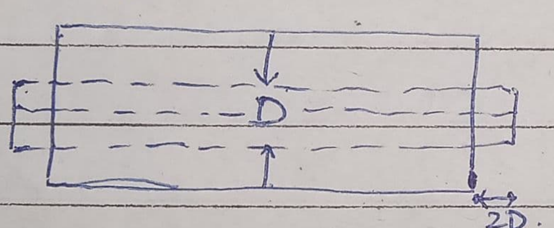
A core is a device used in casting & moulding process to produce internal cavities. It is disposable item that is destroyed to get it out of the piece. Most commonly used in sand casting but are also used in injection moulding.

CORE PRINT: The core print is an added projection on the pattern and it forms a sheet in the mould on which the sand core rest during pouring of the mould. It must be of adequate shape & size so that it can support ~~thes~~ weight of the core during casting operation.

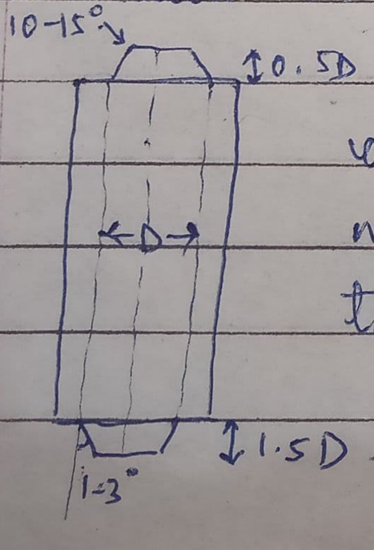
TYPES OF CORE PRINT –

(i) Horizontal Core-Print



This core print is provided on horizontal axis along the join line on the pattern so that the core is laid horizontally in the mould.

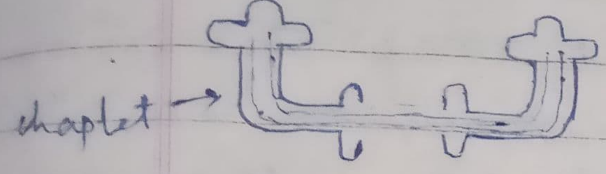
(ii) Vertical Core Print



This core print forms a sheet for a core that will stand vertically in the mould. Also called cope & drap print. A tapper should be given on the coreprint especially on the cope side i.e. 10-15° to facilitate the pattern withdrawn and the replacement of the cope ~~on~~ on the drag.

The taper on the drag print is only 1-3°.

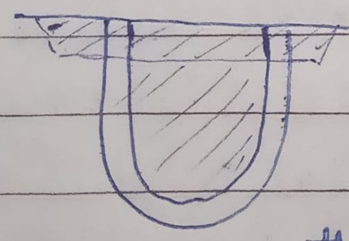
(iii) Balanced Core-Print –



When the shape of the casting is such that its not possible to support the core from both sides, a balanced print is required and the core print and the core are then designed that the part of the core in the mould cavity balances the part that rest in the core sheet. The shape at the print may not necessary be the same as that of the core in the mould cavity. To add in the support of the core in the cavity, our chaplet may be used.

Chaplet – Small pieces of metal having a height equal to the space between the core and the mould wall. The metal of the chaplet and casting should be identical.

(iv) Cover Core Print –

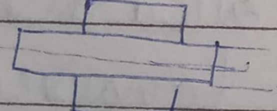


This is also called a hanging core print, is favoured when the entire pattern is rammed in the drag part and the core is to be suspended in the cope side.

Wing Core-Print – This type of core print is used when a hole or recess is required to be coat above or below the parting line Owing to the large size of core print required in this case draft provided on the vertical walls of the core is fairly high. Also known as drop chair and tail core print. Depending on the position of the core in the mould and its shape.

CORE LOCATION: Adequate location of cores is very important to avoid the tendency to shift their position or turn about when the core must sit in one particular position. The need for proper setting becomes essential

CORE PRINT SUPPORT:
The size of the core print should be correctly worked out or estimated so that adequate grip is obtained between the mould & the core. Core has no tendency to sit or rise



when molten metal which has a buoyancy effect is poured.
Buoyancy of the molten metal is due to the weight of the liquid metal being displaced by the core. If the molten metal is iron & its weight in kg/m^3 is 7200 and weight of the core/m^3 is 1600, then buoyancy force

$$=7200-1600=5600\ kg/m^3.$$

then ratio of buoyancy force to weight of core $= \frac{5600}{1600} = 3.5 \rightarrow < I$

Steel - 3.9, Copper - 4.5; Brass - 4.25; Al = 0.66.

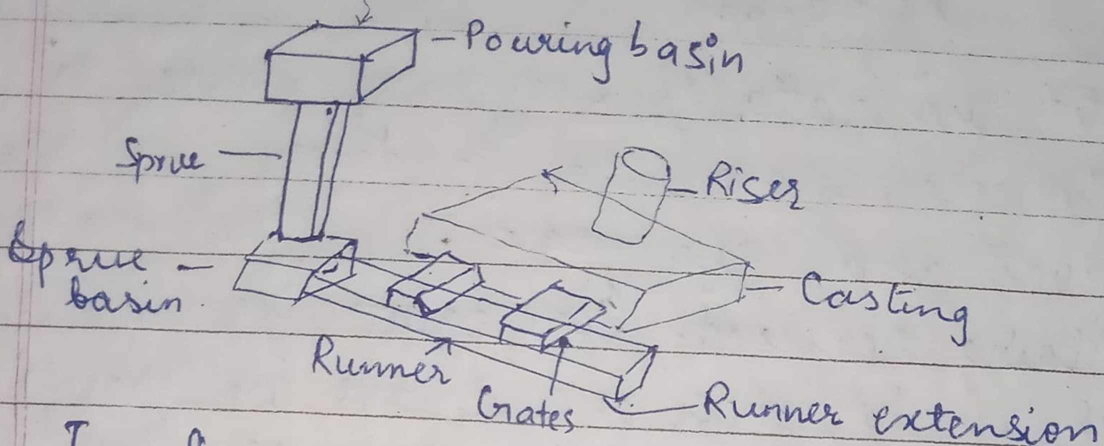
Greater the ratio of buoyancy force to the wt of the core, more the tendency for the core to float and the more the method of moulding required. Core print for heavy metal such as Fe, steel and brass are therefore larger than those like metal such as Al. Once the core buoyancy is known, the selected core print size can be verified for effectiveness.

Unsupported Load = Core buoyancy - core print holding load
where core print holding force = core print surface area × compressive strength of moulding sand.

If sand strength is taken $0.5\ kg/m^3$, core print holding force = 0.5 × core print surface area
Unsupported load obtained should be 0 or -ve to ensure the stability of the core in the mould not withstanding the buoyant effect of the ~~mould~~ molten metal. If the result is a +ve value, the proportion of the core print should be altered and the unsupported load again worked to ascertain that its value is 0 or -ve in order to get better support to core and to prevent their deflection, chaplet is often used.

13/5

Grating System:



* Functions of Gating System

(i) To fill the mould cavity before ~~fill~~ freezing.
(ii) To minimize the turbulance
(iii) To avoid erosion.
(iv) To regulate the flow of molten metal
(v) To consume less metal and less scrap
(vi) To establish the directional solidification

* Design of Pouring basin

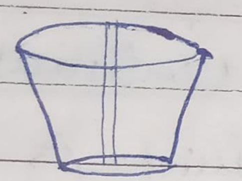
(i) Typical dimension of round inlet & outlet

Inlet dia (mm)	Outlet dia	Height
51	25	38
127	64	133
203	76	140
254	102	203

(ii) Square inlet and round outlet.

78 x 90	33	117
105 x 134	38	127
140 x 159	51	152

How to minimize turbulence in pouring cup?



Adding an anti-swirl bar.

* **Sprue** - Vertical passage inside the mould through which molten metal ~~reaching~~ reaches the runner. and eventually the mould cavity.

Rules for design of a Sprue -

(i) Size of the sprue should be optimised to limit the flow rate of molten metal.

(ii) Vortex formation tendency in a sprue with circular cross section is higher, hence rectangular cross section sprue are better than the circular ones with the same C.S.A. However round sprue are more economical for small casting.

(iii) Height of the sprue is determined by the casting and the top riser height.

(iv) Sprue should be tappered by approximately 5% to avoid ~~as~~ aspiration of air.

(v) Standard filter should be placed at the outlet of the sprue ~~and~~ or ~~sprue oil~~ as the metal flows into the runner.

(vi) The sprue should be located centrally on the runner with equal no. of gates on each side.

~~Rate of Flow of Mass~~ Law of Continuity

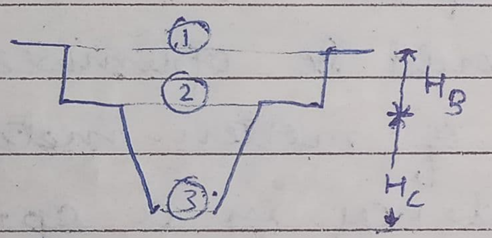
The rate of flow of mass of fluid is constant at any cross section.

$$m = \rho A_1 v_1 = \rho A_2 v_2 = \rho A_3 v_3$$

where m = rate of flow of mass

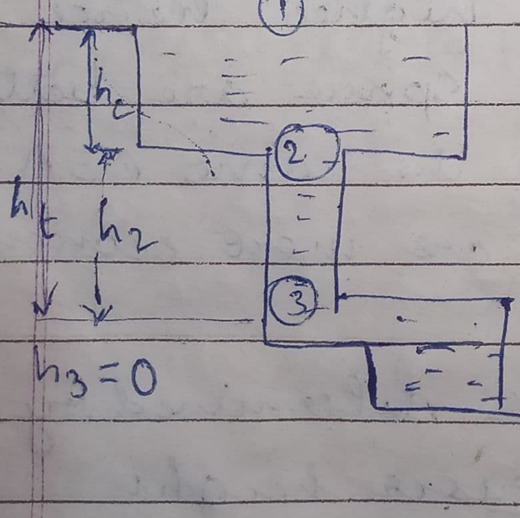
ρ = density of liquid metal

v = velocity of liquid metal



$$\frac{m}{\rho} = Q = A_1 V_1 = A_2 V_2 = A_3 V_3$$

$$V_2 = \sqrt{2 g H_B}$$



Applying Bernoulli's eqn. for 1 & 3

$$h_t + \frac{V_1^2}{2g} + \frac{P_{atm}}{dg} = h_3 + \frac{V_3^2}{2g} + \frac{P_{atm}}{dg}$$

$$h_t + 0 + \cancel{\frac{P_{atm}}{dg}} = 0 + \frac{V_3^2}{2g} + \cancel{\frac{P_{atm}}{dg}}$$

$$h_t = \frac{V_3^2}{2g} \quad \Rightarrow V_3 = \sqrt{2 g H_t}$$

Applying Bernoulli's eq for 2 & 3

$$h_2 + \cancel{\frac{V_2^2}{2g}} + \frac{P_2}{dg} = h_3 + \cancel{\frac{V_3^2}{2g}} + \frac{P_{atm}}{dg}$$

$V_2 = V_3$ (Assume cross section area same)

$$h_2 + \frac{P_2}{dg} = 0 + \frac{P_{atm}}{dg}$$

$$P_2 = P_{atm} - h_2 dg$$

P_2 is less than P_{atm}, so air is sucked from atmosphere and gets entrapped → "aspiration of air".

2 & 3

$$\frac{P_2}{dg} + \frac{V_2^2}{2g} + h_2 = \frac{P_3}{dg} + \frac{V_3^2}{2g} + h_3$$

Assuming $P_2 = P_3$.

$$\frac{V_2^2}{2g} + h_2 = \frac{V_3^2}{2g}$$

$$h_2 = \frac{V_3^2}{2g} - \frac{V_2^2}{2g} = \frac{V_3^2 - V_2^2}{2g}$$

$P_2 = P_3$

$A_2 V_2 = A_3 V_3$

$\frac{A_3}{A_2} = \frac{V_2}{V_3} = R$

$\Rightarrow V_2 = R V_3$

$$h_2 2g = \frac{V_3^2 - R^2 V_3^2}{2g}$$

$$\frac{h_2 2g}{V_3^2} = 1 - R^2$$

$$\Rightarrow R = \sqrt{1 - \frac{2gh_2}{V_3^2}}$$

$V_3^2 = 2gh_t$

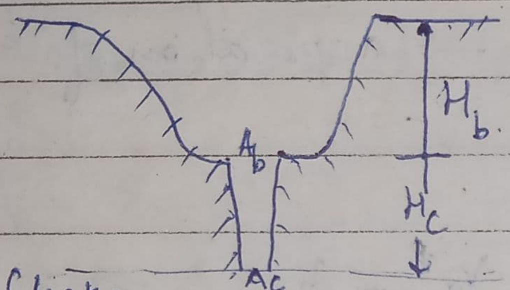
$$R = \sqrt{1 - \frac{2gh_2}{2gh_t}} \Rightarrow R = \sqrt{\frac{h_t - h_2}{h_t}}$$

$$\Rightarrow R = \sqrt{\frac{h_t - (h_t - h_c)}{h_t}} \Rightarrow \boxed{R = \sqrt{\frac{h_c}{h_t}}}$$

$$\boxed{\frac{A_3}{A_2} = \sqrt{\frac{h_c}{h_t}}}$$

If $h_c = 20$, $h_t = 80$.

$\frac{A_3}{A_2} = \sqrt{\frac{h_c}{h_t}} \Rightarrow \boxed{A_2 = 2A_3}$ ⟶ This means taper is required to avoid aspiration



Choke area.

Choke - Smallest area that occurs at the Bottom of the sprue.

A_b - C.S.A. of sprue at its top.
A_c = C.S.A of sprue at the choke
V_b = velocity of liquid metal at the top of sprue
V_c = " " " " at the bottom of the sprue
H_b = Height of the pouring basin
H_c = Height of the total metalhead above the choke

A/c Bernoulli's Theorem
Velocity of the liq. metal at the Top of the sprue i.e. $V_B = \sqrt{2gH_B}$
Velocity at the choke, $V_c = \sqrt{2gH_c}$

Volume of flow at choke in a given time =

$$A_c \times V_c \times t = \frac{W}{\rho}$$

where W = wt. of poured metal.

ρ = Density of liq. metal.

Thus $A_c = \frac{W}{\rho V_c t \times C}$ where C is the coefficient of discharge

$$A_c = \frac{W}{\rho t c \sqrt{2gH_c}} \quad [\because V_c = \sqrt{2gH_c}]$$

where W = wt of poured metal in kg.

c = coefficient of discharge [0.7 — 0.9]

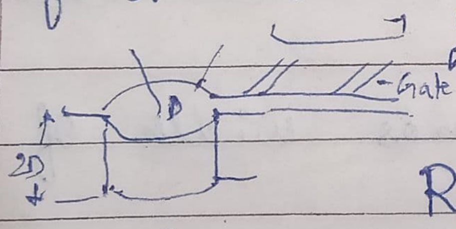
ρ = density of liq. metal (kg/m^3)

t = Pouring time (in sec.)

g = Accn due to gravity (981 cm/s^2)

H_c = Ht. of total metal head above choke

* Sprue Well - It is used to catch & trap the first metal and to absorb erosion of the sand due to kinetic energy of molten metal.



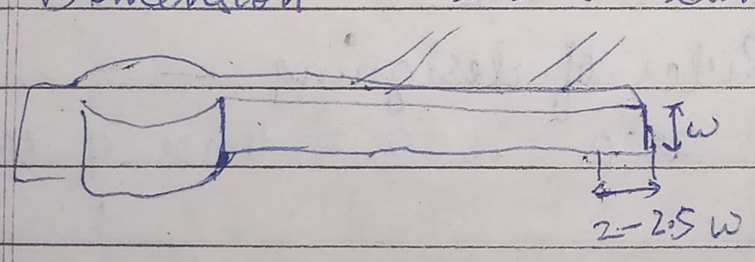
Rules of designing —

(i) Sprue well area is 2-3 times of the sprue exit

* Runner — It is the horizontal channel through which the molten metal flows from the sprue to the gate.

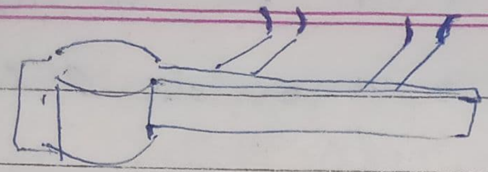
(i) Typical cross section of a runner is square
(ii) Runner cross-sectional area is generally 2-4 times the cross-sectional area of the choke (based on the gating ratio)
(iii) Abrupt change in the direction of runners should be avoided if the change in dirⁿ is more than about 15°, the joint needs to be filated
(iv) Runner should be maintained a minimum distance from the casting i.e. 4-5 times the thickness of the gate

* **Runner Extension** — It is used to catch & trap the slags & impurities in the first metal that are likely to enter the mould cavity
Dimension — 2-2.5 times width of the runner



* Rules For Designing Gate —
(i) Multiple ingates are often favourable for large part

(ii) A fillet should be used where ~~ing~~ ingates meet casting produces less turbulence



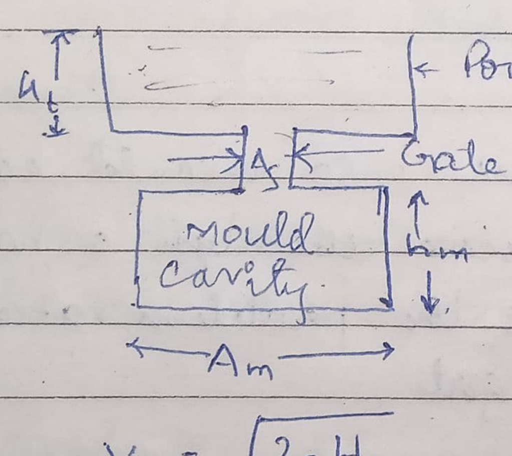
(iii) The min ingate length should be 3-5 times the ingate width depending on the metal to be cast.

(iv) Curved ingates should be avoided as far as possible.

* TYPES OF INGATES

(I) Top gate
(II) Parting line gate
(III) Bottom gate
(IV) Side gate

(i) Top Gate



A_s = Gate C.S.A.
H_m = height of mould
H_t = filling or pouring height

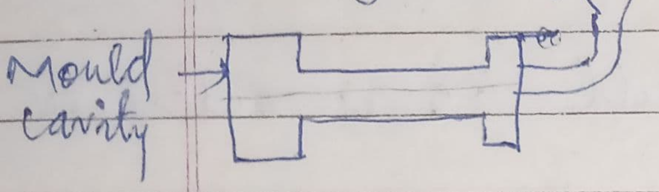
$V_g = \sqrt{2gH_t}$

$$\text{Pouring time} = \frac{\text{Volume of mould}}{\text{Gate cross sectional area} \times \text{velocity of metal at gate}}$$

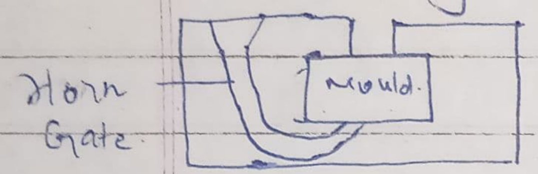
$$= \frac{A_m \times H_m}{A_s \times V_g}$$

Turbulence & erosion caused in the case of large parts and can be used where moulds are erosion resistant.

(ii) Parting line gate



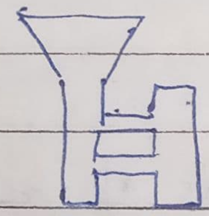
(iii) Bottom gate



~~Molten flow~~,

Turbulence & erosion are min.

(iv) Side Gate



Metal enters into mould cavity from side through a no of gates & solves the problem raised in bottom gate.

TYPES OF GATING SYSTEM:

(i.) Pressurized Gating System –

(ii) Unpressurized Gating System –

Pressurized	Unpressurized
(i) The total C.S.A. gradually decreases from choke to ingate.	The total C.S.A. gradually increases towards the mould cavity.
(ii) Mould turbulence & chances of mould erosion	~~No~~ Less turbulence
(iii) Casting yield is more	Less casting yield.
(iv) Complex and thin sections may be cast.	~~Casting~~ Complex & thin sections may not be cast.

Pressurized Grating System

$A_c : A_R : A_G$

1 : 1.3 : 1.1 (For gray iron)

1 : 2 : 1 (For Al)

1 : 2 : 1.5 (For steel)

Unpressurized Gating System

1 : 4 : 4 (For G.I)

1 : 3 : 3 (For Al)

1 : 3 : 3 (For steel)

Logical Approach for a Proper Design of Grating System –

1.) Estimation optimum pouring time

2.) Calculation of sprue - choke area

(3) Selection of appropriate gating system

4) ~~Calcu~~ Selection of gating type and ingate location

5.) Calculation of runner & ingate size

(1) Calculation of pouring time

G I casting < 450kg

Pouring time 't' $= k\left(1.41 + \frac{T}{14.59}\right)\sqrt{W}$ sec

k: (fluidity factor). which depends upon temp composition of the molten metal

$k = \frac{\text{fluidity of iron in inchs}}{40}$

T = avg thickness of the casting in mm

W = mass of the casting in kg.

* GI casting > 450 kg

$$t = K\left(1.236 + \frac{T}{16.65}\right)\sqrt[3]{W} \text{ sec}$$

* Steel Casting

$$t = (2.4335 - 0.3953 \log W)\sqrt{W} \text{ sec}$$

* SG Iron

$$t = K_1 \sqrt{W} \text{ sec}$$

$k_1 = 2.08$ for casting thinner sections < 10 mm

$= 2.67$ " Medium section 10-25 mm

$= 2.97$ for heavier (thick) section > 25 mm

W = mass of casting in kg.

* Cu - alloy casting

$$t = k\sqrt[3]{W}$$

k = 1.3 (top gating)

= 1.8 (Bottom gating

* Al - alloy

$$t = A \sqrt[3]{TW}$$

$$A = 1.7 - 3$$

Problem no. I - Calculate the optimum pouring time for a casting whose mass is 20 kg and average section thickness of 15 mm. The material of the casting is gray iron. Take fluidity of the material as 28 inch

Since, weight < 450 kg.

$$t = k\left(1.41 + \frac{T}{14.59}\right)\sqrt{W}$$

$$= \frac{28}{40}\left(1.41 + \frac{15}{14.59}\right)\sqrt{20}$$

$$t = 7.632 \text{ sec}$$

Solve it when the material is steel.

$$t = (2.4335 - 0.3953 \log W)\sqrt{W}$$

$$t = 8.583 \text{ sec}$$

Design the gating system for a casting made up of C.I. whose dimensions are $500 \times 250 \times 50$ mm. Density of solid CI = 7.86 g/cc, density of liquid C.I. = 6.9 gm/cc. Fluidity length 22 inch. Height of cope = 100 mm.

Assume casting yield is 70%.

Volume of casting $= 500 \times 250 \times 50$

$= 6250000 = 6.25 \times 10^6 \, mm^3$

$= 6.25 \times 10^3$ cc

Mass of casting = $vol^m \times$ Density

$= 6.25 \times 10^3 \times 7.86 = 49125$ g

$= 49.125$ kg

$\frac{\text{Mass of casting}}{\text{wt of Poured Metal}} \times 100 = \text{Casting yield} = 70$

$\Rightarrow$ wt of Poured metal $= \frac{\text{Mass of casting}}{0.7}$

$= \frac{49.125 \text{ kg}}{0.7} = 70.18$ kg

Pouring time 't' $= K\left(1.41 + \frac{T_s}{14.59}\right)\sqrt{W}$

$= \frac{22}{40}\left(1.41 + \frac{50}{14.59}\right)\sqrt{70}$

$t = 22.258$ sec.

$t \approx 23$ sec.

Design of choke area.

$$A_c = \frac{W}{C \rho t \sqrt{2gH_c}} = \cancel{\frac{70.18}{0.8 \times 6.9 \times 23 \times \sqrt{2 \times 9800 \times 100}}}$$ $C = 0.8$

$$A_c = \frac{70.18}{0.8 \times 6.9 \times 10^{-6} \times 23 \sqrt{2 \times 9800 \times 100}} =$$

Choke area $A_c = 381\ mm^2$

Dia of choke $= \approx 22\ mm$

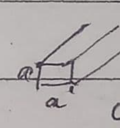
Since, the chape is simple; unpressurised gating ratio is taken.

$A_c : A_R : A_G$

$1 : 4 : 4$

Design of a Runner.

$A_R = 4 \times A_c = 4 \times 381 = 1524\ mm^2$



$a^2 = 1524$

$a \approx 39\ mm$

Design of ingates

$A_G = 4 \times A_c$

$= 1524\ mm^2$

No of ingates taken $= 2$

Cross-sectional area of each ingate $= 1524/2 = 762\ mm^2$

Let Height of ingate $= a$

Width of ingate $= 2a$

$2a \cdot a = 762$

$\Rightarrow 2a^2 = 762$

$\Rightarrow a^2 = 381$

$a \approx 20\ mm$

Height of each ingate = 20 mm
Width of each ~~g~~ ingate = 40 mm

(2.) Design the gating system for a ~~gating system~~ casting of size 400 x 200 x 40 mm madeup of steel. ~~The casting has a two~~ Density of solid steel 7.86 g/cc; ρ of liq steel = 6.9 g/cc. Height of cope box = 150 mm. Fluidity length = 24 inch

Vol. of casting = $400 \times 200 \times 40$
$= 3200000 = 3.2 \times 10^6\ mm^2$
$= 3.2 \times 10^3\ cc$

Mass of casting = Vol × density
$= 3.2 \times 10^3 \times 7.86 = 25152\ g$
$= 25\ kg.$

Q3.) Design the gating system for a casting of size 600 x 300 x 100 mm made up of steel. The casting has two thin fins at the two sides. The dimension of each fin 250 x 50 x 3 mm. ρ of solid steel = 7.86 g/cc. ρ of liq steel = 6.9 g/cc. Height of cope box = 150 mm. Fluidity length = 24 inch.

Riser Design

Primary function of riser -
It acts as a reservoir of molten metal in the mould to compensate shrinkage during solidification.

Secondary function of riser -

(i) It gives an indication that the cavity is full with the molten metal.

$\times 150$

(ii) It ~~gives indication~~ also enables the escape of hot gas during pouring of molten metal.

Why Designing of Runner is Required ?

* An undersized riser could lead to shrinkage defects and ultimately result in the rejection of casting.
* An oversized riser requires excess molten metal and results in excess power, fuel consumption for melting

The size of the riser must be optimised.

- Riser
  - Blind Riser (inside the mould cavity, not visible & not exposed to atmosphere)
  - Open Riser
    - Side Riser
    - Top Riser

In general for side riser, height is equal to its diameter $H = D$

For Top riser ; $H = 0.5D$

Guidelines for Riser Design & Location :

(i) The riser or feeder must not solidify before casting.

(ii) The volume of the riser must be large enough to feed the entire shrinkage of the casting.

(iii) The pressure head from riser should enable complete cavity filling.

(iv) Riser must be placed so that it enables directional ~~sod~~ solidification. Excessive progressive solidification leads to shrinkage defects.

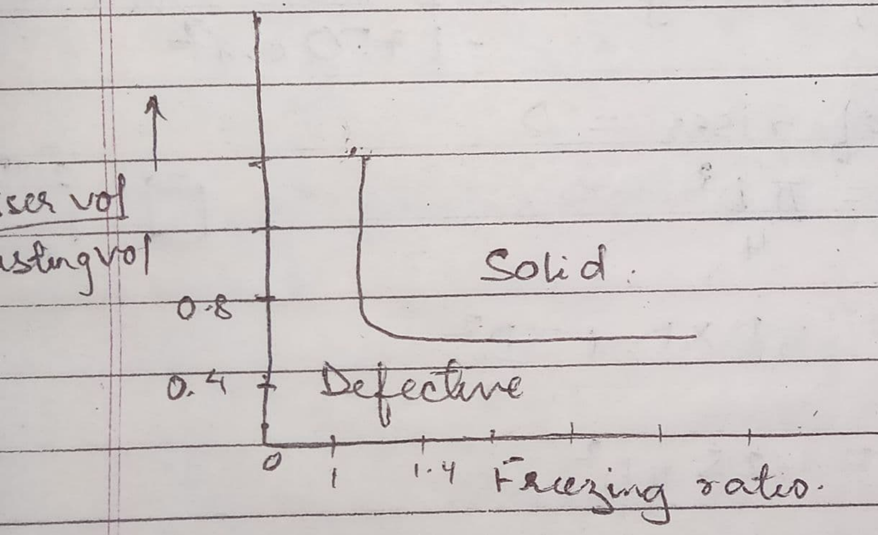
Methods Of Riser Design.

(1) Caines Method
(2) Modulus Method
(3) Naval Research Laboratory Method (NRL)

(1) Caines Method –

Caines developed a term called Freezing ratio

$$\text{Freezing ratio} = \frac{\dfrac{\text{Surface area of casting}}{\text{Volume of casting}}}{\dfrac{\text{Surface area of riser}}{\text{Volume of riser}}}$$



Another definition of freezing ratio.

$$X = \frac{a}{y-b} + c$$

X = freezing ratio

$y = \dfrac{\text{vol of riser}}{\text{vol of casting}}$

a, b, c = constants depending upon material of casting

	a	b	c
Steel	0.1	0.03	1.0
Al	0.1	0.06	1.08
C I	0.04	0.017	1.0

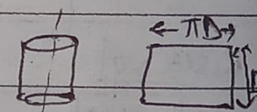
Calculate the size of cylindrical riser necessary to feed a steel slab casting of size 25 x 25 x 5 cm
H of riser = Dia of riser.

Sol^n Volume of the casting $= 25 \times 25 \times 5 = 3125\ cm^3$

Surface area of casting $= (2 \times 25 \times 25) + (4 \times 25 \times 5)$
$= 1750\ cm^2$

Let diameter of riser $= D$

Vol of riser $= \dfrac{\pi D^3}{4}$



S.A of riser $= \pi D \times D + \dfrac{\pi D^2}{4}$

$= 1.25\ \pi D^2$

Freezing ratio $= 0.112\ D$

$$X = \frac{a}{y-b} + c$$

$$y = \frac{\pi D^3}{4 \times 3125} = 0.000251\ D^3$$

$$\Rightarrow 0.112\ D = \frac{0.1}{0.000251 D^3 - 0.03} + 1$$

$\Rightarrow D \approx 11.44\ cm \approx 12\ cm$

$\Rightarrow H \approx 12\ cm$

Drawbacks of this method -

(I) For each material, a, b, c keeps changing.
(II) Calculation of Freezing ratio is difficult if the surface of the casting is complex.
(III) The solution is to be obtained by Trial & error method, so it is tedious.

(2) Modulus Method

Solidification time directly related to a casting volume to surface area ratio

Solidification modulus or modulus = $\frac{V}{A}$

Chvorinov's Rule.

$$TST = C_m \left(\frac{V}{A}\right)^n$$

TST → Total solidification time

V = vol of casting

A = Surface area of casting.

n = exponent usually taken as 2.

C_m = a constant which depends upon mould material.

- A casting with higher modulus cools & solidifies much slowly than one with lower modulus.
- To feed the molten metal to casting, TST of riser must be greater than an TST of casting.
- Since the mould constant of riser & casting

will be equal, riser should be designed to have ~~a~~ more ~~sp~~

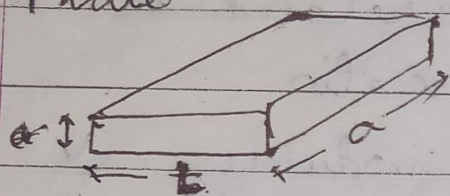
Ideal shape of riser is sphere.

Requirement of the riser to feed the casting is $M_R = 1.2 M_c$.

M_R = Modulus of riser

M_c = " " casting

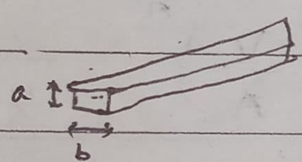
Plate



$M = 0.5t$.

$a < 5t$.

Long Bar.



$$M = \frac{ab}{2(a+b)}$$

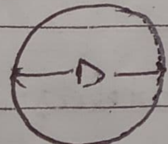
Cube

$M = D/6$

Cylinder

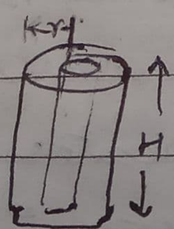
$M = D/6$

Sphere



$M = D/6$

Hollow Cylinder



$$M = \frac{rH}{2(r+H)}$$

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Q: Determine the size of a side riser for a casting of dimension ~~25×20×5~~ 25×25×5 cm. using modulus method.

Vol of casting = 25×25×5 = 3125 cm^3.

SA_c = 2×(25×25) + 4×(25×5) = 1750 cm^2

Modulus of casting $M_c = \frac{V_c}{SA_c} = \frac{3125}{1750} = 1.7857$

Modulus of riser = $1.2 \times M_c = 1.2 \times 1.785$
$= 2.1429$

Riser is cylinder; so $M_R = \frac{D}{6} = 2.1429$

$\Rightarrow D = 12.6$ cm

$\Rightarrow H = 12.6$ cm.

Q: ~~Determine~~ During the casting of a certain alloy using a sand mould, it took 155 sec for a cube shaped casting to solidify. The cube was 50 mm on each side.

(a) Determine the value of mould constant.

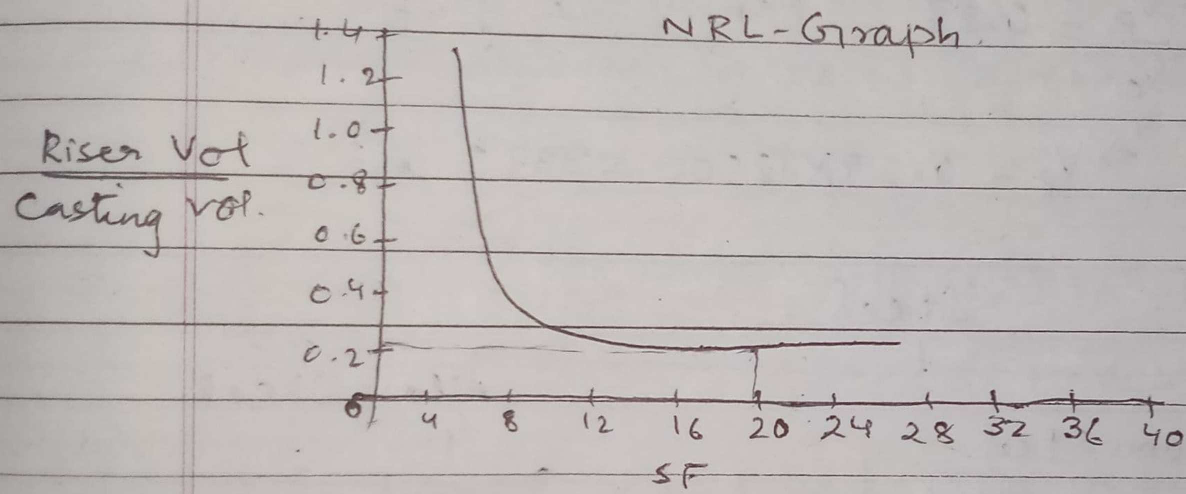
(b) For the same alloy & mould, determine the solidification time for a cylindrical casting whose diameter is 30mm and length is 50mm

NRL METHOD: 1955

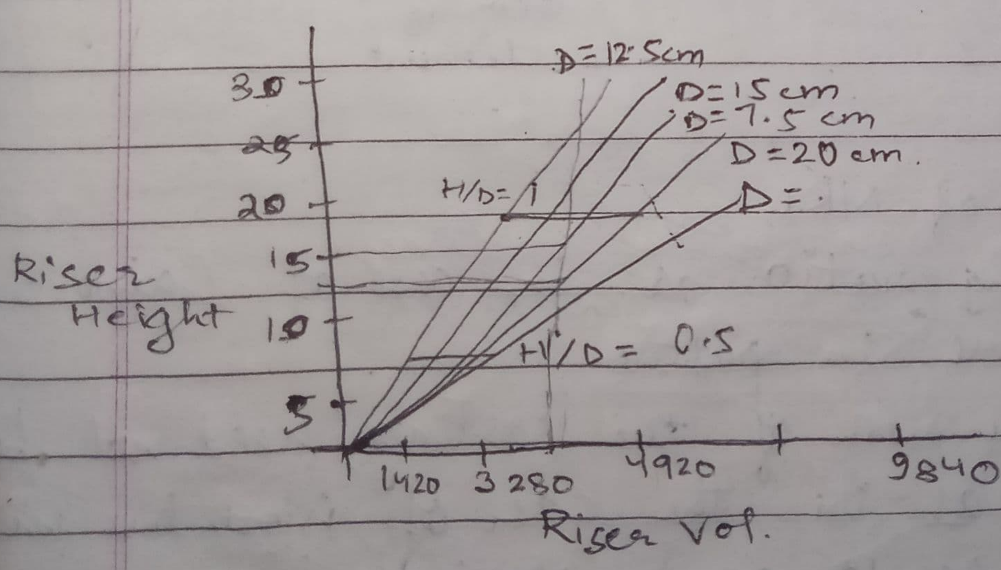
$$\text{Safe Factor (SF)} = \frac{L+W}{T}$$

where L = length, W = width, T = thickness.
and $L > W > T$.

Once the SF is ~~cal~~ calculated, empirical relation-ship betⁿ SF and



NRL Riser Selection Chart.



Q. Design the top riser for a plate like casting whose dimensions are 50 x 50 x 5cm. The material of the casting is low alloy steel.

Safe Factor $= \frac{L+W}{T} = \frac{100}{5} = 20$

Casting Vol $(V_c) = 50 \times 50 \times 5 = 12500 \text{ cm}^3$

$\frac{V_R}{V_c} = 0.27$ (From the graph).

$\Rightarrow V_R = 0.27 \times 12500 = 3375 \text{ cm}^3$

Steel
- Plain Carbon Steel
  - Low Carbon 0.05 - 0.3% C
  - Medium carbon 0.3-0.8%
  - High carbon 0.8-2.1%
- Alloy Steel.
  - Low alloy steel < 5% alloying element
  - Medium alloy 5-8%
  - High allo[y] > 8%.

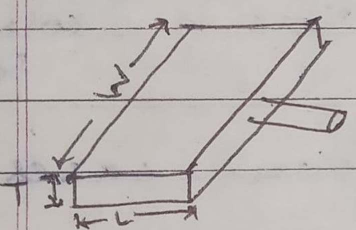
Advantages of NRL
- The freezing ratio as in case of Caine's Meth[od] doesnot come in picture.
- The surface area of the casting need not be calculated as in the case of modulus method.
- Most of the results can be obtained from graphs, so very less calculation.

→ Riser dimension can be selected in different combination of diameters & heights as per the convience.

Limitations

→ This method is applicable to only plain & low alloy steels.

Parasitic Volume in NRL Method



Final Riser Volume = Riser volume calculated without parasitic vol + 30% of parasitic vol.

Q. Design a riser for a casting
L = 35 cm, W = 20 cm, T = 10 cm, Parasitic length = 20 cm; square = 4 x 4 cm.

$$SF = \frac{35+20}{10} = 5.5$$

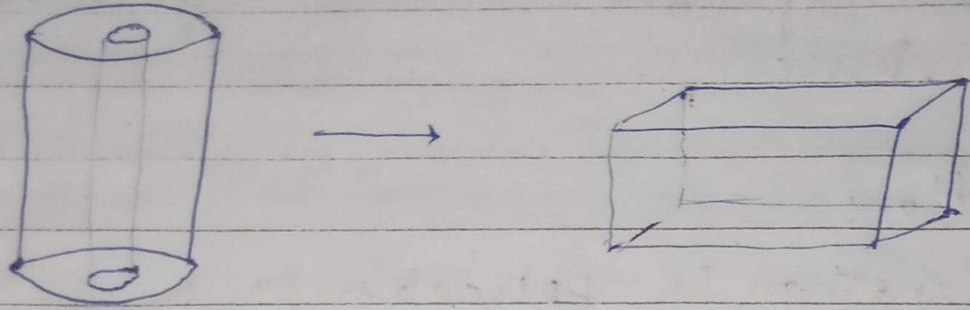
From NRL Graph; $\frac{V_R}{V_c} = 0.7$

$$\Rightarrow V_R = 0.7 \times (35 \times 20 \times 10) = 4900 \text{ cm}^3$$

$V_p = 20 \times 4 \times 4 = 320 \text{ cm}^3$

Total vol of riser $= 4900 + 0.3 \times 320$
$= 4996$

Correction factor in NRL Method



$$SF = L+W / T$$

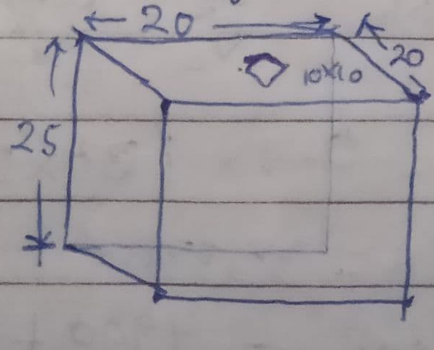
In actual casting, inner portion is not exposed mould wall & takes more time to solidify, so the Riser vol should be more

Corrected SF $= \dfrac{L+W}{kT}$ where k = correction factor

The correction factor in different cases is different.

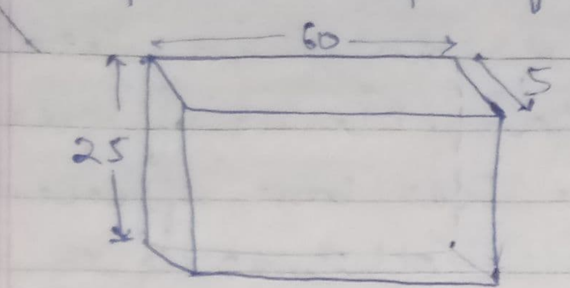
Core Dia (or thickness)	0.5 T	T	2T	4T
k	1.17	1.14	1.02	1.00

Design the riser for the casting -



$$SF = \frac{L+W}{kT}$$

Expected shape of the casting after stretching

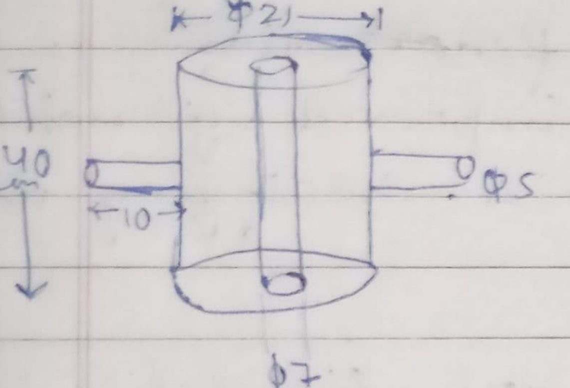


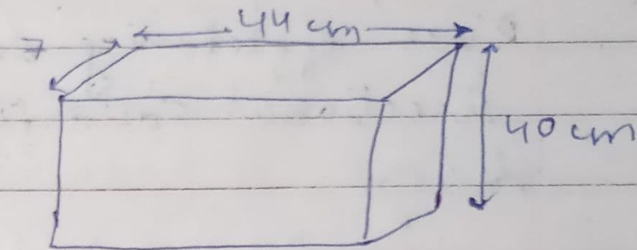
$D = 2T$

$k = 1.02$

$SF = L+W / kT$

Q. Design the riser for a casting





$L = \pi D = \pi \times \cancel{40}\ 14$
$= \cancel{28\pi}\ 44\,cm$

$T = 7\,cm$

$W = 40\,cm$

$$SF = \frac{L+W}{kT}$$

$$\Rightarrow \frac{44+40}{1.14 \times 7} = 10.52$$

$V_c = 44 \times 40 \times 7 = 12320\ cm^3$

$\frac{V_R}{V_c} = 0.42$

$V_R = 12320 \times 0.42 = 5174.4$

$V_p = 2 \times \frac{\pi \times 25}{4} = 393\,cm^3$

Total vol of riser $= 5174.4 + (0.3 \times 393) =$

Riser Efficiency - Ratio of total feed metal available to the ~~total~~ volume of risers.

Open cylindrical riser has low efficiency generally $< 15\%$ and exothermic cover & slip increase its efficiency upto 70% or more.

~~And~~ Max. efficiency of a riser depends upon its shape and use of feed aids.

Riser efficiency can be improved by achieving directional solidification & modifying its design.

Q. Design an open side riser (without any feeding aid, insulating slip, exothermic cover) for a casting of dimension $25 \times 25 \times 5$ cm using modulus method check its adequacy when (a) the material of the casting is plain carbon steel (b) the material of the casting is pure aluminium.

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Feed Metal Volume – The riser should take care of the casting shrinkage as well as its own shrinkage. Little volume of liquid metal from the riser solidify during the process of feeding. Thus the entire volume of the riser will not be available for the purpose of feeding. Thus the feeder must compensate solidification shrinkage by the following

$$\alpha (V_c + V_R) = \eta_f V_R$$

α = % volumetric shrinkage of cast metal

Al – 6.6 %

Al-12 Si alloy – 3.8

Al-4.5 Cu – 6.3

GI = 0 – 1.8

WI = 4 – 5.5

Plain carbon steel – 2.5 – 4

Cu – 4.5

Sn Bronze – 5.5

Al – Bronze – 4.0

Mg – 4.2

Zn – 6.5

Pb – 3.2

Au – 5.5

η_f = Riser efficiency

Sol^n Vol of casting = $3125\ cm^3$

$SA_c = 1750\ cm^2$

$M_c = \frac{V_c}{SA_c} = \frac{3125}{1750} = 1.7857$

$M_R = 1.2 \times M_c = 2.1429$

But, M_R of cylinder $= \frac{D}{6} = 2.1429$

$\Rightarrow D = 12.8\ cm$

$D = H = 12.8\ cm$

Case I: Demand = Supply.

$\alpha(V_c + V_R) = \eta_f V_R$

$\alpha(V_c+V_R) \Rightarrow 0.04(3125+1572) = 188\ cc$

$\eta_f V_R = 0.15 \times 1572 = 236\ cc$

$\alpha = 2.5-4\%$
$\eta_f = 15\%$
$V_R = \pi\left(\frac{D}{2}\right)^2 \times h$
$= \pi \frac{D^3}{4}$
$V_R = 1572\ cc$

Supply > Demand

So, size of riser is adequate

Case II → For pure aluminium

$\alpha = 4\%$

$\eta_f = 15\%$

Demand ~~Supply~~ $= 0.066(3125+1572) = \cancel{188\ cc}\ 310.002$

Supply ~~Demand~~ $= \eta_f \times V_R = 0.15 \times 1572 = 236\ cc$

Supply < Demand,

So riser size is inadequate