"Optimization of gating system Design for Cast Iron & S.G Iron Foundries"

[1] G.Ravi, [2] Dr.Pradip Kumar Talapatra
[1] *M.Tech Student, Department of Mechanical Engineering, GD RCET, Bhilai Chhattisgarh*
[2] *Professor, Principal I/C, Department of Mechanical Engineering, GD RCET, Bhilai Chhattisgarh*

Abstract *- The gating and riser system design plays an important role in the quality. Due to the lack of existing theoretical procedures the designing processes are normally carried on a trial and error basis. This paper review casting produced by foundry with internal shrinkage as a major defect was analyzed and identified that gating and feeding system was improperly designed. The designed gating system reduced defect and increase yield. Finally, a more reasonable gating system was obtained by analysis of drawing and method effective calculations. In the current global competitive environment there is a need for the casting units and foundries to develop the components in short lead time. Defect free castings with minimum production cost have become the need of foundry.*

Keywords— *Optimization; Casting design; Optimized casting design; Gating system; gating and riser design; Casting defects.*

1. Introduction

Two major considerations in the casting design are the quality of the final product and the yield of the casting. Production of sound & quality casting mainly depend on gating system. In Casting design the gating & riser system design has a direct influence on quality of cast component. Most engineering problems, casting designs done trial and error basis. Availability of modern software tool give designer an insight into the detail of fluid flow, heat transfer. Gating/riser system design is critical to improving casting quality. Casting as a manufacturing process to make complex shapes of metal materials in mass production may experience many different defects such as porosity, shrinkage, blowhole and incomplete filling. Improving the casting quality is important .In casting there are two main stages,which are filling process and solidification process. In filling process consist of gating system composed of pouring cup, runner, sprue, and gate. Risers serve dual function, they compensate for solidification shrinkage and heat source so that they freeze last and promote directional solidification. Risers provide thermal gradients from a remote chilled area to the riser. 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. Casting quality is heavily dependent on the success of gating/riser system design, which currently is conducted mainly relied on technicians experience. Therefore there is a need for the development of better method analysis on the basis of calculation depends upon the drawing and nature of material optimization functions to ensure the quality of casting.

Gating system is referred as all channels by means of which molten metal is delivered to mould cavity. Clean metal implies preventing the entry of slag and inclusions into the mould cavity, and minimizing surface turbulence. Casting processes are widely used to produce metal parts in a very economical way, and to obtain complicated shapes with minimal machining for intended end use .A riser or a feeder is a reservoir to feed the molten metal to the casting to compensate the shrinkage during solidification. Riser is a passage made in the cope through which the molten metal rises after the mould is filled up. Risering in casting involves the determination of such size and location of risers which will enable the production of favorable temperature gradients for the directional solidification to take place effectively. Chills are achieving directional solidification. It is used preferably when the intricate shape of the casting does not allow placing of risers on all the thick sections or in which the large sections are so located that it is impossible to place risers over them. In such cases there will be different cooling rate for different section, giving rise to internal stresses causes cracks. Simulation is the process of imitating a real phenomenon using a set of mathematical equations implemented in a computer program. Using casting simulation visualization of mould filling, solidification and prediction of the location of internal defects such as shrinkage porosity, cold shuts and sand inclusions can be done. Moreover it is not only used for existing castings but also used in developing new castings without shop floor trials. but each and every product used to draw in this so if drawing available and we know about mathematical calculations about gating that was much easier than simulation analysis. 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. The filling process gating system, composed of pouring cup, runner, sprue, sprue well and ingate , is designed to guide liquid metal filling. Riser system is used to

compensate shrinkage caused by casting solidification. 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. As such, improvement of the casting quality becomes important. Casting quality is increasingly dependent on the success of gating/riser system design, which is currently conducted mainly relying on the technician's experience. Bad design of the gating and feeding system can result in defects in the castings. One of the main variables that should be considered when designing a gating system is the flow of molten metal while filling the mould. Gating and Feeding system plays very important role for any casting. Risers are used for compensating for the solidification shrinkage which occurs during the process of solidification . Generally this can be visualized as if these sections feed thinner sections; so, thick sections experience deficiency of molten metal at last and that location contains no metal resulting in defects such as shrinkage cavity. For any newer casting, the development of gating and feeding system takes huge amount of time, cost as well as man power for the manual trial and error method. Sometimes,existing method of castings does not serve its purpose and need modification.

The main elements needed for the gating system are as follows:

Pouring basin or bush, Sprue or downspure, Sprue Well, Runner, Ingate, Ladle Slag trap or filter.
The characteristics of each element are mentioned below:

Pouring basin : This is otherwise called as bush or cup. It is circular or rectangular in shape. It collects the molten metal, which is poured, from the ladle.
Sprue : It is circular in cross section. It leads the molten metal from the pouring basin to the sprue well.
Sprue Well : It changes the direction of flow of the molten metal to right angle and passes it to the runner.
Runner : The runner takes the molten metal from sprue to the casting. Ingate: This is the final stage where the molten metal moves from the runner to the mold cavity.
Slag trap : It filters the slag when the molten metal moves from the runner and ingate. It is also placed in the runner.

Gating Systems Factors controlling the functioning of gating system

- Type of pouring equipment, such as ladles, pouring basin etc.
- Temperature / Fluidity of molten metal Rate of liquid metal pouring.
- Type and size of sprue.
- Type and size of runner
- Size, number and location of gates connecting runner and casting
- Position of mould during pouring and solidification.

CASE STUDY FROM INDUSTRY

At the time of investigation in Beekay Engineering Foundry Divison, Hathkoj Bhillai, I had selected one main producing Product named 3.5 Ton BP Ingot mould . This ingot mould used to produce ingot in TATA Jamshedpur. From one casting they used to cast 150 ingots. So it needed good surface and accurate draw taper for defect free ingots. After investigation I came on conclusion that rejection rate of this Product through Manual or Traditional casting process is 7% and with the help of Casting method calculations for gating system design with lesser defects rejection rate comes down to 2.5%. I came to know that rejection rate by traditional casting is more because of defects in casting such as shrinkage porosity and blowholes. These defects are observed inside the component and proven to be the major reason of enhancement in rejection rate. So I had suggested them to go with the method calculations to design gating system eliminating defects and then proceed production through manual process.

"Optimization of gating system design calculations had following steps in Cast Iron and S.G Iron for 3.5 T Bottom Pouring Ingot Mould.

1. Find out the minimum casting thickness from drawing.(After providing machining and draft allowances.

Minimum Metal thickness of 3.5 T BP Ingot Mould is 60 mm. This is must to calculate pouring temperature.

2. Select pouring temperature from Fig-1.

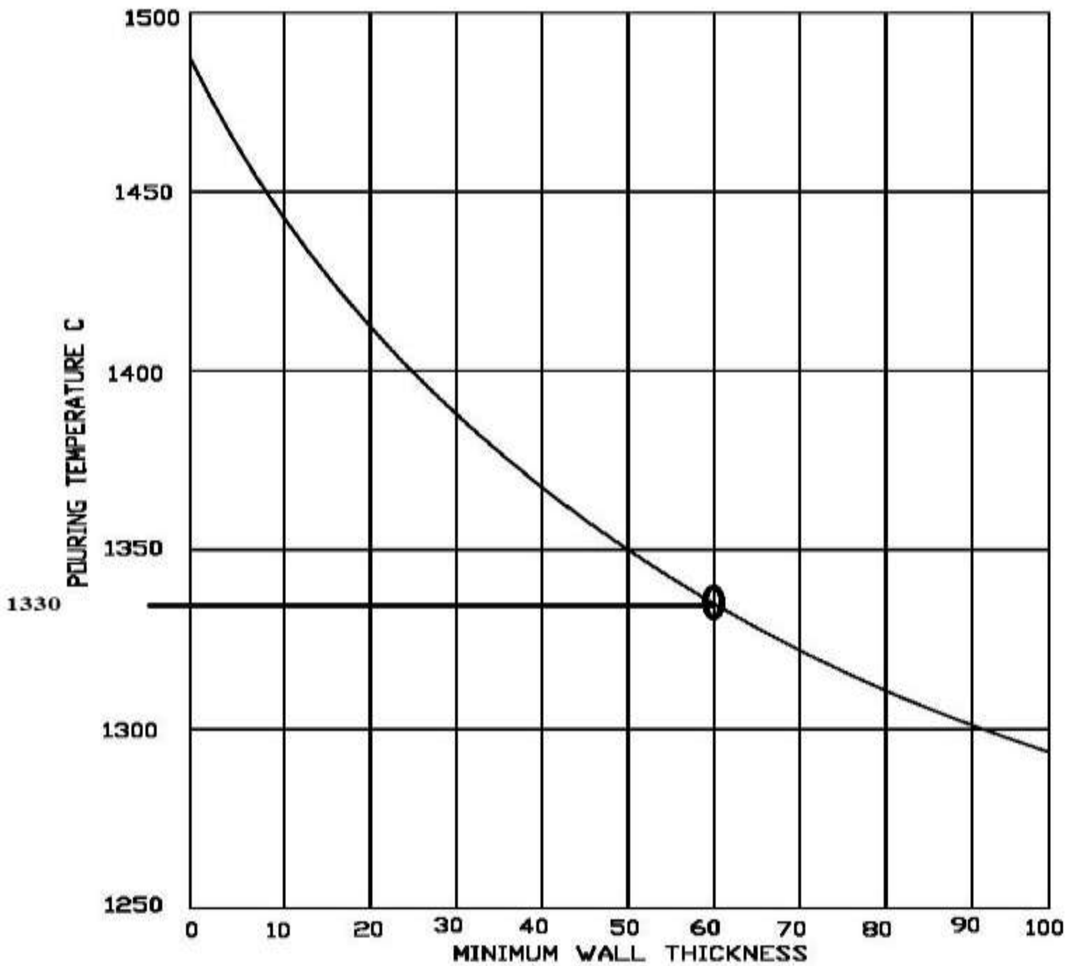


FIG-01

- **So pouring temperature for this mould is 1330º C**

3. Select gate thickness from Fig – 2.Remember minimum is optimum 25% plus side variation is acceptable, depending on local conditions.

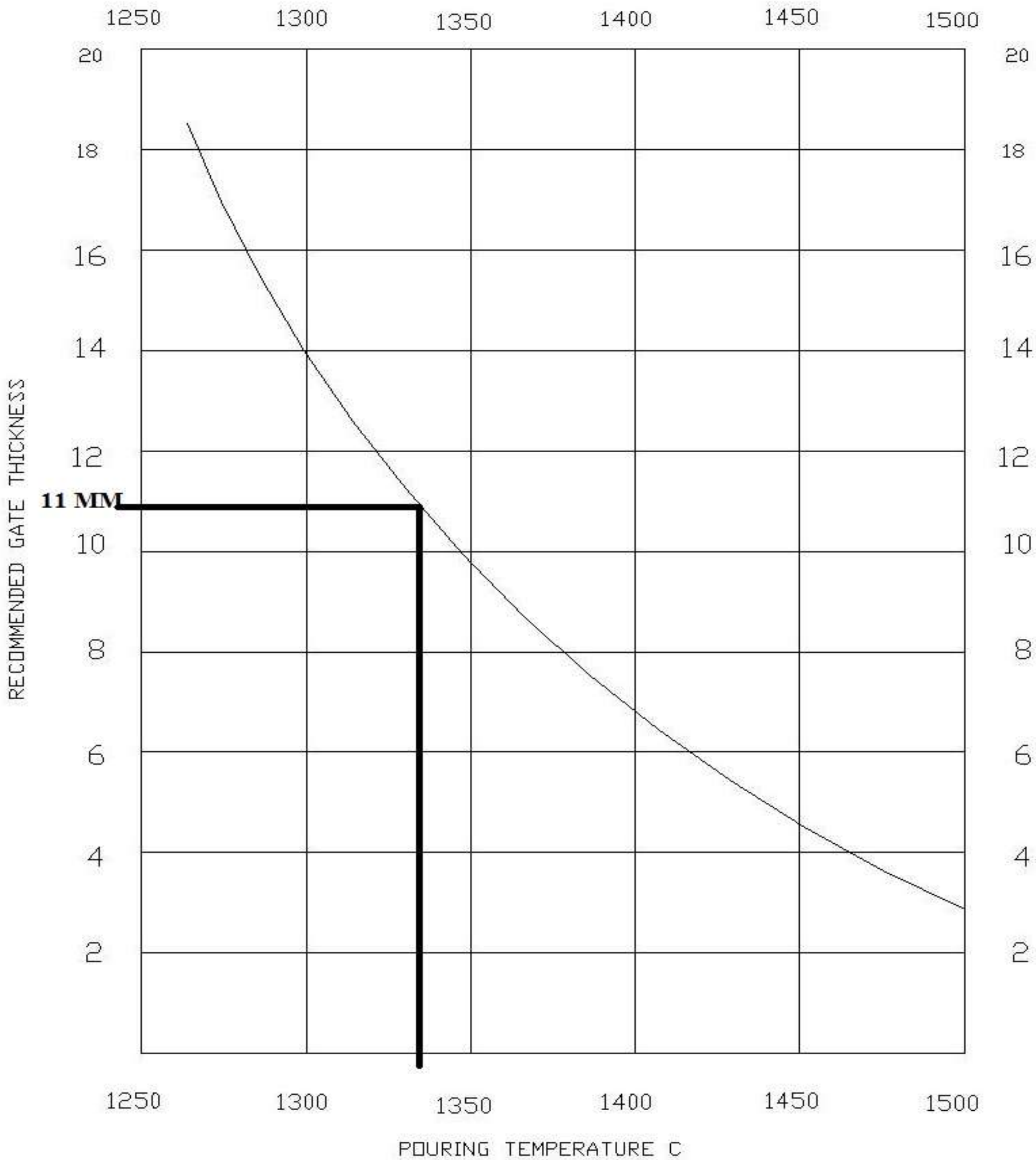
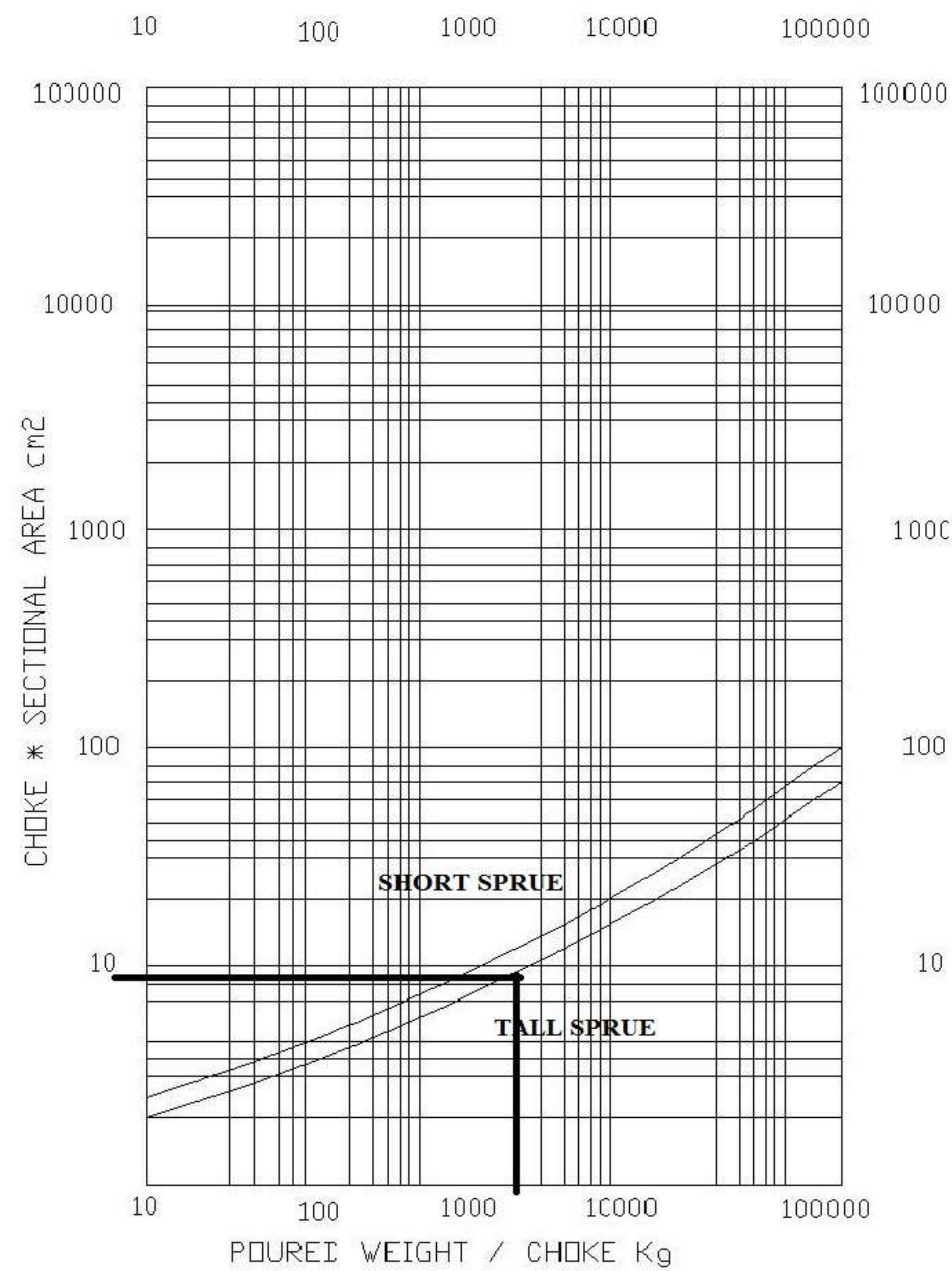


Fig-2

- **So from Fig- 2 ingate thickness should be 11 mm but after considering local conditions I take it 20*15 mm in three different place where metal feeding by down sprue is maximum and sprue size should be Dia 70 – 01 Nos related to choke area feeding.**

4. Select total choke area for casting above 100kg and Fig – 3 are used for large castings.


10
100
1000
10000
100000
100000
10000
1000
100
10
CHOKE * SECTIONAL AREA cm2
SHORT SPRUE
TALL SPRUE
POURED WEIGHT / CHOKE Kg

5. Generally apply pressurized gating system Sprue : Runner : Ingate :: 4:8:3. this means choke is the total ingate area which shows on.For guidelines on good practice. It is good practice to use thin and wide gates.It is also important to have as large number of ingates as possible depending on box layout specially for weak moulds like green sand.

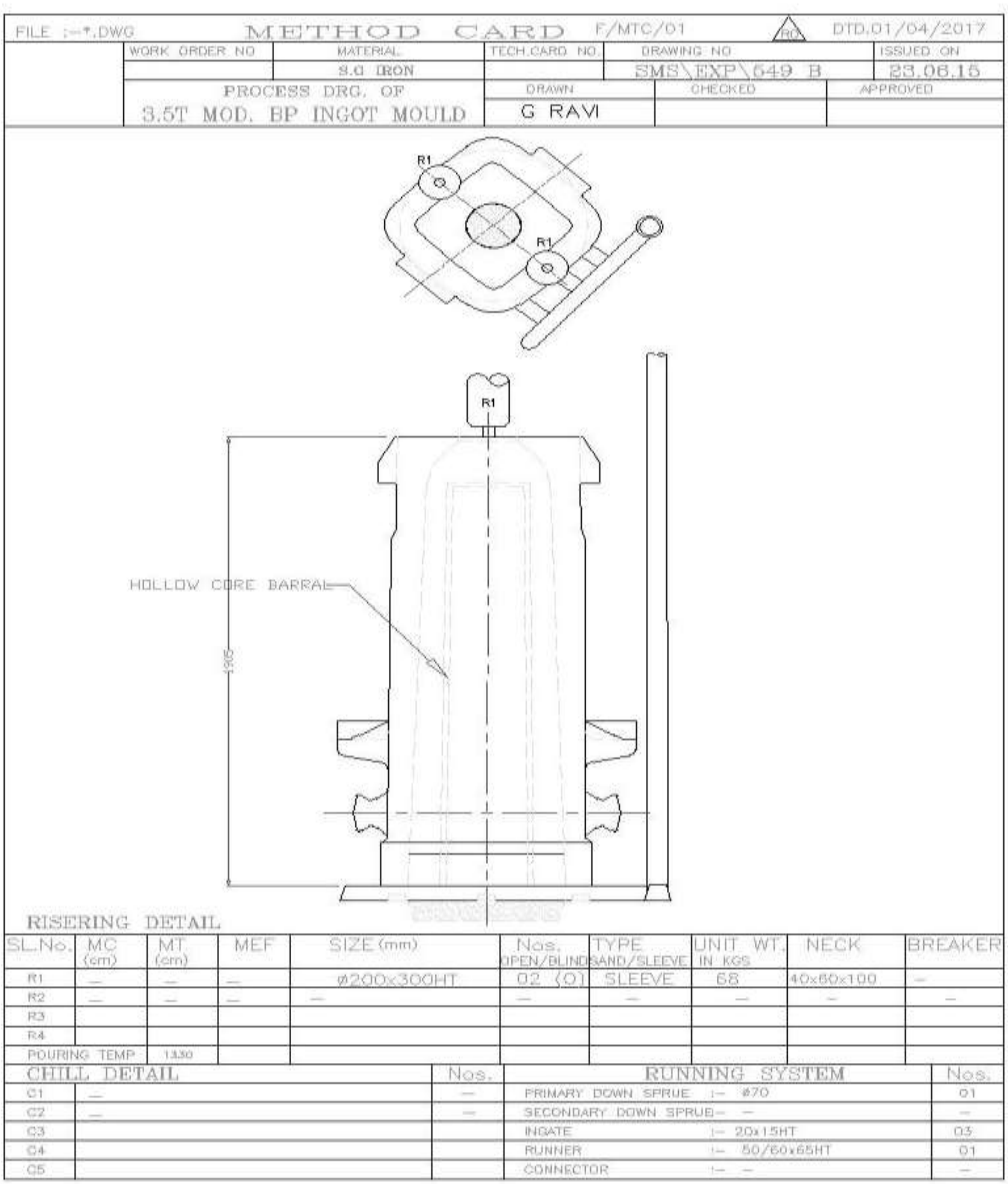


FIG – 4 METHOD CARD

6. Non Pressurized systems follows ratio of S:R:G:: 1:4:2 or even 1:4:4 for good practice. In case

choke is designed as a constriction in the runner sprue can have an area of 1.33 * (Choke) , otherwise sprue is choke.

7. After calculating choke area and applying gating ratio runner should be 50/60*65 HT – 01 NOS.

8. Select the system which gives maximum yield even hybrid systems Shown in need to try own without forgetting the principles involved.

9. Calculate modulus of casting sections. Maximum castings section moduli. Generally require risering especially when cast in weak moulds like green sand in backed shell moulds. For strong moulds like cement sand silicate co2 system risering may be extremely rare.

10. Calculate riser modulus or transfer modulus Mt based on casting modulus Ms .

11. Riser size is dependent on riser shape should be Dia200*300 Ht – 02 NOS.

So after calculating all gating elements we need to put that on one sheet to understanding to workes.so need to draw that on auto cadd.shown above Fig – 4.

Concluding discussion

The case studies introduced in this paper show that the combination of different methods such as optimization with different strengths is important in terms of energy optimization and system analysis. The strength of the combined two methods is a valuable addition when seeking to improve energy efficiency as it can be used to predict system behavior, give very detailed information about how systems work, decrease the system cost and it can be used as a part of industrial decision support. In this work we have presented a methodology for obtaining a gating system design of good quality.

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A proper runner and gating system is very important to secure good quality of sand casting through providing a homogeneous mould filling pattern. A numerical method technique was used for optimization of the runner and gating systems for the sand casting using method calculations.