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DESIGN OF TOP RISERS USING PARABOLIC METAL FLOW CONCEPT DURING SOLIDIFICATION

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ABSTRACT: In this article, the parabolic metal flow method was employed to study the riser design on the shrink pipe formulation during the solidification of Aluminum castings. The risers designed by the concept of parabolic metal flow concept have promoted greater metallostatic pressure head and consequently reduced the macro porosity and micro porosity in the aluminum castings.

Keywords: Parabolic metal flow, riser design, porosity

1. INTRODUCTION

The primary function of a riser is to feed metal to the casting as it solidifies. In some instances, it may also be considered as a part of the gating system. The riser requirements depend considerably on the type of metal being poured. Aluminum alloys which have extended solidification range, require excessive feeding of solidifying Aluminum castings involves the solution of two problems:

- Prevention of micro shrinkage
- Prevention of macro shrinkage

In addition to the high percentage of volume contraction, the solidification mechanism of Aluminum alloys results in the following general principles for designing risers (Taylor and et al, 1960):

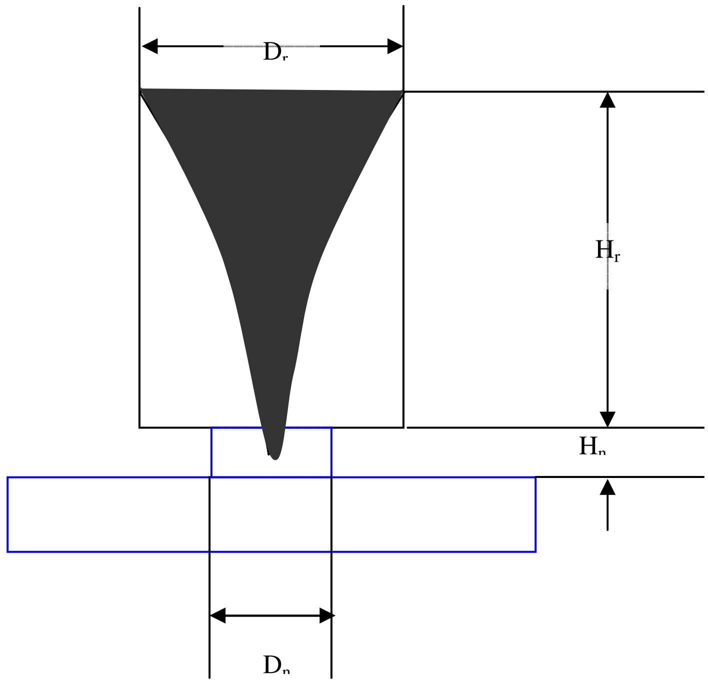
- The mushy nature of the solidification of most Aluminum alloys requires the use of fairly large risers and a large number of risers.
- Very steep thermal gradients are required to eliminate completely all traces of micro porosity.
- Surface defects due to inadequate risering may occur since a solid skin does not form on most Aluminum alloy castings until late in the solidification process.
- Overheating of the sand in one location may result in surface shrinkage because of weak skin formation.

Heine (1965) and Wlodawer (1966) have developed systems that take different approaches to these problems. Wlodawer has established the requirement that the modulus of the riser must be 1.1 times as great as the modulus of the connection, and the modulus of the connection must be 1.1 times greater than the modulus of the casting. John (1980) has developed a formula for riser diameter of steel castings based on the pipe being a parabolic curve and the feed metal requirements from Heine's curve.

The size of risers necessary to feed Aluminum casting is at present still largely a matter of experience. The riser must have a sufficient volume of liquid to supply. This article focuses on the design of risers using parabolic metal flow concept for Aluminum alloys.

2. EXPERIMENTAL APPROACH

The calculations of riser dimensions were carried as mentioned in appendix-A. In the present work, the weight of riser was a variable parameter. A correlation was assumed between riser diameter and its height. While deriving an equation for riser diameter in the parabolic metal flow concept as shown in Fig.1, the percentage of volume contraction of the casting was considered to be the volume of the parabolic pipe (i.e., the volume of metal to be fed by the riser to avoid shrinkage in the casting). The dimensions of the plate casting are 300mmX150mmX50mm. The reckoned riser sizes are given in Table-1.



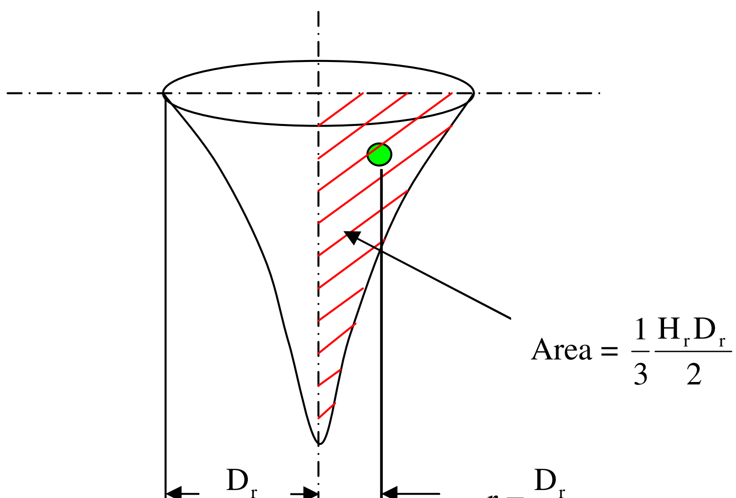


Fig.1 Design of ... ing parabolic me... cept

Table –1: Riser size

$\frac{\text{Riser height}}{\text{Riser diameter}}$	Riser diameter, mm	Neck diameter, mm	Neck height, mm
1.00	104.30	26.10	73.00
1.25	96.82	24.20	67.77
1.50	91.11	22.78	63.78

The green sand was rammed around the pattern. The gating system was located at the parting line. The riser and sprue were provided in the cope. The surfaces of the mould cavity were sprayed with zircon flour. All the moulds were dried for four days in the open air. The moulds were poured with Al-12%Si alloy which was melted in a diesel furnace and degasified by Coveral (of Foseco India Limited) tablets. After solidification, the moulds were knocked out. The castings were weight to analyze for soundness. The castings were also sectioned to reveal the pattern of shrinkage in the risers.

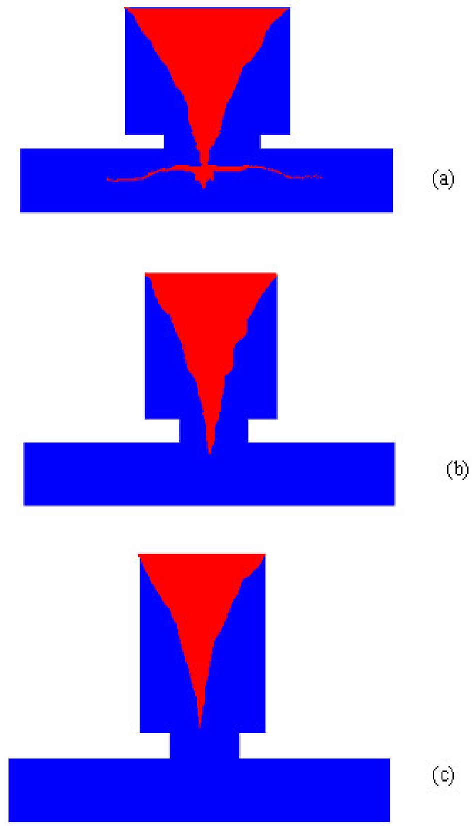


Fig.3 Cross-sectional diagrams of plate castings fed by top riser
(a) $H_a = D_r$ (b) $H_a = 1.25\ D_r$ (c) $H_a = 1.5D_r$

3. RESULTS AND DISCUSSION

As the metal solidifies, it contracts in volume and, if no provisions have been made to maintain a supply of liquid metal, a shrink pipe will form. The purpose of the riser is to provide a source of liquid metal to keep the incipient cavity filled. It can be seen from Fig.3 that when the riser height equals to riser diameter, there is a pipe pierced into the plate casting. Once the riser height was raised to 1.25 times of riser diameter, there was slight introduction of pipe into the plate casting. There was no incidence of pipe shrinkage in the castings when the riser height equals to 1.5 times as great as riser diameter. Table-2 gives the information of riser yield. It is approximately equal in the three cases. The risers have good density characteristics. This may be owing to less micro porosity, which might have resulted on account of greater metallostatic head developed by the risers.

4. CONCLUSION

it is concluded that the height of riser has great effect on the reduction of shrink pipe 9macro porosity) and micro porosity in the aluminum castings. The risers designed by the parabolic metal flow concept have provided sufficient reservoir of liquid metal to feed the casting during solidification. Maximum benefit of metallostatic pressure in risers is obtained by considering the height of the riser equals to one and half times the diameter of the riser. This point is more important in aluminum alloys because of their low specific gravity.

Table-2: riser Yield

$\frac{\text{Riser height}}{\text{Riser diameter}}$	Yield, %
1.00	71.63
1.25	72.45
1.50	72.45

Nomenclature:

V_c = Volume of the casting
A_c = Area of the casting
V_r = Volume of the riser
A_r = Area of the riser
H_a = Active height of the riser
D_r = Diameter of the riser
H_r = Height of the total riser
H_n = Height of the neck
D_n = Diameter of the neck
S = Percentage of volume contraction

Appendix-A:

The governing equation for parabola is

$$Y = \frac{D_r}{2}\sqrt{\frac{X}{H_a}} \quad --(1)$$

Volume of the parabolic pipe, $V_p = \frac{\pi}{24} D_r^2 H_a$ ----(2)

Volume of the riser, $Vr = \frac{\pi}{4} D^2{}_r H_a$ ----(3)

The volume of the pipe is equal to the volume of shrinkage in the casting.

Volume of the shrinkage $= \frac{S}{100}$ X volume of the casting

$$= \frac{SV_c}{100} \quad ----(4)$$

$$\frac{\pi}{24} D_r^2 H_a = \frac{SV_c}{100} \quad ----(5)$$

$$D_r = \sqrt{\frac{24}{100}\frac{SV_c}{\pi H_a}} \quad -----(6)$$

Neck height, $H_n = \frac{D_r}{4}$ -----(7)

Neck diameter, $D_n = 2H_n + 0.2\, D_r$ -----(8)

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