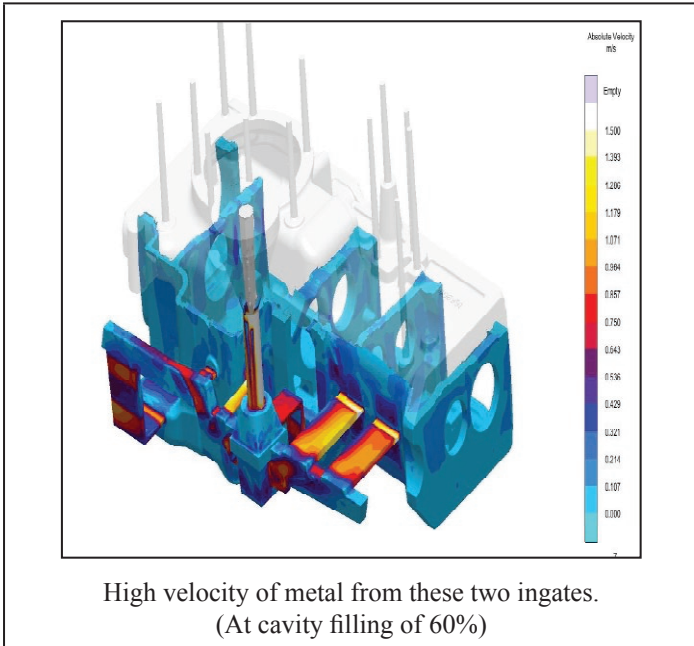


Fig. 4: Casting With New Gating Design

Table 1 Gives comparative results of casting cavity filling for both old and new gating system

Table 1: Temperature and Velocity Resulting Images of Old and New Gating System at Same Cavity Filling Percentage

Analysis of old gating system	Analysis of new gating system
Resulting images for temperature.	
 <p data-bbox="207 806 686 873">No cold metal filling observed from ingates (At cavity filling of 35%)</p>	 <p data-bbox="909 806 1388 873">No cold metal filling observed from ingates (At cavity filling of 35%)</p>
 <p data-bbox="207 1411 686 1478">No cold metal filling observed from ingates At cavity filling of 70%.</p>	 <p data-bbox="901 1400 1380 1467">No cold metal filling observed from ingates At cavity filling of 70%.</p>
Analysis of Old Gating System	Analysis of New Gating System
Resulting figures for velocity.	
 <p data-bbox="191 2060 702 2116">High velocity of metal from these two ingates. (At cavity filling of 20%)</p>	 <p data-bbox="893 2049 1388 2116">mooth filling of metal from these two ingates. (At cavity filling of 20%)</p>



With the modified gating design and neck modulus simulation shows promising results for shrinkage as shown in fig. 5 below.

A. Summary of Analysis

Table 2: Analysis Summary

PARAMETERS	OLD DESIGN	NEW DESIGN
Pouring Temp.	1400-1420 °c	1400-1420 °c
Gating system weight	40 kg	34 kg
Gross weight	236 kg	230 kg
Number of gates	06	05
Cavity filling time	17	19
Yield	83%	85.5%
Shrinkage	At middle ingate.	Ingate is removed.
Sand Inclusion	At ingate face and top surface of ingate.	Improved
Number of runner bars	02	02
Filling velocity at inlet	1.5 max	1.1 max
Sprue area(Scale)	1256 mm ² (1:1)	1340mm ² (1:1)
Runner area(Scale)	2512 mm ² (1:2)	1876mm ² (1:1.4)
Ingate area(Scale)	1985 mm ² (1:1.58)	2140mm ² (1:1.6)
Riser neck modulus	0.6 cm	0.7 cm

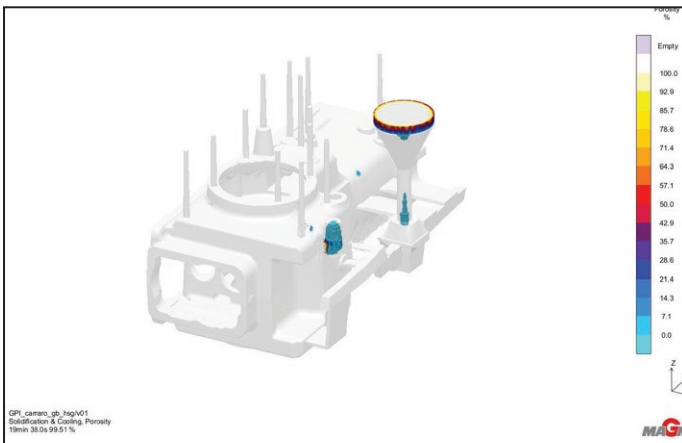


Fig. 6 below shows improvements in inclusion defects of casting as observed in old gating system (Fig. 2). By reducing molten metal velocity through ingate (initially it was 1.5 m/s) improvements in inclusion is observed(velocity bring to 1.1 m/s)

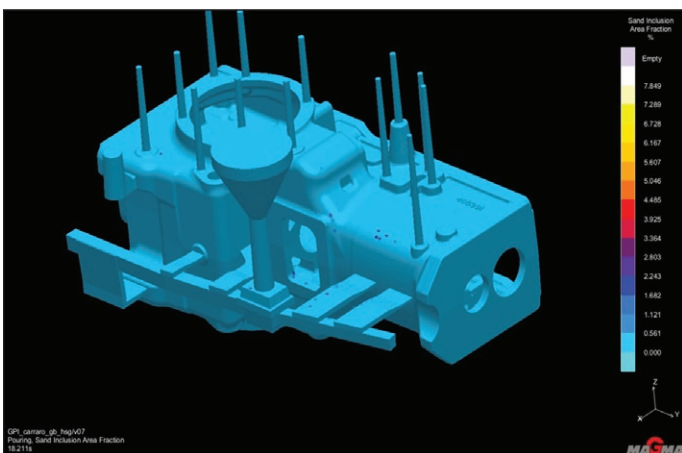
B. Yield Improvement

Improvement in casting yield is observed because of new gating system and it is calculated as,

$$\% \text{ yield improvement} = \frac{\text{Gross weight of casting (old) kg} - \text{Gross weight of casting (new) kg}}{\text{Gross weight of casting (old) kg}} * 100$$

$$\% \text{ yield improvement} = \frac{236 - 230 * 100}{236}$$

Yield improvement = 2.5%



V. Conclusion

Due to simulation on software, traditional gating system of any casting component has changed into new gating system. The time required is very less as compared to the conventional method of design of methoding. Visualization of mold filling phenomenon makes the process easy to understand to the user. Analysis of defects like shrinkage porosities computer aided casting simulation technique is the most efficient and accurate method. By simulation results we conclude that with change in number of ingates and its area, shrinkage tendency gets reduced and by controlling velocity of molten metal flowing through ingate, sand inclusion defect is improved by great extent. Also yield improvement with newly designed gating system is calculated and it is about 2.5 % higher than old gating system.

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