Application of Computer Aided Casting Simulation for the Profitability of a Foundry- Reducing Casting Defects and Improving Casting Yield- Some Industrial Case Studies

Tapan Roy
Prof. MICME (UK)
Asst. General. Manager – Methods & Development
Texmaco Rail & Engg. Ltd., Steel Foundry. Division
Belgharia, Kolkata – 700056.
Email : tapan.roy@texmaco.in

ABSTRACT

This study reports an in house experience of the applications of simulation techniques to solve different defects associated with steel castings by improving the method design. This study also utilises simulation techniques to improve the casting yield of different castings by optimising the feeder design, gating design etc.

This report is divided into two parts-

1. Development of sound and defect free castings by proper method design which is validated by simulation software.

2. Improvement of casting yield by optimizing the feeder and gating design.

Key words- *Hot tear, Shrinkage, Air Entrapment, Flow simulation, solidification Simulation, casting yield.*

Introduction

In our steel foundry we have analysed different chronic defects with the help of casting simulation software and also, we have tried to improve the yield of some of the castings by simulation techniques. Some of the case studies showing the actual defects and their simulation results are discussed in the following sections

CASE STUDY 1- Analysis of erosion scab and Simulation results of 9C bolster to identify the reason of scab defects and sand inclusion

This is a simulation analysis of 9C bolster castings to identify the root cause of Scab defects. We have analysed it by mould filing behaviour with simulation software and 3D modelling.

Figs. 1 & 2 shows simulation figures which clearly indicate that during flow of hot molten metal, the metal enters into the mould cavity through the ingates and its direction is towards the belly of the bolster which area is very susceptible to erosion. The resulting scab defect is called erosion scab.

Moreover the metal flow shows that it is entering into the mould cavity through the two ribs and then tries to raise its level and during that time any sand entrapped or washed away will be trapped (Fig.3).

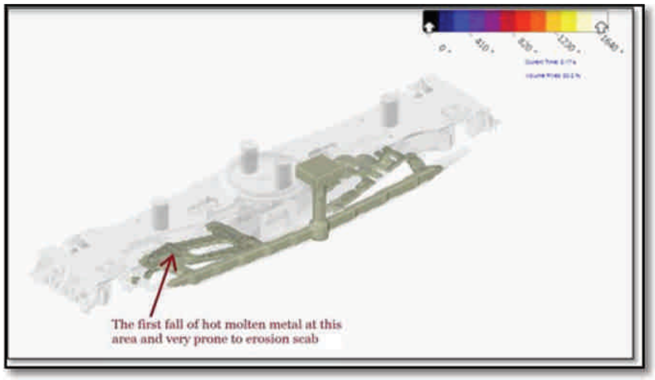

Fig.1 Flow simulation 10% fills (by Auto Cast Cast)

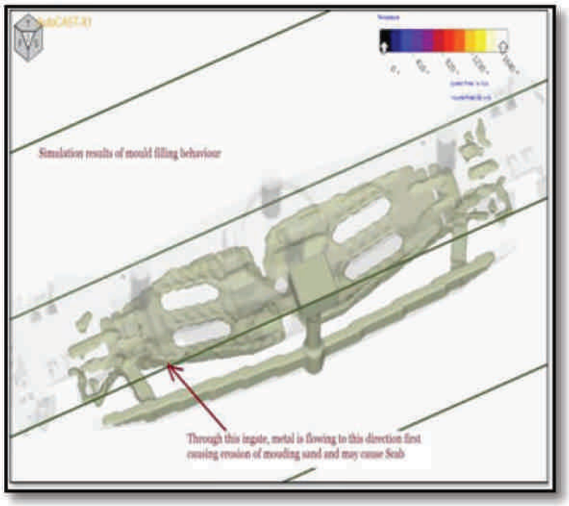

Fig.2.Flow simulation 30% fills (by Auto Cast)

Fig.3 Actual scab defects.

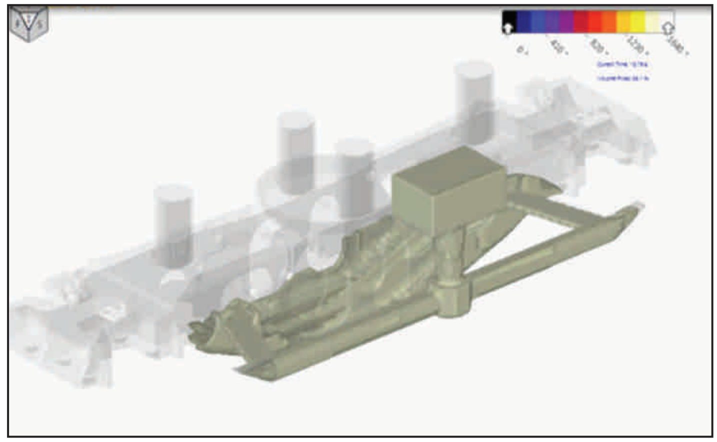

Fig4 Reversing the ingate direction, no scab found

Fig.5 Casting after changing the ingate, no scab defect found.

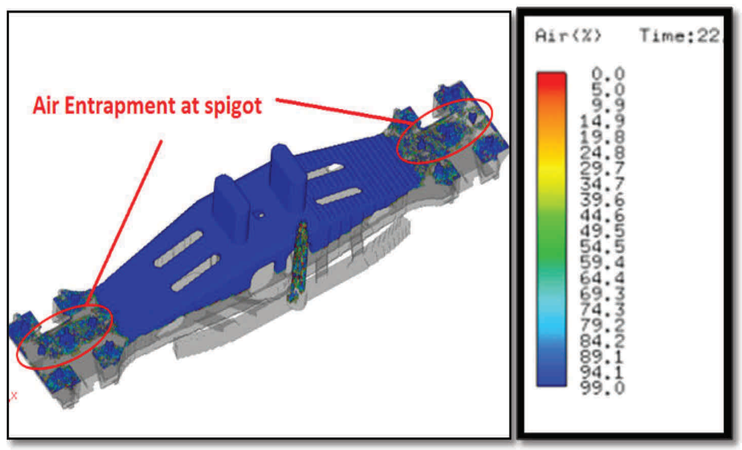

Fig. 6 Simulation view of air entrapment at the spigot area of Bolster casting. (By Adstefan Software)

But after changing the ingate in a different direction (Fig4 & 5), the defect has been reduced and almost eliminated.

CASE STUDY NO. 2

Air entrapment problems in green sand moulds produced in high pressure moulding line in Bolster castings (Bogie items) :

Simulation view shows air entrapment at the spigot area of Bolster casting during flow of molten metal inside mould cavity (Fig.6).

Fig.7 shows a problem in spigot formation in real casting. But after introduction of several vents at this area (simulation view- Fig.8), prominent spigot formation is observed as per Fig. 9 in real casting.

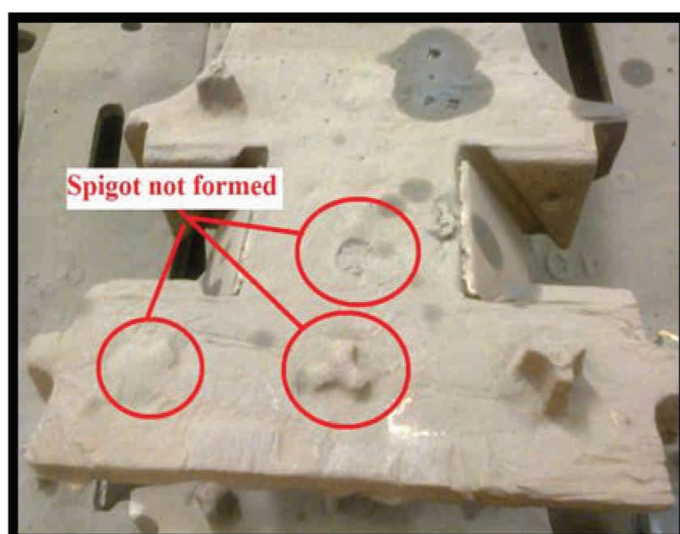

Fig.7 Spigot not formed in Bolster casting due to air entrapment.

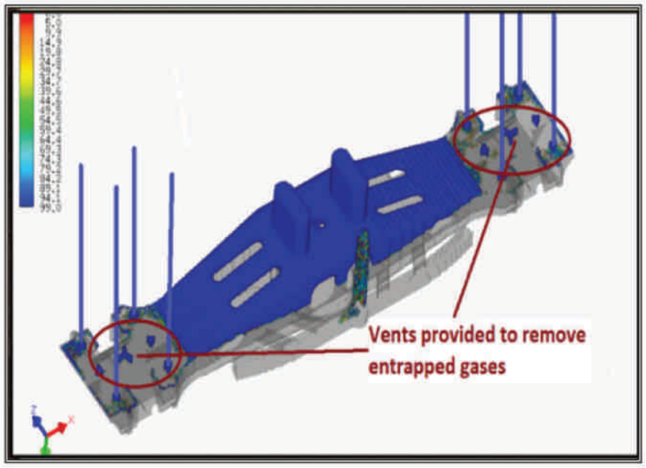

Fig8 Simulation view shows effective venting.

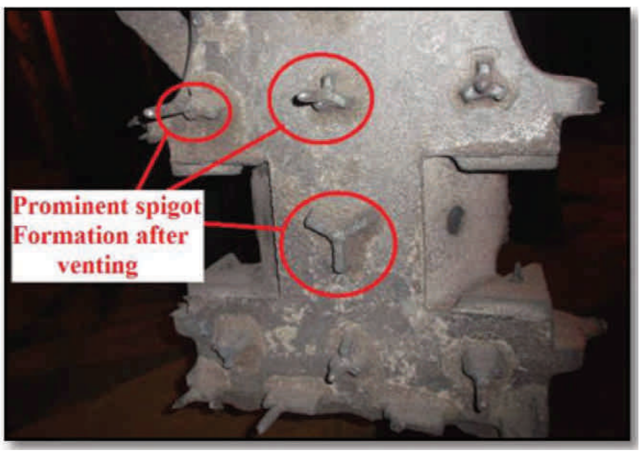

Fig.9 Prominent spigot formation after venting.

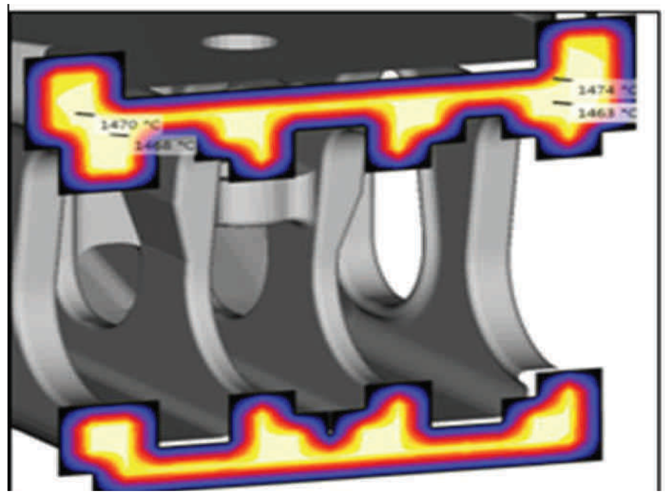

Fig.10 showing hot zone (temp.1470°C).

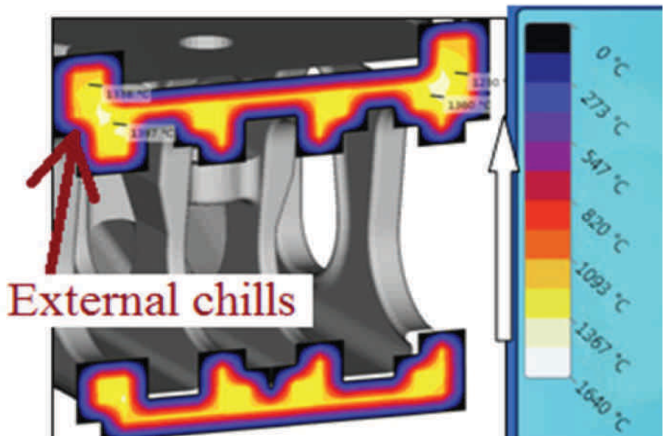

Fig.11 No hot zone (temp.1380°C).(by Auto Cast)

CASE STUDY NO- 3

Bolster simulation and case studies on hot tear

Fig.10 shows the simulation result of Centre pivot area of Bolster castings. The view shows that the hot metal at this junction has a temperature of 1470 °C which is wellwithin solidus range. The melt is in mushy form and solidifies latter causing hot tearing due to constructional hindrances by mould or core materials as per Fig.12. But after positioning of external chills Fig. 13 at this area the temperature at this area is reduced to 1380 °C as per Fig.11, which indicates faster cooling of this area and no hot tear found as per Fig 14.

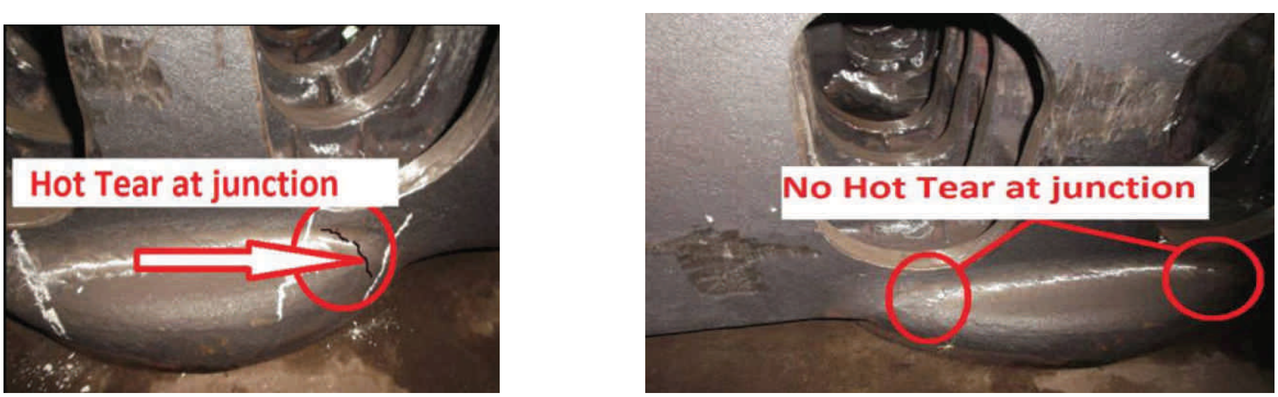

Fig.12 Hot Tear at junction (before)

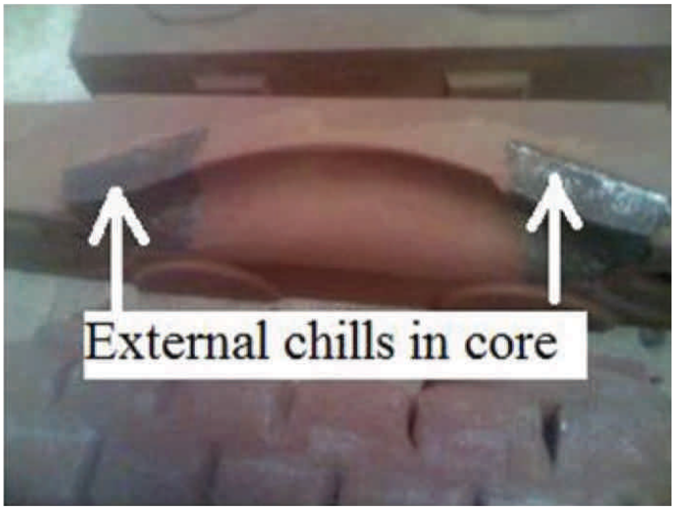

Fig 13 External chills to arrest hot tears.

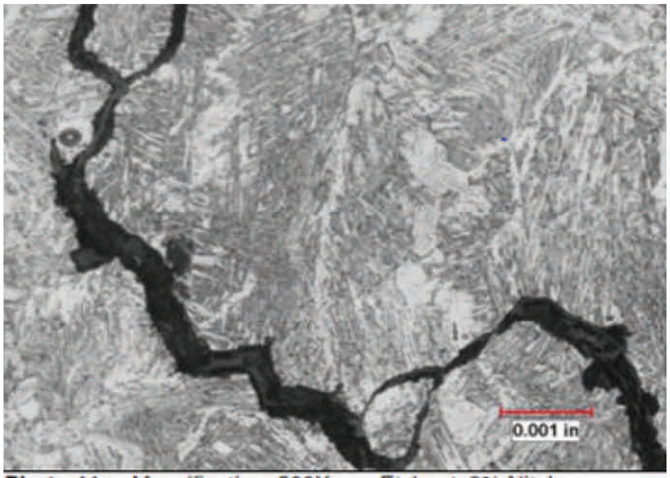

Photo 11: Magnification: 500X; Etchant: 3% Nital
Higher mag. view of Photo 10.

Improvement in Yield of Castings-

Yield is defined as the ratio of total weight of good saleable casting to total weight of the metal melted to produce them.

Yield is an indicator of the ability of a foundry to make acceptable castings in an effective manner. Improving yield of castings gives a foundry many commercial and technical advantages. Along with direct cost control better yield leads to better process control. By using computer simulation an optimum gating and feeding system can be established which can give better yield with better quality and profitability. By improving yield of steel castings by 5%, a foundry can make a profit of Rs.10/Kg (assuming

Fig.16 Yoke casting with 5 nos. risers

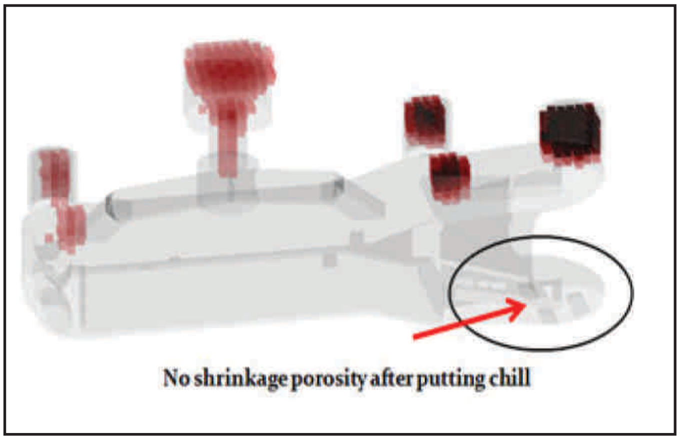

Fig17 Simulation view (By Auto Cast)

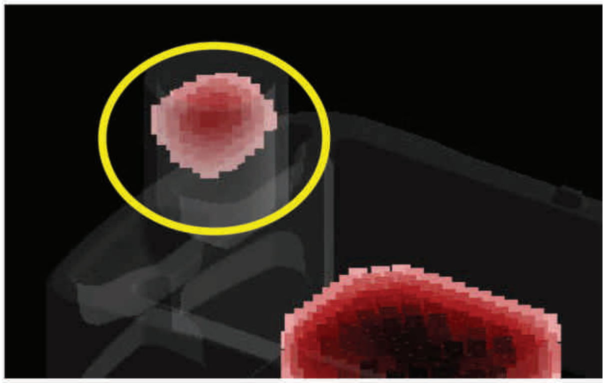

Fig.18 Shrinkage Pattern in riser after reduction of riser & Shrinkage Pattern in Simulation.

Rs.200/Kg of steel casting). One of the case studies involves the yield improvements in Yoke castings for Railways.

Case Study -4

In our one of the railway casting of Yoke, we have tried to increase the yield from 75 % to 80% (improvement of yield is 5%) by reducing the number of the riser sleeves and incorporating chilling at some area at the bottom to establish directional solidification. Also, we have used blind sleeve riser.

Table1. Shows the comparison of two methods (previous and revised) for the profitability.

Conclusions

Foundries should not accept high levels of scrap and customers also not accept long lead time. So casting simulation has become an industry standard to develop new casting in a short period of time with lesser number of trials and the route for developing the castings should be economical with higher yield with better soundness of the castings.

Table.1 Comparison of two methods for profitability

Sl.nos.	Previous Methods	Revised Methods
1.	Nos. of risers= 5 nos.	Nos. of risers=4 nos.
2.	Yield =75%	Yield =78.4%
3.	Fettling cost more	Fettling cost less
4.	——-	Saving of Rs 60 per casting

This study also shows that after taking remedial measures, the simulation can results can validate a positive.

From the above study it concludes that the defect analysis done by simulation results help a practical foundry man to take decision and corrective actions to eliminate these defects with lesser efforts.

ACKNOWLEDGEMENT

This work was supported by the practical study in the Steel Foundry Division of Texmaco Rail & Engineering Limited., Kolkata, India and simulation of the components was done by Auto CAST X1 software and ADSTEFAN, Japanese casting simulation software developed by HITACH, Japan.

REFERENCES

1. Hot Tears in steel castings – By J.F.Meredith, articles published in Metal Casting Technologies of Vol. 53, No. 2, June 2007.
2. Directional Solidification of Steel Castings – By R.Wlodawer
3. Principles of Metal castings – By Heine, Loper and Rosenthal. Second edition- McGraw-Hill.
4. Yield improvement of castings using computer aided simulation- A case study by Dhruva Sadekar & G.R.Bharath Sai Kumar
5. Simulation of the components is done by Auto Cast-X1 Simulation Techniques & ADSTEFAN, Japanese casting simulation software developed by HITACH, JAPAN.