Introduction of Manufacturing (or) Production Processes

→ **Definition** :- Manufacturing is an activity of making goods and articles by hand (or) machines at reasonable price

(or)

Manufacturing is an activity of turning raw material into finished products to be used for some purpose. It also involves assembly of parts to make final product.

→ Types of Manufacturing Processes

1. Primary manufacturing Processes
2. Secondary Manufacturing Processes

① **Primary Manufacturing Processes** :- It involves the conversion of "initial Material into Semifinished Products"

Ex: Casting, rolling, forging and extrusion. etc..

② **Secondary Manufacturing Processes** :- In this Process the "accurate size of final Products" are obtained.

Ex: coining, drawing, sheet forming etc...

Based on the Primary and Secondary Manufacturing Processes we can classified as

(a) casting [Starting Material is 'liquid']

(b) Metal forming (or) Metal Working Processes [Starting Material is 'Solid' which consists of Plasticity.]

(c) Machining (or) Metal forming (or) cutting: Starting Material is Solid which extra Material is removed.

(d) Powder Metallurgy (or) Particulate Process: Starting Mat is Powder which is compacted and Sintered.

(e) Joining and Assembly Processes: New Product is formed due to assembly of two (or) more Products.

(f) Surface treatment Processes: unwanted Material like oil, dirt will removed by this Process.

→ Selection of Manufacturing Processes:

Many factors are involved in Selection of Manufacturing Process. Some of the considerations are.

① Material to be used
② Shape and size of the Components.
③ Accuracy and Surface finish
④ volume of Production
⑤ Economy.

→ Importance of Manufacturing Process:-

Now-a-days the economic development of Country is completely based on Material resources, skill and energies expend in utilising resources i.e. Manufacturing. Manufacturing is a Series of complex interaction between Materials, Machines, energy and People. It begins with creation of individual Parts that will finally assembled to Produce final Products.

UNIT-I

CASTING: Steps involved in Making a casting - Advantage of casting and its applications - Patterns and Pattern making - Types of Patterns - Materials used for Patterns, Pattern allowances and their construction, Principles of Gating, Gating ratio and design of Gating System.

→ History and Introduction of casting:-

History:- Casting is one of the oldest and cheapest method of Producing Parts of desired shape. Casting is the 6000 Years old Process. and this Process was extensively used for Making ornaments, weapons, tools, utensils [bowls] etc...

Introduction:- Casting is defined as "the shaping of Material in liquid state." Here the liquid Metal is Poured in a mould cavity, usually made of Sand; and it is allowed to solidify. after completion of solidification the Part is removed from mould either by breaking (or) Separating the two Parts of mould. The Part obtained by casting is called "casting" (or) "founding".

→ Terms used in Casting:-

① **Drag:** Lower - Moulding flask

② **Cope:** Upper - Moulding flask

③ **Cheek:** In 3-Piece moulding, it is intermediate flask

④ **Pattern:** It is replica of a final object to be made. The mould cavity is made with help of Pattern.

⑤ **Parting line:** It is a dividing line b/w 2 Moulding flask.

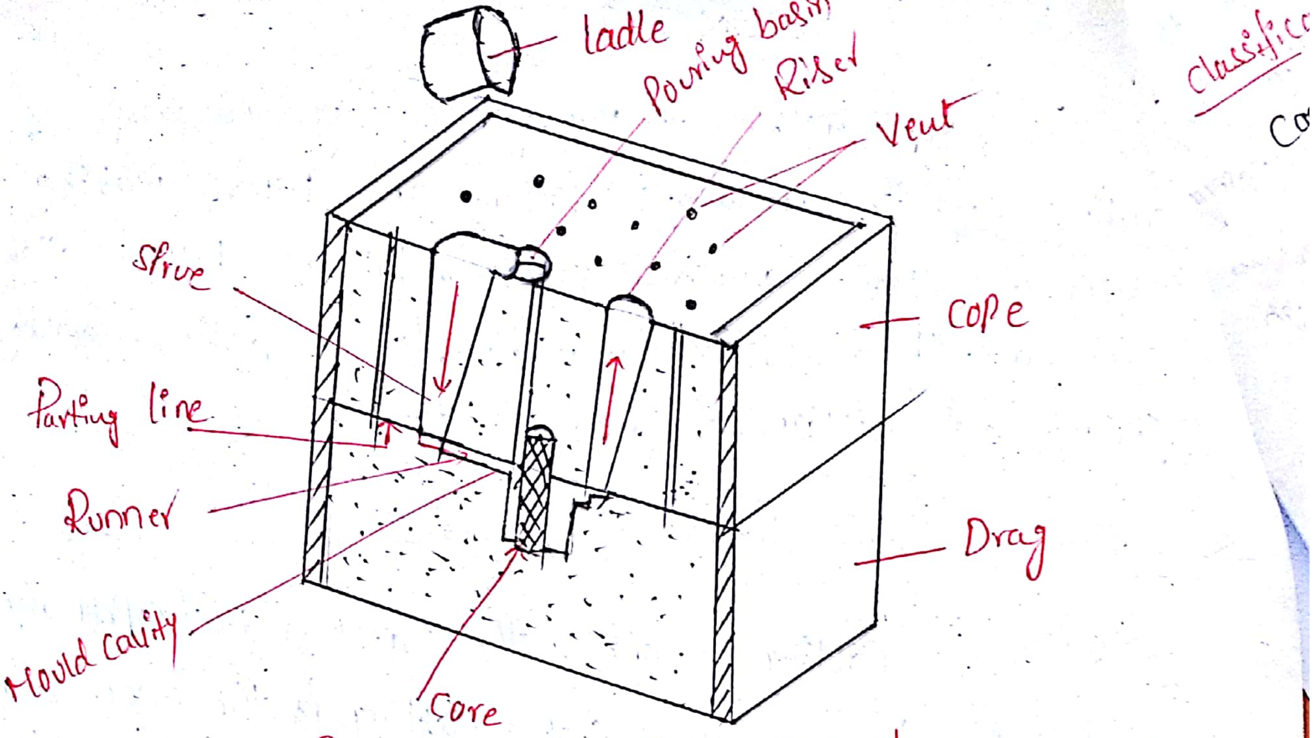


Fig. Cross-Section of a Sand Mould

⑥ Facing Sand: It is a small amount of Carbonaceous Material sprinkled on the inner surface of Moulding cavity to provide better surface finish.

⑦ Moulding Sand: It is a mixture of silica, clay, moisture with certain proportions.

⑧ Core: It is used for making hollow cavities in castings.

⑨ Pouring Basin: It is a small-shaped cavity at the top of the mould into which molten metal is poured.

⑩ Sprue: It is a passage through the molten metal from the pouring basin.

⑪ Runner: It is a passageways, which molten metal flow is regulated before they reach the mould cavity.

⑫ Gate: The actual entry point through molten metal enters the mould cavity.

⑬ Riser: It is a reservoir of molten metal provided in the casting, so that hot metal can flow back into the mould cavity.

➢ **Classification:** Based on type of Mould used, casting can be classified as

① Expendable Mould Casting

Ex: Sand Casting, shell moulding, and investment Casting.

② Permanent Mould casting

Ex: Gravity die casting, pressure die casting and Centrifugal casting.

① Expendable Mould Casting: In this type of casting the moulds are made of Sand, Plaster, Ceramics which are mixed with various binders. In this process firstly the molten metal is poured into the pouring cup which is passes through the sprue, gate and finally ~~the~~ molten metal will be entered into the Mould Cavity after some time the Solidification Process was done. after complete solidification the part is removed from mould either by breaking can separting 2 parts of a mould. Sand casting is the most important example of the expendable mould casting. More intricate and large size castings are prepared with this casting.

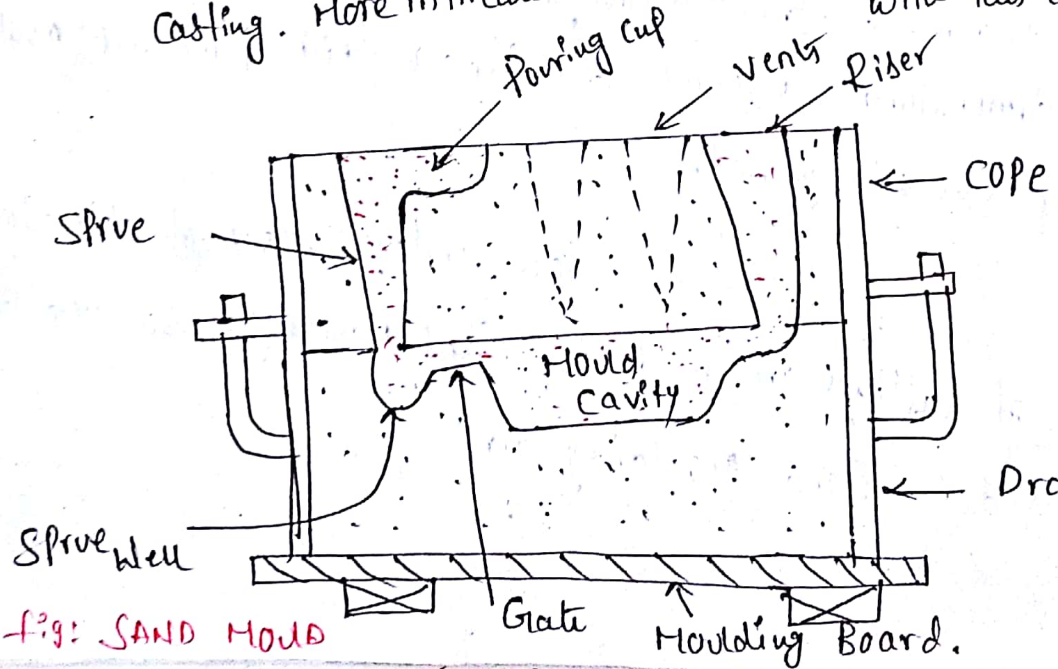


fig: SAND MOULD

② **Permanent Mould Casting:** In this type of casting, the Moulds are used "Repeatedly to produce many castings". They are designed in special way that the "casting can be easily removed" and the mould used for the next casting. This type of Moulds are made of "metals" which Maintains the "high heat resistance."

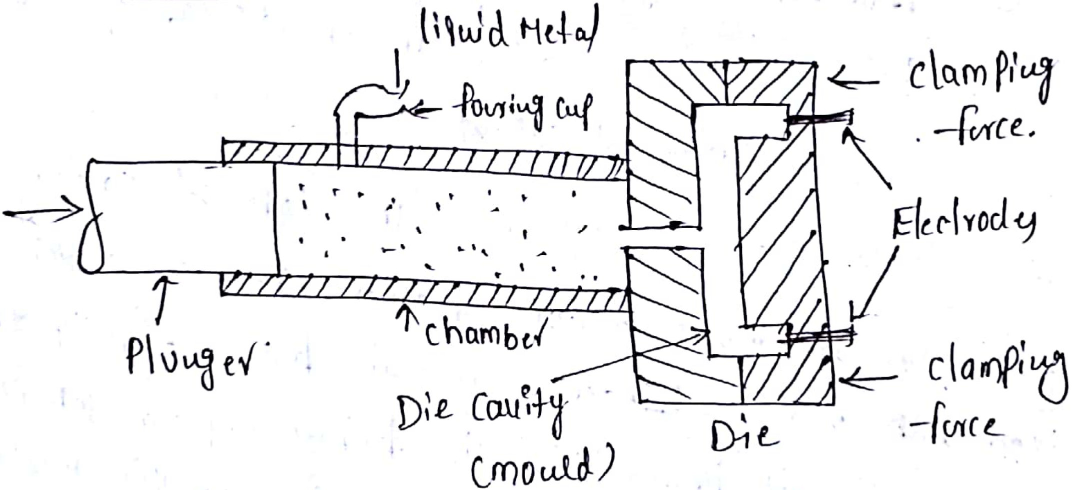


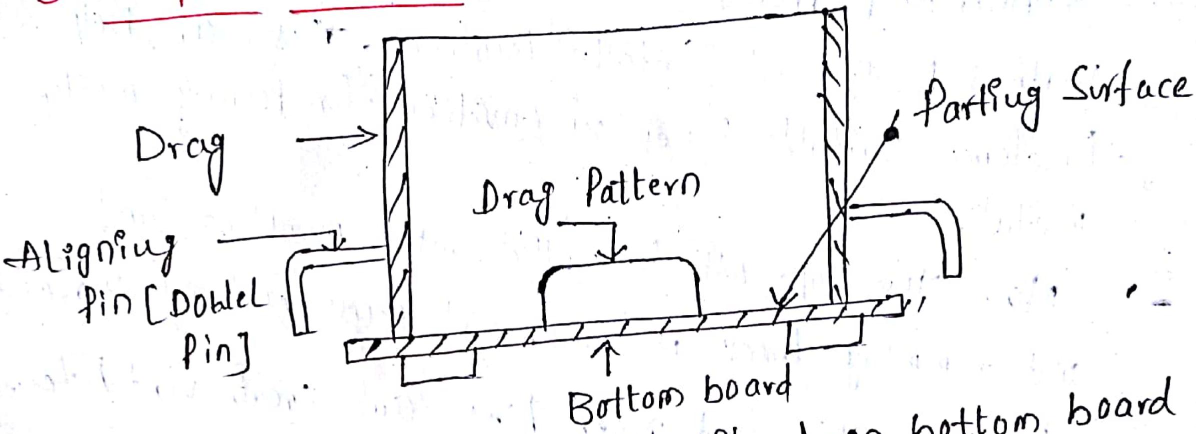
fig: Cold chamber die casting

In this casting the liquid metal will be poured into the pouring cup and this is entered into the chamber, so the Plunger will be ~~foor~~ Moved in the forward direction with high pressure at the same time clamping force will be acts in the opposite direction of Plunger. finally the molten metal will be sticky in Die casting, after that Solidification will be allowed, and the part will be removed from the cavity. At high production rate with good dimensional accuracy and surface finish Permanent mould casting was widely used.

Steps involved in casting: Now-a-days 75% of the total output of castings are made in Sand-Moulding. So the steps involved in Sand Moulding are

Selection of Mould box / flask: Based on the requirements [i.e., size, l, etc..] of casting we can Select the mould, which must be of proper size to adjust mould cavity, riser and gating System etc...

② Preparation of Drag:



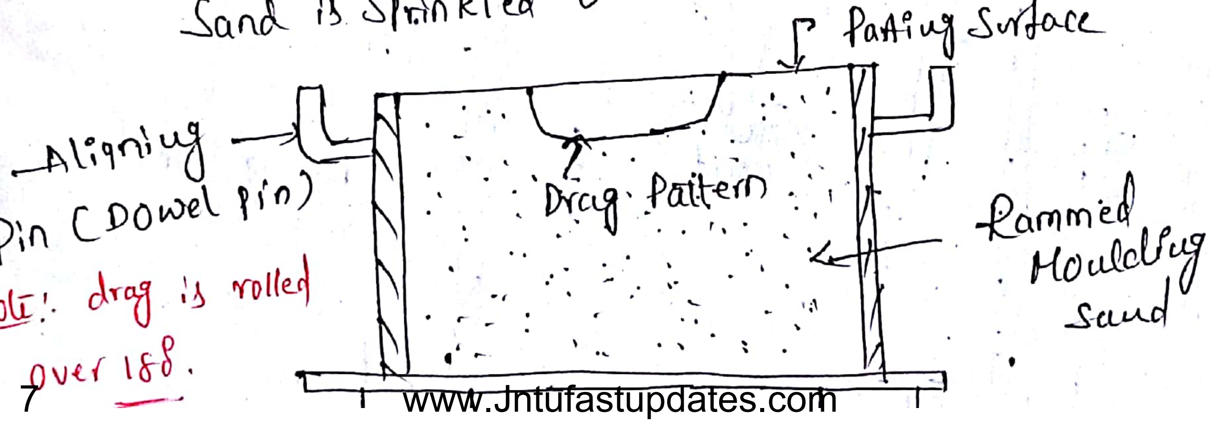
→ Initially the drag will be Placed on bottom board

→ "Facing Sand" is sprinkled carefully around the 'drag pattern' with moulding sand So that the Pattern doesnot Stick during removal of Pattern

→ The drage is filled with moulding sand and rammed this sand around the Pattern, the ramming process is done 3(or) 4 times.

→ The excess amount of sand is removed with help of Strike off bar.

→ The drag is the "rolled over by 180°" and the Parting sand is sprinkled over on the top of drag as shown below



Note: drag is rolled over 180.

Remov

③ Preparation of Cope:

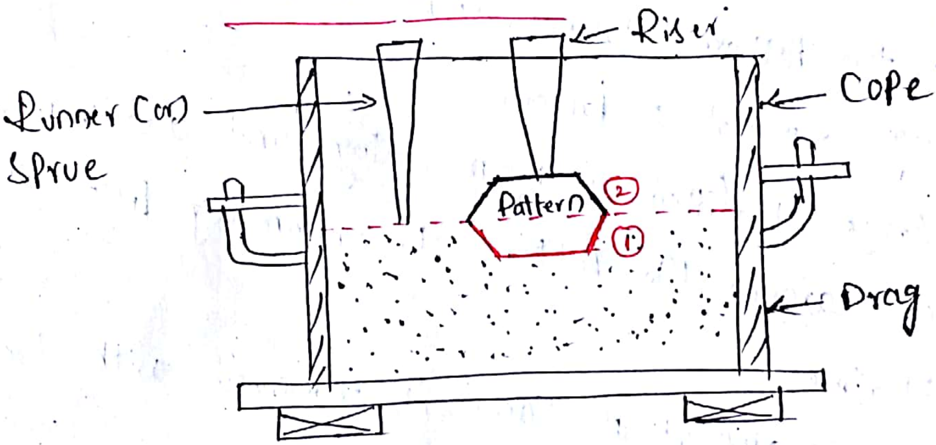
→ The cope Pattern is Placed on the drag Pattern with help of dowel pins.

→ The "Parting Sand" is sprinkled carefuly around the ↗ Cope Pattern.

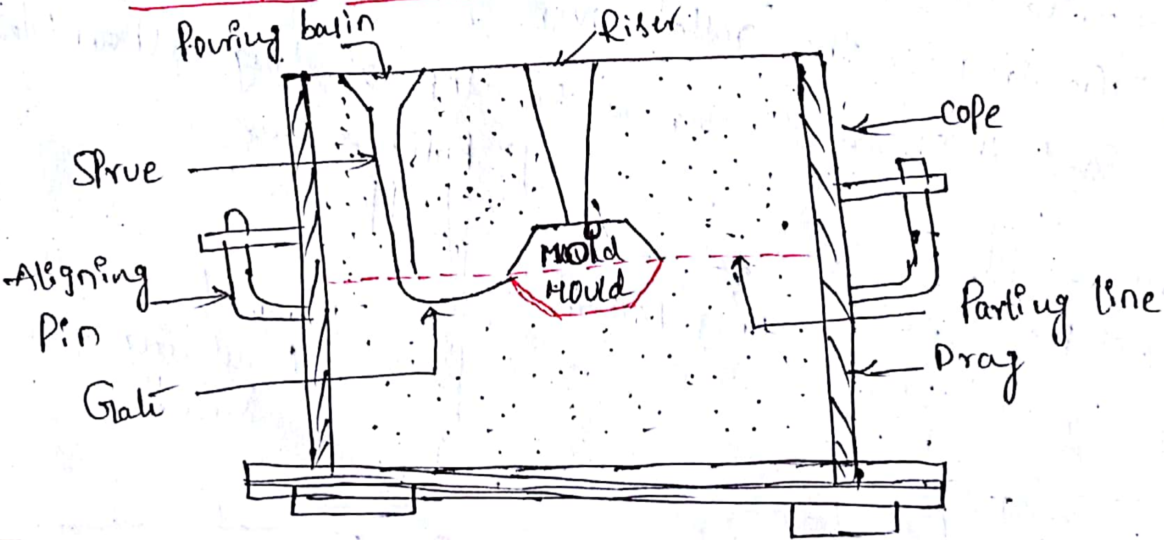
→ Runner Pin [Sprue] and Riser Pins are located in Vertical Position at Suitable locations. These are help to form Suitable Sises of cavities for Pouring molten metal.

→ Now the cope will be filled with moulding Sand and ramming Process is done. and Excess Material is removed

→ Remove Sprue and riser Pins and Create vent holes. These are helps to "escape of gases during Pouring and Solidification" of Casting.



④ Cutting of Gate & Pouring of Metal:



→ Remove both the Cope and drag Patterns, and repair the mould Suitable if needed and dressing is applied.

→ The gate is then cut connecting the lower base of Sprue basin with runner and then the mould Cavity.

→ The cope is then clamped with drag and the mould is ready for Pouring.

→ **Advantages of Casting:**

1, Casting Can create complex part geometries i.e. Parts ranging in Size from Small to very large [few grams to hundred tons].

2, Can create both external and internal shapes.

3, Metal casting can be applicable for mass Production

4, There are Several metal [Eg.C.I] which can only be cast.

→ **Disadvantages (or) Limitations of casting:**

1, Limitations on Mechanical properties

2, The accuracy and Surface finish was poor in Some Castings like Sand casting.

3, Safety hazards to workers due to hot molten metal

4, Environmental problems.

→ ~~Advantage~~ **Applications (or) Parts Made by Casting:**

1, Intricate shapes are obtained

2, Typical parts like cylinder blocks, liners, pistons, Piston rings, Machine bed & frames, mill rolls, water and Sewage Pipes.

Pattern

→ **Definition of Pattern:-** Pattern is the replica of the object [t be casted] except for various allowances. it generates its shape to the mould cavity where the molten metal solidifies to the desired form and size. Pattern should be simple in design for ease of Manufacture and enable to draw easily from sand. The quality of casting is depends on the Material of Pattern, its design and construction.

The Pattern is not an exact copy of part to be made. It differs from the patterns castings in the following manner.

1, It is made in larger size than casting to compensate for shrinkage and machining allowances.

2, Taper is provided on vertical sides (draft) to enable to draw from the sand without damaging the mould.

→ **Pattern Allowances!** Pattern may be made from wood (or) Metal and its colour may not be same as that of casting. A pattern is always larger in size as compared to final product because it carries allowances due to Metallurgical reasons [shrinkage on cooling] and mechanical reasons [Machining, draft, shake, sharp edges etc....], based on these reasons Allowances are classified as

1, Shrinkage allowance
2, Machining (or) finishing allowance
3, Taper (or) Draft allowance
4, Distortion allowance
5, Shake (or) rapping allowance.

) **Shrinkage allowance:** The Pattern must be made oversize to compensate for contraction of metal. based on contraction in volume is divided into 3 Parts.

(a) **liquid Contraction:** The contraction during the Period in which the temperature of liquid metal falls from Temperature to the liquidus temperature.. [Pouring Temp ⟶ liquidus Temp]

(b) **Solidifying Contraction:** contraction on cooling from the liquidus to Solidus Temperature [liquidus Temp ⟶ solidus Temp]

(c) **Solid Contraction:** Contraction that results after until the temperature reaches the room temperature.

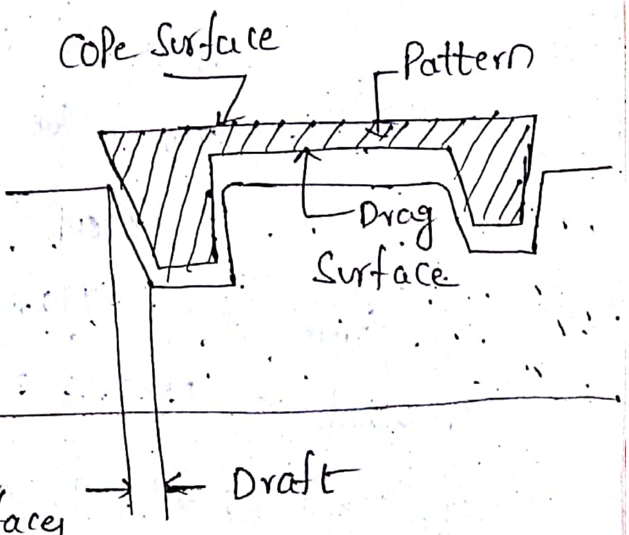
[Solidus Temp ⟶ Room Temp]

Note: shrinkage is generally greater for "cast steel" than for other alloys.

② **Machining Allowance:** It is a positive allowance given to compensate for the amount of Material that is lost in Machining (or) finishing the casting. If this allowance is not given, the casting will become "undersize" after Machining.

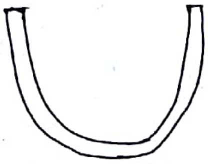
③ **Draft (or) Taper Allowance:**

The Provision of taper on vertical faces of Pattern is called draft. Draft allowance is a Positive Pattern which is applied on vertical faces of Pattern So that its withdrawal becomes easier. The amount of draft recommended on external Surfaces varies from 10 to 20 mm/m & for Internal 60 mm/m.



④ **Distortion Allowance:** This type of allowance is appli the castings of "irregular shapes" that are distorted in because of metal Shrinkage.

Ex: - A 'U'- shaped design with ||el legs will not allow distortion compared to U-shaped design with legs slope towards.



⑤ **shake (or) Rapping allowance:**

Whenever we remove the Pattern it is rapped and thereby the size of mould cavity will be increases. This type of allowance doesnot effect the Small Sise Pattern. but it is rises in large castings.

→ Materials Used for Pattern:

The desired shape and Sise of Pattern is based on Matirial of Pattern. The basic requirements of Pattern Materials are

1, Should be easily Workable, durable

2, should be maintain dimensional accuracy during in its Service life

3, should be light weight and convient to handle, ~~cheap~~ cheap and readily available.

Some of the Matirials used for Pattern making are

1, Wood 2, Metal 3, alloy 4, Plastic 5, Wax 6, Rubber

7, Steel 8, Al 9, cast Iron 10, Plaster of Paris etc...

Wood: The most common Material used for Pattern Making is wood. The main varieties of woods are 1, Pine wood 2, Teak wood 3, Mahogany 4, Shisham etc...

→ **Advantages**: 1, Easily available, reasonable cost
2, Easy to handle, light weight etc..

→ **Disadvantages**: 1, Wood is susceptable to shrinkage.
2, It is highly affected by moisture.

② **Metal**: Metal Pattern are widely used in mass production

Advantages: 1, High strength, durable
2, high wear resistance, stability.

Disadvantages: 1, More weight, difficult to repair
2, Poor resistance to corrosion.

③ **Plastic**: The type of Pattern which is made by Plastic must be very strong and highly resistance to wear. Thermo-setting resins [phenolic resin, epoxy resin] have the desired Qualities of Pattern Materials.

Characteristics of Pattern Materials

Characteristics → ↓ Materials	Machinability	Strength	Weight	Resistance to Wear	Resistance to Corrosion	Resistance to Swelling
Wood	Excellent	Fair	Excellent	Poor	Excellent	Poor
Alluminium	Good	Good	Good	Good	Excellent	Excellent
Steel	Fair	Excellent	Poor	Excellent	Poor	Excellent
Cast Iron	Good	Good	Poor	Excellent	Poor	Excellent
Plastics	Good	Good	Good	Fair	Excellent	Excellent.

Types of Patterns

Generally Patterns are classified into 2 types.

① Permanent [Reusable] Pattern ② Disposable [expendable] Patt

→ **Permanent Pattern:** These are generally made up of wood (or) Met here the mould cavity is generated by removing of Pattern from the sand.

Note: The Pattern will be removed.

→ **Temporary [Disposable] Pattern:** it is made up of Polystyrene, and is used in full-mould Process. The Pattern material is vapourised by hot metal when it is poured in through the sprue.

→ Types of Removable Pattern:

① Solid [Single Piece] Pattern
② Split (or) Multi-Piece Pattern.
③ Match Plate Pattern
④ Gated Pattern.
⑤ Cope & Drag Pattern
⑥ Loose-Piece Pattern
⑦ Segmental Pattern [Part Pattern]
⑧ Follow-board Pattern
⑨ Shell Pattern
⑩ Sweep Pattern
⑪ Skelton Pattern.

① Solid [Single Piece] Pattern:-

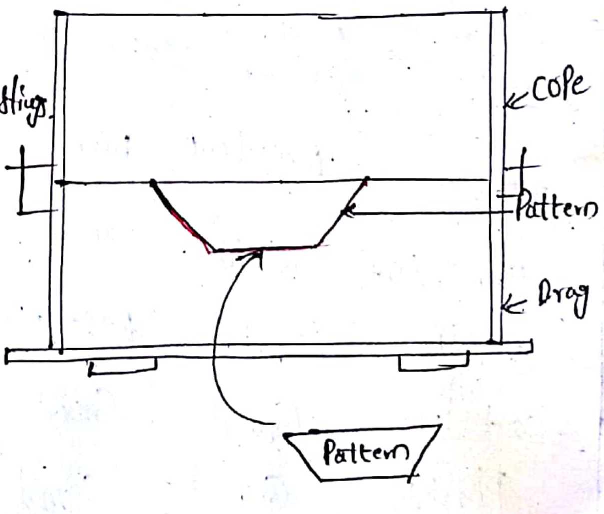
i) It is the simplest form of Pattern

ii) it is inexpensive and used for making large production in simple castings.

iii) It is placed either cope (or) drag

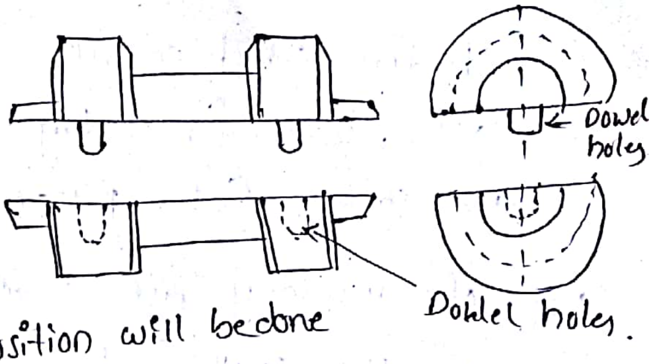
iv) The shape of solid Pattern is exactly same as that of casting.

Ex: Stuffing box of steam engine



⑧

a, Split (or) Multi Piece Pattern: [2 Pieces]



i, These are used for intricate Castings.

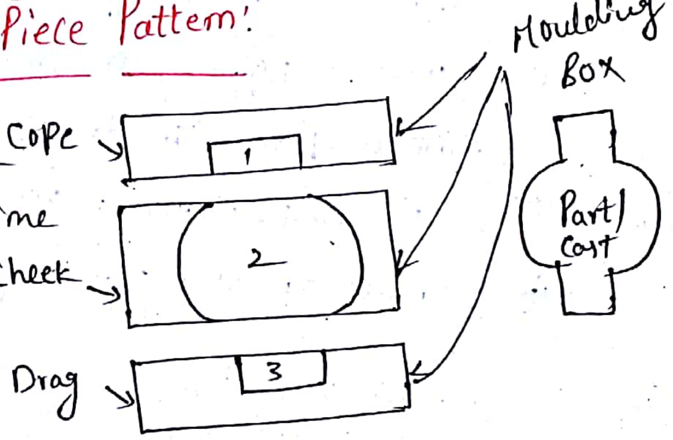
ii, it is made in 2 Parts, one is Placed on drag and another one is Placed on cope.

iii, The exact arrangement (or) Position will be done with the help of dowel pins.

iv, The Pattern will be drawn [removed] from the mould before Pouring of molten metal.

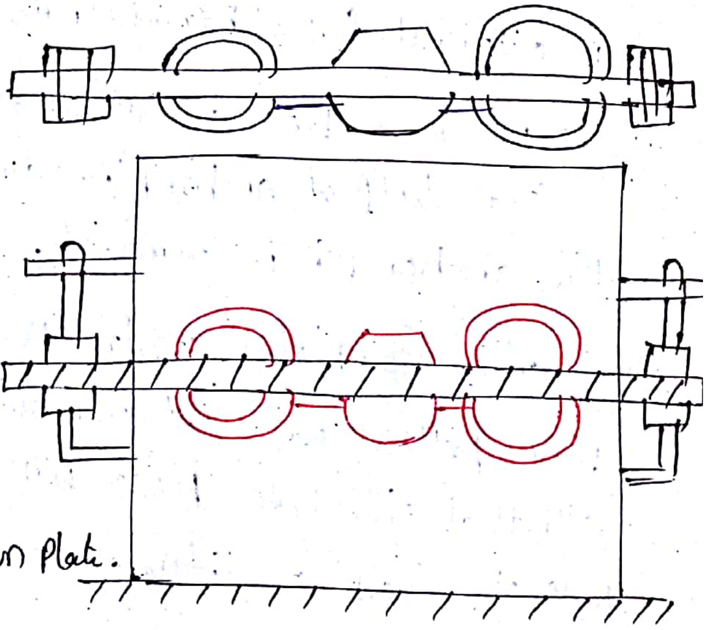
(v) Ex: Taps, Water stop cocks etc.

② [b, Three Piece (or) Multi Piece Pattern:



Some Pattern are of compli-cated kind in shape at that time This Pattern is used. so that the difficulty of withdrawn of Pattern will be avoided.

③ Match Plate Pattern:-



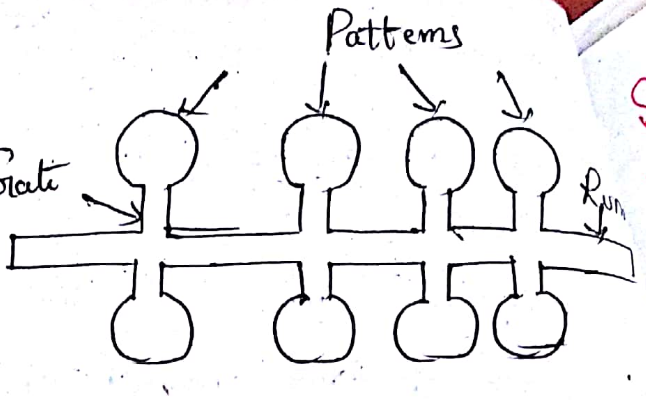
i, This Pattern was widely applicable for Production of large number of Small Castings.

(ii) here the Pattern in 2 halves are attached on opposite sides of wooden (or) metal Plate.

(iii, The gates & runners are Placed on Plate.

(iv) Ex: Piston rings of IC engine

④ Gated Pattern:



(i) The Pattern which consists of gates & riser for casting are called Gated Pattern.

(ii) The moulding time greatly reduced.

(iii) A gated casting produce many castings at one time & are used for mass Production of small castings.

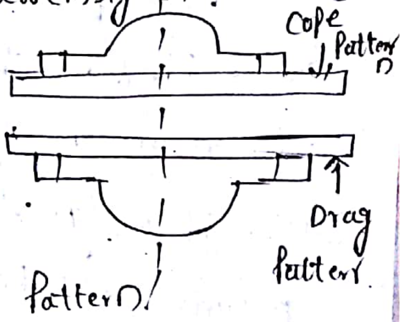
⑤ Cope & Drag Pattern:

(i) This Pattern is essentially same as split pattern.

(ii) Here 2 halves are Present, one is Placed on cope & another one is Placed on drag.

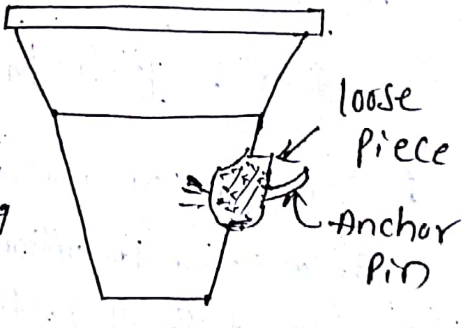
(iii) The complete mould was formed, after assembly of 2 halves

(iv) These are used for very large castings.



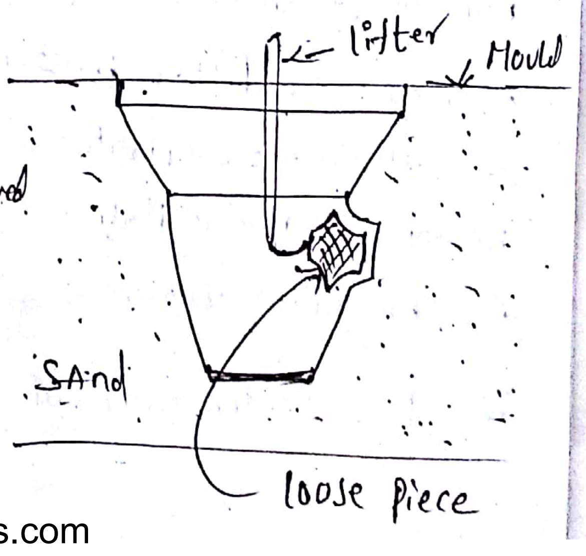
⑥ Loose Piece Pattern:

(i) loose piece Pattern is used, when Pattern is difficult for withdrawl from mould.

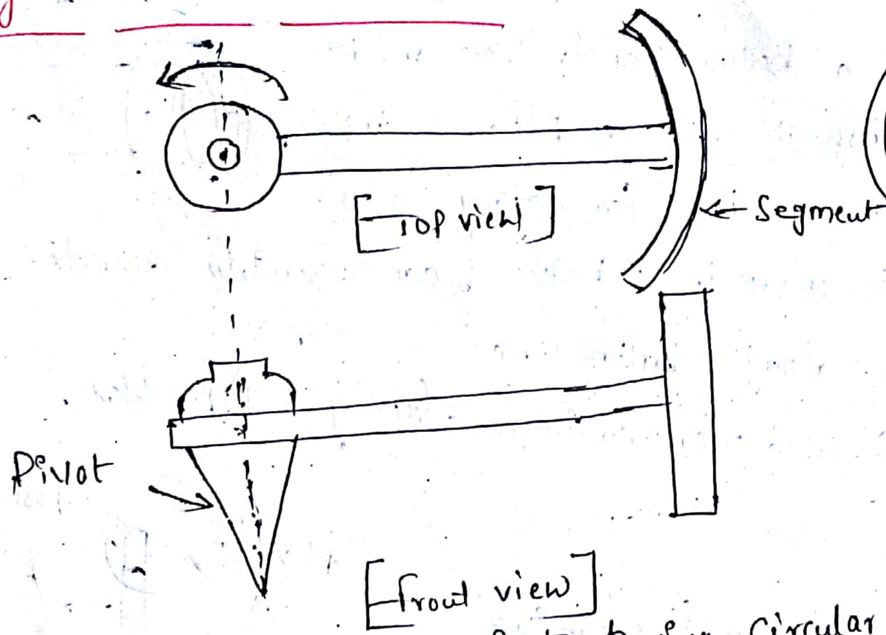


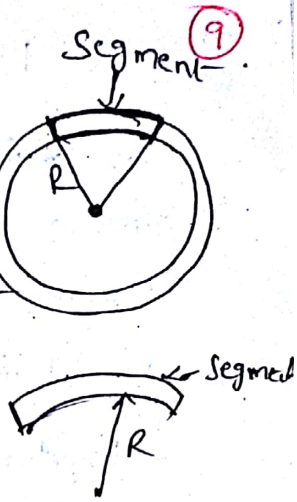
(ii) The loose piece is attached to Pattern with help of anchor Pin. during moulding the anchor pin is removed.

(iii) after completion of Process, the Main Pattern was first removed, after that the loose Piece will removed with the help of lifter.



Segmental (or) Part Pattern:-



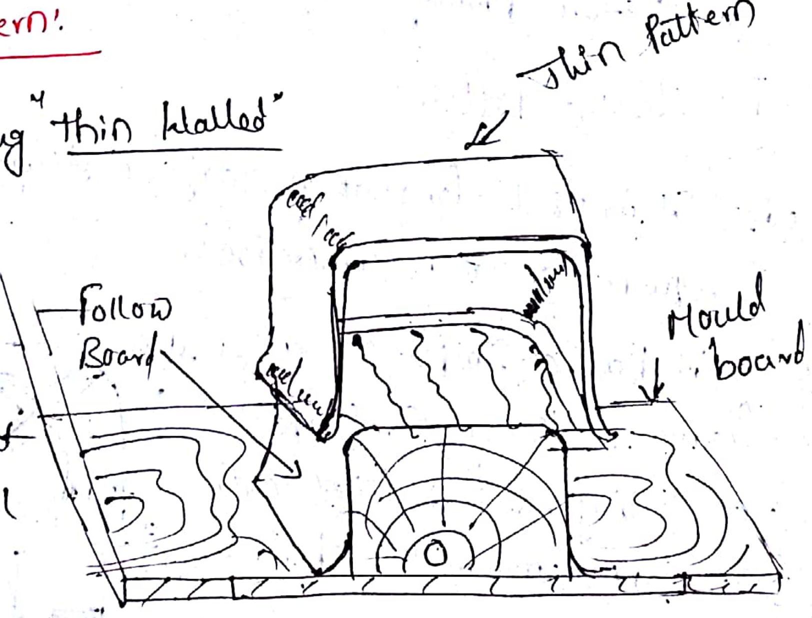


(i) It is used for moulding Parts having circular Sections like rings, wheel rims and gears etc....

(ii) The Pattern revolves about centre and after ramming one Section,.. it moves further to means forward to another Section to complete the mould.

(iii) The movement of Pattern is guided by central Pivot.

⑧ Follow-Board Pattern:



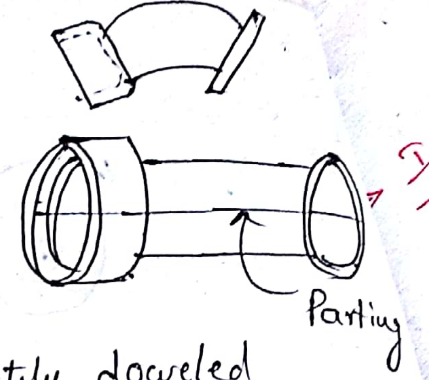
(i) it is used for making "thin walled" Castings.

(ii) here support Pattern will be placed inside of thin wall Pattern so that the breaking Problem will be reduced.

(iii) Follow board is removed after ramming drag.

(iv) The drag is inverted after cope Part is rammed.

⑨ Shell Pattern:

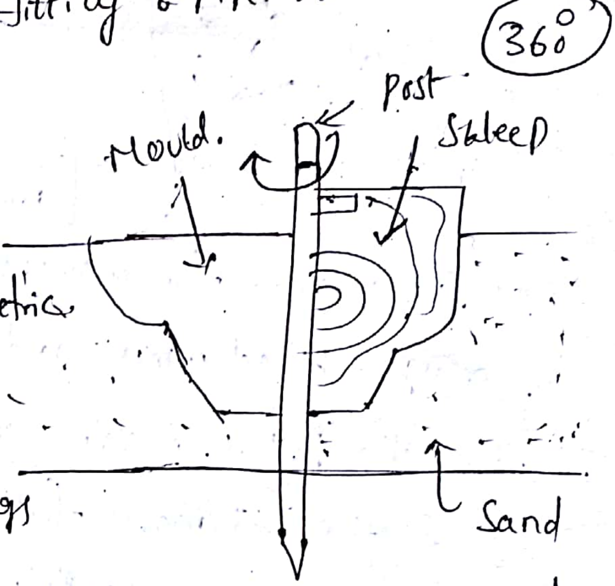


(i) It is a hollow construction and its outside shape is used as pattern & inside is used as core box for making cores.

(ii) It is made in 2 halves & are accurately doweled together along parting line

(iii) It is used for drainage fitting & pipe work.

⑩ Sweep Pattern:



(i) These are used for forming large 'circular' moulds of symmetrical kind by 'revolving sweep' attached to a spindle as shown in fig.

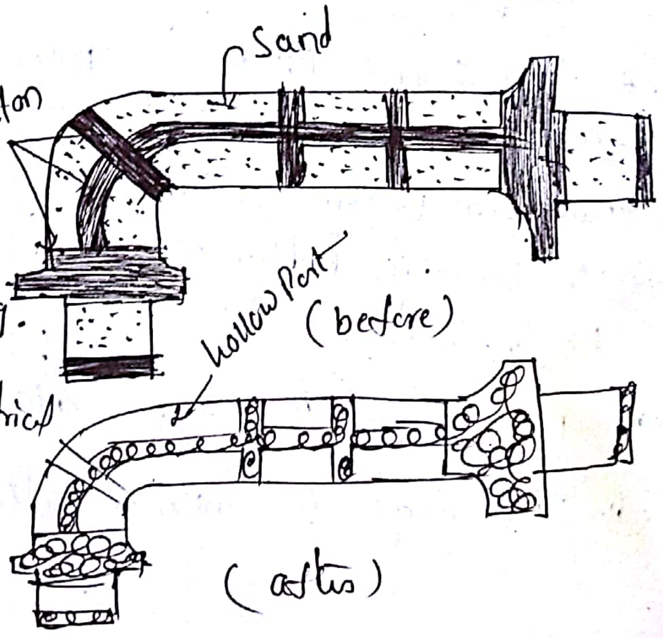
(ii) It is suitable for simple castings like wheels, rims, bell shapes.

(iii) after forming the mould, the sweep & spindle will be removed before pouring the molten metal.

⑪ Skelton Pattern:

(i) It is used for making large castings in small number & donot require accurate dimensions.

(ii) it has a simple wooden skelton frame outlining the shape of casting. & it is filled with loam sand & rammed as shown in fig.

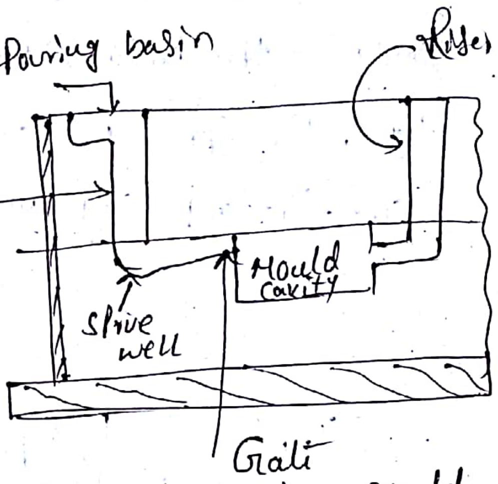


(iii) ~~after~~ it is suitable for geometrical shape like M/c frames, Pipe fittings & housings.

Gating System

Introduction: When the molten metal poured into the Mould cavity, turbulence and erosion will be raises, this problem will be reduced with the help of gating system. this gating system will be arranged in between bottom part of sprive [Runner] to mould cavity and mould cavity to the bottom part of the raiser.

→ Elements of gating system! —



— The components used in gating system are

(1) Pouring basin (2) Sprue (Runner)

(3) Sprue Well (4) Runner

(5) Gates.

→ Types of Gates:- According to the gate position in mould cavity, gates are classified as

(1) TOP gates (2). Bottom gates (3) Parting line gates (or) Side gates.

(1) TOP gate:- Here the molten metal is directly poured into the mould cavity. This is simplest gating system. but the erosion of mould occurs due to impact of molten metal.

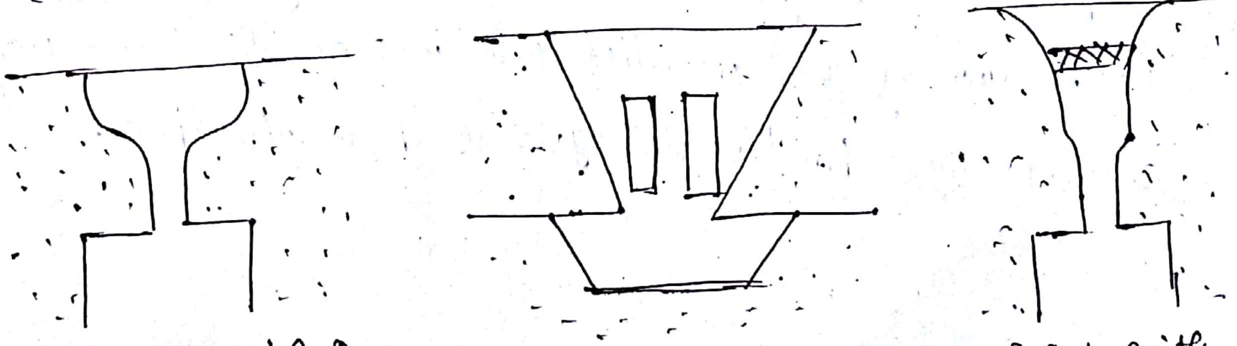
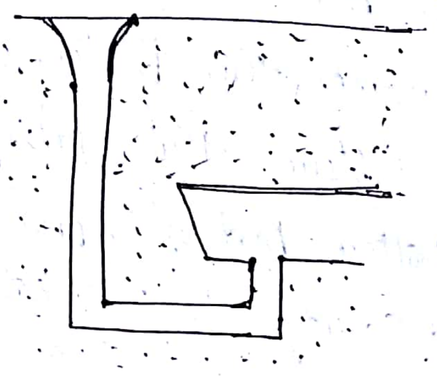
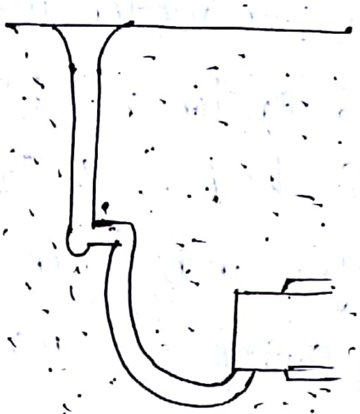


fig: (a) TOP gate with Pouring basin (b) Slit gate (c) TOP gate with Strainer.

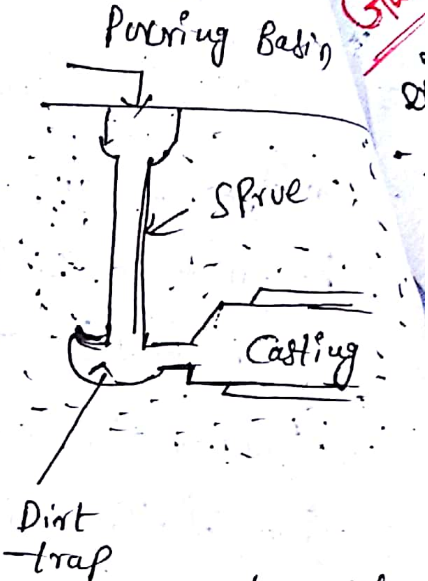
(2) Bottom Gate:



(a) Simple Bottom Gate



(b) Horn Gate

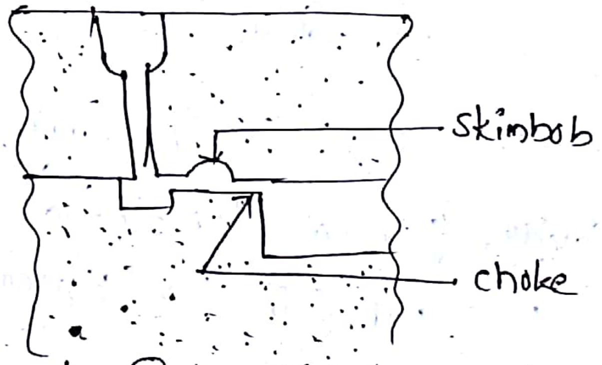


(c) Bottom gate with dry sand core.

The molten metal enters the mould Cavity at the bottom. ~~The~~ In dry sand core type, the sprue is curved at the bottom end to trap slag and dirt.

(3) Parting line or side gates:-

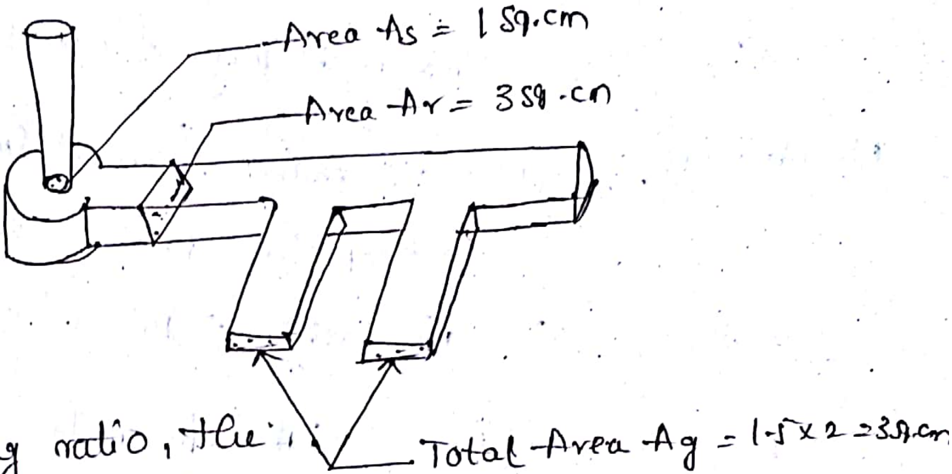
(a) Simple Parting line gate



(b) Gate with skim bob & choke.

Parting line gates are located at the Parting line or Side of the casting. In this type, the molten enters the mould Cavity at the Parting line. The skim bob may be used to trap slag. Skimming gate or relief gate is connected to runner so that light Particles of slag rise up in this Sprue.

Gating Ratio:- The dimensional features of any gating system is ④ expressed in terms of gating ~~system~~ Ratio. It is defined as the ratio as "the ratio of Sprue area to the total runner area to total gate area". Grating ratio of gating system having Sprue cross-sectional are af 1sq.cm, a runner cross-sectional area of 3sq.cm and 2 gates of each 1.5 sq.cm is 1:3:3.



According to gating ratio, the gating system classified as

(1) Pressurized gating system (2) Un-Pressurized gating system.

(1) Pressurized gating system:- In this system the Sprue area is greater than the total gate area. The gating ratio such as 1:0.75:05 [1>0.5]. In this system sufficient back pressure is maintained, on the Sprue. this system is commonly used for steel and cast iron.

Advantages:- 1, Due to sufficient back pressure, the gating system is kept full of molten metal.
system resulting high casting.

2, less metal is left in the gating

Disadvantages: 1, Careful streaming is required to avoid turbulenc

2, high velocity of molten metal may results high turbulenc

(2). Un Pressurized System:- In this System, the cross-Section area of Sprue is less than the cross-Sectional area of runn

- Here velocity of flow in runner and gates is less than.

The gating ratio such as 1:2:2 (1<2)

Advantages:- (1) Reduce in velocity minimise the turbulence

(2) Directional solidification is Possible due to Smooth filling of runners.

Disadvantages:- (1) The rate of flow is Small & it's difficult to keep the Sprue filled.

(2) This System requires large runners.

→ Gating System Design:- The parameters influenced by gating System are (1) Pouring time (2) Rate of flow.

① Pouring Time:- The optimum Pouring time for commercial Casting as:

$$t = k\left[1.41 + \frac{T}{14.59}\right]\sqrt{W} \quad [\text{for cast Iron}]$$

where k = constant which depends on fluidity

T = avg. thickness, W = mass of casting (kg)

$$K = \frac{\text{fluidity of iron, mm}}{1.575}$$

for Steel:- $t = [2.4335 - 0.3953 \log W] \cdot \sqrt{W}$

for copper Alloys:- $t = k_1 \sqrt[3]{W}$

$k_1 = 1.9$ for ~~brass~~ brass

$K_1 = 2.8$ for bronze.

The Pouring-time is largely determined by experience

Rate of flow:- Generally the rate of flow is determined by choke area and sprue.

(i) **Choke Area:-** The smallest portion of gating system is called as choke area.

The velocity of metal at bottom of sprue is

$$v = \sqrt{2gh},$$

volume flow rate $= Av$ and —①

volume flow rate $= \left[\frac{w}{t \cdot \rho}\right]$ —②

from ①&② $Av = \frac{w}{t \cdot \rho}$

$$A = \frac{w}{t \cdot \rho \sqrt{2gh}}.$$

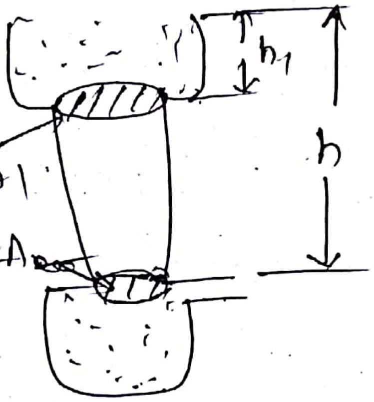
Considering the efficiency factor

$$A = \frac{w}{c \cdot t \cdot \rho \sqrt{2gh}}$$

where c = efficiency factor $= 0.4-0.9$

(ii) **Sprue:-** The area at top of sprue (A_1) can be obtained from

$$\frac{A_1}{A} = \sqrt{\frac{h}{h_1}}$$



From continuity eqⁿ $Av = A_1v_1$

$$\frac{A_1}{A} = \frac{v}{v_1} = \frac{\sqrt{2gh}}{\sqrt{2gh_1}}$$

$$\boxed{\frac{A_1}{A} = \sqrt{\frac{h}{h_1}}}$$

→ Design and Positioning of Riser:–

The metal in riser should be kept molten stai for longer time, so that the casting will be achieved in a proper working condition. This will be happen when it consists of "minimum surface area of riser" for a given volume. But for the same volume moulding a "spherical riser" is difficulty the next shape is "cylinder". in practice riser is designed with cylindrical shape.

The suitable size of riser will be calculated by some methods. They are

(1) Caine's method (2) Modulus method (3) NRL method.

① Caine's Method:–

Caine develops an emperical relation for the "freezing ratio". i.e.

$$\text{freezing ratio} = \frac{[\text{Surface Area} / \text{volume}]\ \text{Casting}}{[\text{Surface Area} / \text{volume}]\ \text{riser}}$$

$$x = \frac{\left[\frac{As}{V}\right]_{\text{casting}}}{\left[\frac{As}{V}\right]_{\text{riser}}}$$

→ if a, b, c constants of metals given.

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

where y = riser volume / casting volume.

i. for aluminum : $a = 0.1$, $b = 0.06$, $c = 1.08$

$$x = \frac{0.1}{y-0.06} + 1.08$$

ii. for CI : $a = 0.33$, $b = 0.03$, $c = 1.00$

iii) for steel : $a = 0.10$, $b = 0.03$, $c = 1.00$

→ **Chvorinov's rule:-** The Solidification time of casting is

$$t_s = k\left[\frac{\text{volume}}{\text{Surface Area}}\right]^2$$

$$t_s = k\left[\frac{V}{A_s}\right]^2$$

where k = mould constant based on material
≃ 2.09

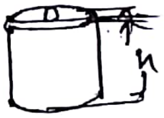
② Modulus Method :-

for steel casting $\boxed{M_r = 1.2 M_C}$ —①

Also, for steel casting, it's generally Preferable ^y cylindrical riser with height equal to the diameter i.e. h=D

Spherical shape

Cylindrical



volume of riser = Area × height

$$= \frac{\pi}{4}D^2 \times h$$

here h=D

$$\therefore V_r = \frac{\pi}{4}D^2 \times D = \frac{\pi}{4}D^3 \quad -②$$

Note:- The Bottom end of riser is in contact with casting & doesnot contribute for surface are

∴ Surface area of riser = Area of circle + (circumference) height

$$= \frac{\pi}{4}D^2 + \pi D h$$

$$= \frac{\pi}{4}D^2 + \pi D^2 \quad [\text{i.e } h=D] \quad -③$$

from ② & ③ $\boxed{M_r = 0.2D}$ —④

from ① & ④ $\boxed{D = 6M_C}$

③ NRL Method:- [Naval Research laboratory]

$$\text{Shape factor} = \frac{\text{length} + \text{width}}{\text{thickness}}$$

Problems

(W)

① A mould has a down sprue whose length is 20cm and the down sprue cross-sectional area at base of down sprue is 1 cm². The down sprue feeds a horizontal runner leading into the mould cavity of volume 1000 cm³. Find the time required to fill mould cavity.

Sol In this problem we have to calculate time required for pouring of molten metal.

given h = height = down sprue ~~wh~~ length = 20cm

$h = 20\times10^{-2}\,m = 0.2\,m$

Area (A) = $1\,cm^2 = 1\times(10^{-2})^2\,m^2 = 1\times10^{-4}\,m^2$

volume to be filled, $V = 1000\,cm^3 = 1000\times(10^{-2})^3$

$= 10^3\times10^{-6} = 10^{-3}\,m^3$

velocity at base $v = \sqrt{2gh} = \sqrt{2\times9.81\times0.2}$

$v = 1.981\,m/s$

volume filled per second i.e rate of flow (Q) = A×V

$= 1\times10^{-4}\times1.981$

$= 1.981\times10^{-4}\,m^3/s$

Finally time required = $\dfrac{\text{volume to be filled}}{\text{volume filled / sec}}$

$= \dfrac{10^{-3}}{1.981\times10^{-4}}$

$$\boxed{t = 5.05\,\text{sec.}}$$

(14)

② Determine the riser size for a cylindrical riser with $h/d = 1$ for a plate-like steel casting length 300 mm, width 200mm and thickness 25mm, using NRL method. Assume $Vr/Vc = 0.26$

Sol

volume of casting $(V_c) = 300 \times 200 \times 25 = 1500000 \text{ mm}^3$

$V_c = 1500 \text{ cm}^3$

$$\text{Shape factor} = \frac{L+W}{T} = \frac{300+200}{25} = 20$$

W.K.T $Vr/Vc = 0.26$

$Vr = 0.26 \times V_c = 0.26 \times 1500$

$Vr = 390 \text{cm}^3$ —①

for cylindrical rise, volume of riser is

$V_r = \frac{\pi}{4} D^2 \times H = \frac{\pi}{4} D^3$ [i.e $H = D$]

$V_r = \frac{\pi}{4} D^3$ —②

from ① & ② $390 = \frac{\pi}{4} D^3$

$D = 7.92 \text{cm} \simeq 8 \text{cm}$

$\therefore \boxed{D = h = 8 \text{cm}}$

③ Calculate the size of cylindrical riser $(h = d)$ necessary to feed a steel slab casting $25 \times 25 \times 5$ cm with a side riser, casting pouring horizontally in the mould. Use Caine's eqn and take constants in Caine's eqn as $a = 0.1$, $b = 0.03$, $C = 1.0$.

Sol

volume of casting $V_c = 25 \times 25 \times 5 = 3125 \text{cm}^3$.

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

$= 1750 \text{cm}^3$

Surface area of riser $= \frac{\pi D^2}{4} + \pi D h$

$= \frac{\pi}{4} D^2 + \pi D^2 = 1.25 \pi D^2$ (i.e $D = h$)

volume of riser $= \frac{\pi}{4} D^2 \times h = \frac{\pi}{4} D^3 = 0.25 \pi D^3$

freezing Ratio (x) $= \frac{\left[\frac{As}{V}\right] casting}{\left[\frac{As}{V}\right] riser}$

$$x = \frac{1750/3125}{1.25\pi D^2 / 0.25\pi D^3} = 0.112D$$

Also $y = \frac{V riser}{V casting} = \frac{0.25\pi D^3}{3125} = 0.000251 D^3$

from caine's eqn $x = \frac{a}{y-b} + c$

$$0.112D = \frac{0.10}{0.000251 D^3 - 0.03} + 1.0$$

$$D^4 - 8.9286 D^3 - 119.52 D = 2490$$

Ans = 12cm

D = 12 cm -

×

Moulding Sands

Moulding Sands rule Major Part in the Casting Operation based on the application We are using Somany varies of the Moulding sands.

→ Types of Moulding Sands:-

① **Green Sand:-** (a) It is a natural Sand which had Soft light, Porous

(b) It is Prepared by mixing of 18-30% of Silica and 6-8% of clay & moisture.

(c) This Sand is easily available and reasonable cost.

(d) Moulds Prepared by this Sand are not requiring backing and hence are known as green Sand moulds.

② **Dry Sand:-** (a) Green Sand that has been dried (or) backed in Suitable oven after making mould and Core is called dry Sand.

(b) It exhibits more Strength, rigidity, thermal stability.

(c) It is Suitable for large castings.

③ **Loam Sand:-** (a) This type of Sand Consists of "more amount of clay" as much as 30-50% and 18% of water.

(b) Patterns are not used for loam moulding and shape is given to mould by Sweeps.

(c) It is mixture of clay, water to a thin Plastic Paste contents.

④ **Facing Sand:-** (a) mostly facing Sand is applied o the pattern which is Placed on the moulding box for Produc better accuracy and easily removable Process.

(b) This Sand is subjected to the most Severe conditions and must passes high Strength refractories.

(c) It is made of silica, clay etc....

⑤ **Backing Sand:-** (a) This sand is used to backup facing Sand and is used to fill the whole volume of moulding flask.

(b) This sand was Sometimes called black sand due to this is old, repeatedly used.

(c) Moulding Sand is black in colour due to addition of Coal dust and burning on coming in Contact with molten metal.

⑥ **Parting Sand:-** (a) whenever we want to remove the Pattern, cope, drag, runner riser without cliving, Simply We use Parting Sand. because it doesnot contains the moisture & binder.

⑦ **Core Sand:- (or) Oil Sand:-**

(a) This Sand consist of oil binders such as core oil. which is compressed of linsed oil, resin, mineral oil, binding materials.

(b) cost is very high

(c) It is used for making Cores.

Constitutes (or) Ingrediants of Moulding Sand

The main ingrediats of moulding Sand are silica sand, Binder, moisture content and additives.

(a) Silica Sand:- [SiO_2]

(i) This sand was specified based on size [small, large, medium and shape [Triangular, round etc..]

(ii) Some impurities like lime stone, magnesia, soda are added to silica sand.

(iii) This sand exhibits high impact strength, stability and Permeability.

(b) Binder:- (Binder means added substances)

(a) The organic (or) inorganic substances are added to silica sand.

(b) The inorganic group includes clay, sodium, Port land Cement etc..

(c) organic group includes dextrin, molasses, linsed oil, resin

(c) Moisture / Water:-

(a) In moulding sand 2 to 8% of water will be added. it helps to increases the bond of sand and additives.

(b) The main reason of using water is for developing the strength in the sand.

(d) Additives:- The characteristics of moulding sand are increases by additives. one of the common additive is core sand.

Properties of Moulding Sand

every moulding Sand exhibits different properties. Some of the properties are discussed below.

(a) **Refractoriness:-** (i) It is defined as the ability of moulding Sand to withstand high temperature without breaking down (or) fusion thus facilitate to get sound casting.

(ii) If the moulding Sand didn't have this property the casting surface may burn and no smooth surface can be done.

(iii) The degree of refractoriness is based on SiO_2 i.e. Quartz content, shape and grain size.

(b) **Permeability:- (or) Porosity:-** It is one of the most important property which allows the escape of any air, gases, moisture content in mould when the molten metal is poured into it. and the Permeability of mould can be increases by venting using vent rods.

→ All gases generated during pouring & solidification process must escap otherwise the casting becomes defective.

(c) **cohesiveness:-** the interact and attraction of ~~gate~~ grain Particles in moulding Sand is called as cohesiveness. The Property of Cohesiveness in moulding Sand helps to increases the green strength, dry and hot strength.

(d) **Green strength:-** The green Sand, after water has been mixed into it, must have sufficient strength and toughness to permit the making and handling of mould. so that the Sand grains must be adhesive. i.e They must be capable of attaching themselves to another body. so that the Pattern can be taken out from mould without breaking the mould.

(17)

(e) Dry Strength:- As soon as the molten metal is poured into the mould, the moisture in sand layer adjacent to hot metal gets evaporated and dry sand layer must have sufficient strength to shape in order to avoid erosion.

(f) Flowability (or Plasticity):- Flowability is the ability of sand to get compacted and behave like a fluid. it will flow uniformly throughout the pattern when rammed. and also sand particles resist moving around corners (or) projections.

(g) Collapsibility:- After complition of the solidification and removal of the required object we want to collapse the mould. So that the moulding sand must be have the collapsibility property.

UNIT-1

CASTING

Steps involved in making a casting :-

Casting:- it is the process of obtaining required component by pouring molten metal in the mould cavity and allowing to solidify.

Steds involved in making a casting are,

1.pattern preparation

2.Moulding

3.Melting and pouring the metal

4.solidification

5.removal of casting and fetling

6.machining

7.Heat treatment

8.finishing.

1. pattern preparation :-

A pattern is the replica of the final product required. Therefore, depending upon size, shape and casting process a pattern is prepared with either wood, metal or wax.

Thus, pattern prepared must include all the allowances to obtain a sound.

2. Moulding :-

It is the main step as it involves making of cavity. The steps involved in moulding are as follows,

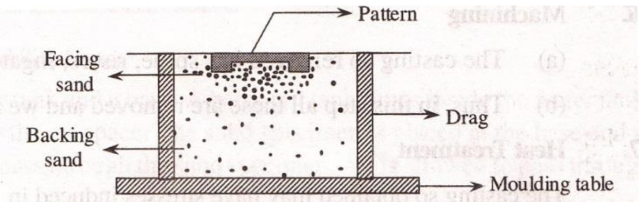


Figure (1): Drag Position

(a) initiay, drag is placed in the inverted position on moulding table.

(b) The pattern is then placed in suitable position inside the drag.

(c) now, parting sand is sprinkled on the pattern and all over drag.

(d) now, facing sand is poured only on pattern and it is pressed thoroughly on the pattern so that every detail of pattern is obtain.

(e) now, backins sand is poured all over the drag and then rammed thoroughly. This is repeated till sand level reaches the surface of drag.

(f) ramming is done all over the drag to get a better mould cavity.

(g) Then, the excess sand is removed using strike- off bar, to maintain a perfect surface level.

(h) using a vent rod, vent holes are made, which allows the air to escape.

(i) now, the drag is again reversed back. This can be seen in figure.

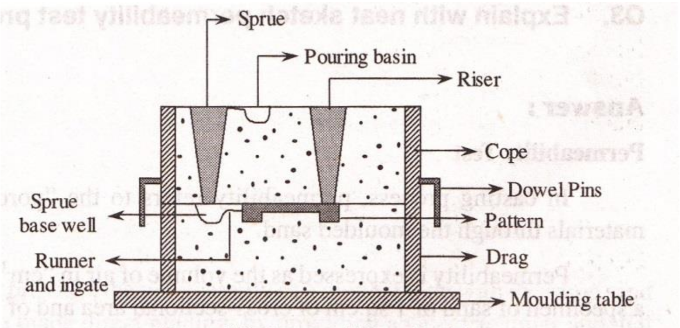


Figure (2): Cope and Drag Position

(j) now, cope is placed exactly above the drag and then parting sand is sprinkled again all over the pattern.

(k) now, the sprue and riser are placed in position in the cope.

(l) sprue is placed beside the pattern, where as the riser should be directly above the pattern.

(m) Facing sand is poured around sprue and riser and pressed throughly to obtain steady position.

(n) now, backing sand is poured all over cope and then ramming is done.

(o) Extra sand is removed using strike- off bar.

(p) now sprue and riser are removed and pouring basin is cut using a gate cutter near the sprue.

(q) above fig shows the arrangement of cope and drag … etc.

(r) Now, the pattern is slowly removed without disturbing the cavity.

(s) Again cope is placed over the drag thus, moulding is obtain i.e., cavity is obtained.

3.Melting and pouring the metal :-

(a) Required metal is melted in oil furnace and then using the saddles molten metal can be transferred into cavity.

(b) care should be taken that metal is poured with uniform velocity, so as to obtain sound casting.

4. solidification :-

In this step, after moltan metal is poured, it is allowed to cool for certain duration, so that induced stresses can be required. Solidification time actualy depends on volume and surface area of casting.

5.Removal of casting and feting :- After the metal gets solidified, casting is removed from the mould and fetling is done.

Fetling is cleaning operation of the cast using a brush to remove the sand particles on it.

6. Machining :-

(a) The casting so removed has sprue, risers, ingates, basewell and pouring basin.

(b) thus, in this step all these are removed and we remain with only the product required.

7. Heat treatment :- The heat treatment is done to relieve these include stresses.

8.Finishing :-

This is the final step where in fine finishing of components is done so as to obtain the dimensional accuracy and surface finish.

Advantages of casting process :-

Advantages of casting process over other manufacturing procee are,

1.it is the most versatile process.

2.difficult and uneconomical shapes may be achieved by casting.

3.metails like castiron difficult to shape by other processes may be eaisly cast.

4.parts which are small or big with intricate shapes can be produced by casting, which is almost not possible by other processes.

5.There is no restrication to the type of metal to be casting as in other production process there may be restrictions (Eg: welding)

6.Even plastics can be casted.

7.surface finish of the product obtained by casting is too high.

8.machining cost can be reduced.

9.component achieves good mechanical properties after casting.

10.cost of casting can be reduced by using mechanical and automatic casting process.

11.number of castings can be obtained at single time.

Disadvantages of casting process:-

1.making of casting needs so much time.

2.In metal casting metal needs to be melted which is a high energy consuming process.

3.metal casting needs more ladder compare to other process.

4.The productivity is less then the other automatic processes, like rolling.

Limitations of casting process:-

1.this process cannot obtain high dimensional accuracies.

2.it is difficult to remove thr deffects which arise due to mositure present in sand casting.

3.several casting defects may arise when moulding and foundary are not performed property.

4.poor surface quality is obtained.

5.more time is required for the casting process.

6. it is high energy consuming process.

7.less productivity is obtained.

Applications:-

1.machine tool beds of lathe .etc..

2.power generaters.

3.Railway crossings.

4.paper mill stock braker parts.

5.air craft jet engine blades.

6.agriculture parts.

7.sanitory fittings to communication,construction and atomic energy applications.

8.turbine vanes(cast iron).

9.mill housings(cast steels).

10.cast parts are used more than 90% in automobile industry and more than 50% of the weight in tractor parts.

What are the composite moulds ? why are they used ?

Composite moulds:-

(i) Moulds which are made of different materials such as shells, sand which binder and graphite are known to be " composite moulds ". Thses types of moulds are extensively used because of their advantages over other moulds.

(ii) They are used extensively because it has advantages of all the materials combined in single mould, that is the reason why different materials are combined together to form a composite mould.

(iii) they are used in shell moulding processes and where a component which with complex shape is to be casted, such as turbine blades etc.

Advantages of composite moulds :-

1. It provides greater strength to a mould.

2. it increase dimensional accuracy.

3.low cost and processing time.

4. Excellent surface finish is obtained.

What is pattern :-

pattern is en element which is used to make cavities in the mould and molten metal is poured in to cavities to produce a casting.

Materials used for patterns:-

The common materials used in pattern making are,

1.wood

2.metal

3.plastic

4.gypsum or quick setting compounds.

1.wood:-

The most commonly used pattern material is wood, the main reason being the easy availablity and the low weight. Also it can be easily shaped and is relatively cheap. But the main disadvantage of wood is its absorption of moisture as a result of which distortions and dimensional changes occur. It is most commonly used for making pattern of sand casting. It is worked easily and readily available.

The different types of wood commonly used for making patterns are pine, teak, maple, birch and cherry.

Advantages:-

1.cost of wood is low compered to their pattern materials.

2.easily available and has low weight.

3.good surface finish can be easily obtained.

Disadvantages:-

1.dimensional inaccuracy.

2.non-uniform in structure.

3.they cannot withstand rough handling.

2.metal:-

metal being more durability and smooth surface finish. Metal patterns are extensively used for large scale casting production and for closer dimensional tolerances. Metal patterns are usually used in machine moulding.

The different types of commonly used metals are castiron,brass, aluminium..etc can be used as pattern materials aluminium and white metal are most commonly used. These are light can be easily worked and are corrosion resistant.

Advantages:-

1.good surface finish.

2.more durable and accurate in size than wood.

3.it can withstand rough handling.

Disadvantages:-

1.costly.

2.not easily repaired.

3.they get rusted.

3.plastics:-

plastic are also used as pattern materials because of their low weight easier formability,smooth surfaces and durability. They do not absorb moisture and are therefore, dimensionally stable and can be cleaned easily. The making of a plastic pattern can be done in sand clay moulds. The most commonly used plastics are cold seting epoxy, polyester resins, phenol formaldehyde… etc most widely used.

Advantages:-

1.makes production process very easy.

2.it does not absorb moisture.

3.surface of patters are smooth.

Disadvantages:-

1.comparatively higher costs of material.

2.cannot withstand high temperature.

4.gypsum:-

gypsum patterns are capable of producing castings with intricate details and to very close tolerances. The main two types of gypsum are soft plastics of paris and hard metal casting plaster. The main characteristics of gypsum are mobility, plasticity and reparability.

Construction of a pattern:-

After finishing the pattern by giving various allowances, the next step of the pattern maker is the shaping of the pieces that are to be used in the construction of the pattern. The method required to be followed depends upon the size and shape of the pattern and number of costings required.

Procedure for pattern constructions.

1.decide the location of parting surface after stusying the layout.

2.after visuolising the shape of the pattern determine the number of separate pieces to be made and the process to be employed for making them.

3.start construction of pattern from the main part of the body. Keep the direction of wood grains along the length of the pattern to get acuracy and strength.

4.different parts are provided adequate draft while cutting and shaping.

5.check all the prepared parts finally by placing them over the prepared layout.

6.outside corners should be rounded.assemble different parts in position by gglusinf or by means of dowels as the case may be:

7.fit all the fillets at desired places.

8.check the relative locations of all the parts assembled on the pattern.

9.check whole of the completed pattern for accuracy.

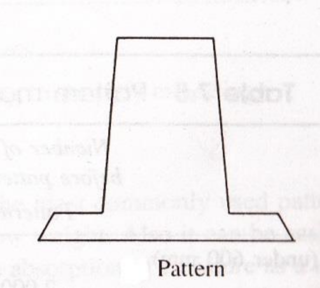
10.finish all the rough surfaces by sanding and give a thin coating of shellac varnish.

11.colour different parts of surfaces with specific colours mixed in shellac or by painting.

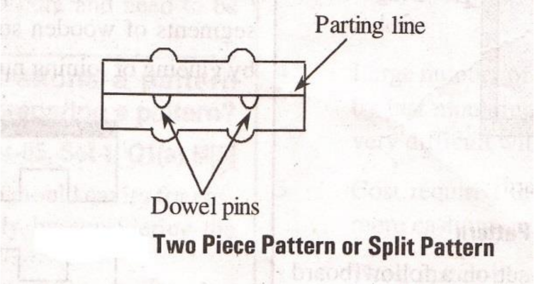
Types of patterns :-

There are various types of patterns depending upon the complexity of the job, the number of castings required and the moulding procedure adopted.

(1) single piece pattern (solid) :- A single piece pattern is made of a single piece and it is not attached to frame. It is also known as solid piece pattern. It is used for small scale production and for casting of simple shapes, single piece pattern is entirely placed in the drag or cope one end of the single piece pattern is flat which is used as the parting plane. It is cheapest and simplest of all patterns.

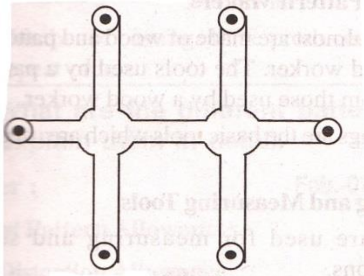


(2) Two piece pattern (split pattern) :- Two piece pattern are usually made in two parts and this is the most used type of pattern for intricate castings. For making a mould using two piece pattern, kept one part of pattern in the drag and other in the cope. It is also known as split pattern. A parting line is formed at the line of separation of two parts. Dowel pins are used to align the true halves properly. Dowel pins are attached to one of the piece of pattern and these pins maten with the holes made in other piece of pattern.



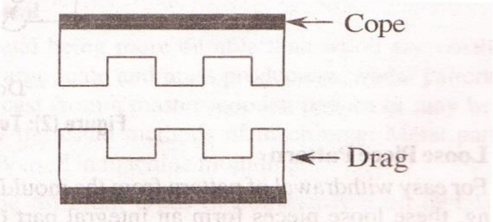
Two Piece Pattern or Split Pattern

(3) Gated pattern :- This is an improvement over the single pattern where the gating and runner system are intefral with the pattern a number of castings by joining gates or runners between the group of pattern.



Gated Pattern

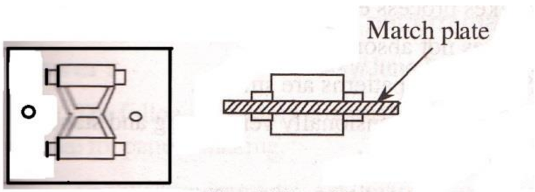
(4) cope and drag pattern :- These are similar to split patterns cope and drag patterns are a combination of two or more pieces. These pattern are also known as built-up patterns. These types of patterns are used for castings which are heavy and inconvenient for handling as also for continuous prosuction.



Cope and Drag Pattern

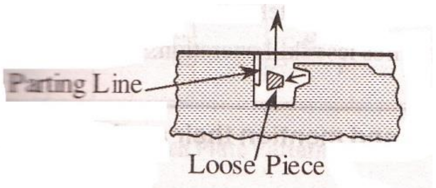
(5) Match plate pattern :- These are extensions of the previous type maten plate pattern is formed by keeping one half piece of pattern on one side of flat plate called maten plate and other half poece on the lther side of the flat plate. The maten plate may carry one pattern or a group of pattern mounted on its two sides.

The complete pattern with match plate is entirely made of metal,usually, aluminium for its light weight and machinability. But when dimensions are critical,the maten plate may be made of steel.these are generally used for small castings with higher dimensional accuracy and large production.



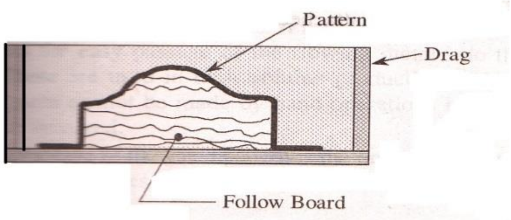
Match Plate Pattern

(6) Loose piece pattern :- A loose piece is attached to the main body of the pattern by a pinor with a dovetail slide. While moulding sand is rammed securely around the loose piece. Then,the pins are removed. The sand is then packed and rammed around the total pattern. When the main pattern is drawn the loose poeces remain in the mould. These patterns are preferred for complex castings. But this type of patterns require more skill to produce and costs more loose pattern shown below.



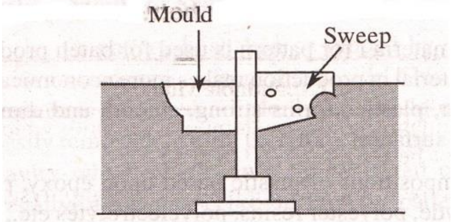
Loose Piece Pattern

(7) Follow board pattern :- A follow board is not a pattern but is a wooden board (device) used for various purposed such as for supporting a pattern which is very thin and fragile, which may break or collapse under the pressure when the sand is rammed above it such pattern is set on a follow board which is shaped to the surface of pattern. It helps to establish a parting plane with ease in a pattern that has an irregular shape.gatted patterns are frequently set on a follow board which is shaped to the parting surface of the mould.



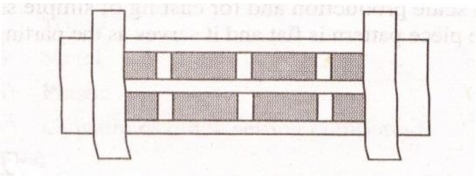
Follow Board Pattern

(8) sweep pattern :- Sweep pattern are used to produce symmetrical moulds. It consists of a wooden board which rotate about a central axis. This types of pattern are used for very large castings.



Sweep Pattern

(9) skeleton pattern :- A skeleton pattern is made of wood (timber) for making a full pattern. It is used for very large castings. The skeleton pattern is constructed with large number of squares of rectangular openings between the ribs. The sand or clay is filled in the frame and then rammed it.after preparing the skeleton is made into two halves. The large castings such as pipe bends,boxes..etc are prepared.



Skeleton Pattern

Pattern colour code:-

The patterns are normally painted with contrasting colours such that the mould maker would be able to understand the functions clearly. The colour code used is :

1.red or orange on surfaces not to be finished and left as cast.

2.yellow on surfaces to be machined.

3.black on core prints for unmachined openings.

4.yellow stripes on black on core prints for machined openings.

5.green on loose pieces and loose core prints.

PATTERN ALLOWANCES:-

The dimensions of the pattern are different from the final dimensions of the casting required. This is required because of various resons. These are detailed as follows.

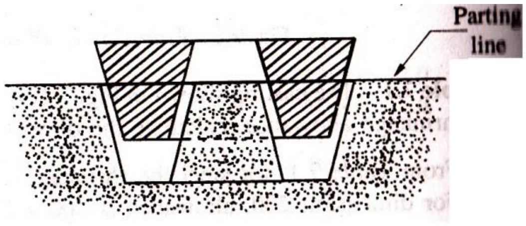
(i)Shrinkage allowance :-

Generally metals shrink in size during solidification and cooling in the mould. So casting becomes smaller than the pattern and the mould cavity. Therefore, to compensate for this, mould and the pattern should be made larger than the casting by the amount of shrinkage. The amount of compensation for shrinkage is called the shrinkage allowance.

Generally shrinkage of casting varies not only with material but also with shape, thickness, casting temperature, mould temperature, and mould strength. Therefore, it is better to determine the amount of shrinkage.

(ii) Draft or taper allowance :-

When a pattern is drawn from a mould, there is always a possibility of injuring the edges of the mould. The slight taper on the vertical sufaces of a pattern is known as the draft. The draft depends upon the method of moulding. The draft is expressed in milimetres per metre on a side or in degrees. The amount of draft needed depends upon (1) the shape of casting, (2) depth of casting, (3) moulding method, and (4) moulding material. Generally, the size of draft is 5 to 30 mm per metre, or average 20 mm per metre. But draft made sufficiently large, if permissible, will make moulding easier.



(3) Finish or machining allowance :-

In case the casting designed to be machined, they are cast over-sized in those dimensions shown in the finished working drawings. Where machining is done, the machined part is made extra thick which is called machining allowance.

Machining allowance is given due to the following reasons:

1. For removing surface roughness, slag, dirt and other imperfections from the casting.

2.For obtaining exact dimensions on the casting.

3.To achieve desired surface finish on the casting.

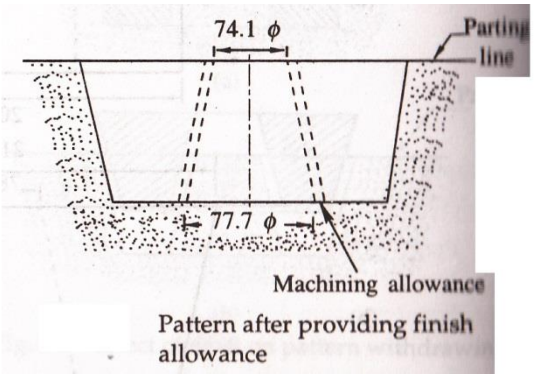
The dimension of the pattern to be increased because of the extra metal required (i.e. finish or

machining allowance) depends upon the following factors:

1.Method of machining used (turning, grinding, boring, etc.).

2. Characteristics of metal (ferrous or non-ferrous, hard and easily machinable or soft).

3. Method of casting used.



Pattern after providing finish allowance

(4) Rapping or Shake allowance :-

A pattern is shaken or rapped by striking the same with a wooden piece from side to side. This is done so that the pattern is loosened a little in the mould cavity and can be easily removed.

When the pattern is shaken for easy withdrawal, the mould cavity, hence the casting is slightly increased in size. In order to compensate for this increase, the pattern should be initially made slightly smaller.

For small and medium sized castings, this allowance can be ignored. But for large sized and precision castings, however, shaking allowance is to be considered. The amount of this allowance is given based on previous experience.

(5) Distortion allowance :-

A casting will be distorted if it is of irregular shape and if all its parts do not shrink uniformly i.e., some parts shrink while other are restricted form doing so. Distortion also arises if the casting is of U or V-shapes, also with long flat casting and which posses arms of unequal thichness and also if one portion of the casting cools at a faster rate as compared to the other.

The amount of distrotion allowance may vary from 2-20 mm depending upon the size, shape and material of the casting.

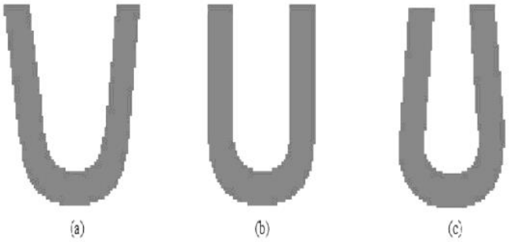


Fig. 1.4 Example of camber: (a) Casting without camber, (b) Actual casting, (c) Pattern with camber allowance

Various elements used in gating system :-

Elementes of a gating system:-

The basic element of gating system are

1.pouring basin

2.Sprue

3.Sprue base (or) well

4.Runner

5.Runner extension

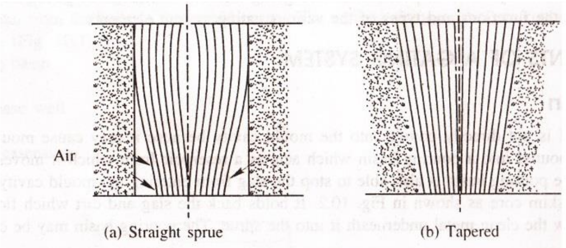
1.pouring basin:-

The molten metal is not directly poured into the mould cavity because it may cause mould erosion. Molten metal is poured into a pouring basin which acts as a reservoiv from which it moves smoothly into the sprue. The pouring basin is also able to stop the slag from entering the mould cavity by means of a skimmer or skim core as shown in fig.

The pouring basin may be cut into the cope portion directly or a separate dry sand pouring basin may be prepared and used as shown in fig.

One of the walls of the pouring basin is made inclined at about 45 degrees to the horizantal.

2.Sprue:-



(a) Straight sprue (b) Tapered

Sprue

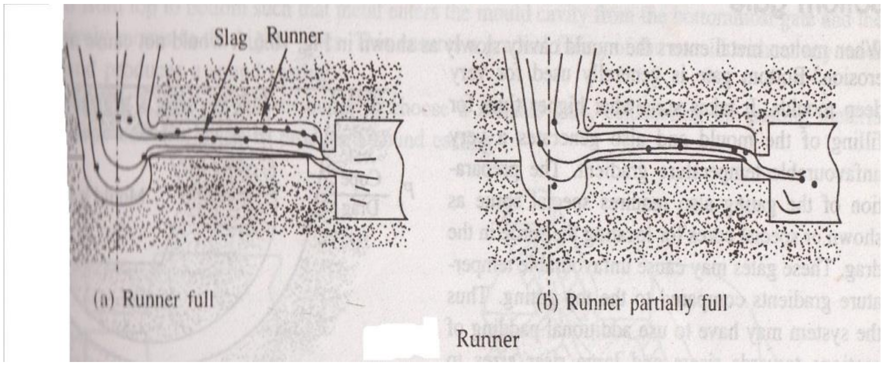
Sprue is the channel. It is used for controlling the flow rate of metal into the cavity of mould. It is the passage through which the molten metal enters the cavity. It is tapered with larger section being at the top and smaller section at the bottom. To avoid the metal damage and air aspiration, the sprue is made of tapered length.

3.Sprue Base (or) well:-

It is a reservoir for metal at the bottom of the sprue to reduce the momentum of the molten metal. The molten metal as it moves down the sprue gains velocity, some of which is lost in the sprue base by which the mould erosion is reduced. This molten metal then changes direction and flows into the runners in a more uniform way.

4. Runner:-

It is generally located in the horizantal plane (parting plane). Which connects the sprue to its ingates,thus letting the metal enter the mould cavity. The runners are normally made trapezoidal in cross section. It is a general practice for ferrous metals to cut the runners in the cope and the ingates in the drag. The main reason for this is to trap the slag and dross which are lighter and thus trapped in the upper portion of therunners.



When the amount of molten metal coming from the down sprue is more then the amount flowing through the ingates, the runner would always be full and slag trapping would take place. But when the metal flowing through the ingates is more then that flowing the runners.

Runner Extension:-

The runner is extended a little further after ingate. This extension is provided to trap the slag in the molten metal. The metal initially,comes along with the slag floating at the top of the ladle and this flows straight, going beyond the ingate and then trapped in the runner extension.

Gates:-

Also called the ingates. Gates are the openings through which the molten metal enters the molten cavity. The shaped and the cross section of the ingate should be such that it can readily be broken off after casting Solidification and also allow the metal to enter quietly into the mould cavity.

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Depending on the application, various types of gates are used in the casting design. They are

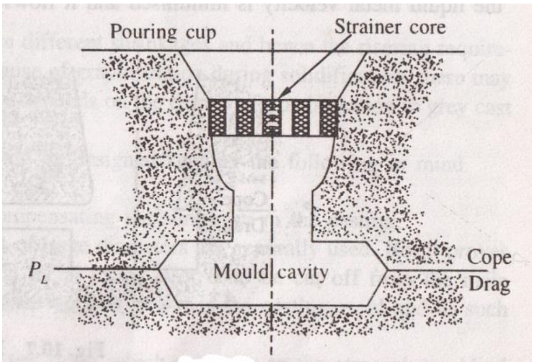
1.Top gate

2.Bottom gate

3.parting gate

4.step gate

1.Top gate :-

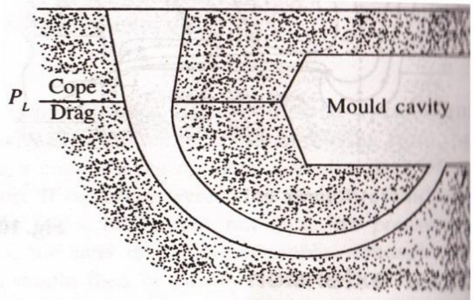


Top gate

This is the type of gating through which the molten metal enters the molten cavity from the top as shown in fig. since the first metal entering the gate reaches the bottom and hotter metal is at the top, a favourable temperature gradient towards the gate is achieved. Also, the mould is filled very quickly. But as the metal falls directly into the mould cavity through a height, it is likely to cause mould erosion. Also, because it causes turbulence in the molud cavity.

It is not suggested for non-ferrous materials and is suggested only for ferrous alloys. It is suitable only for simple casting shapes which are essentially shallow in nature.

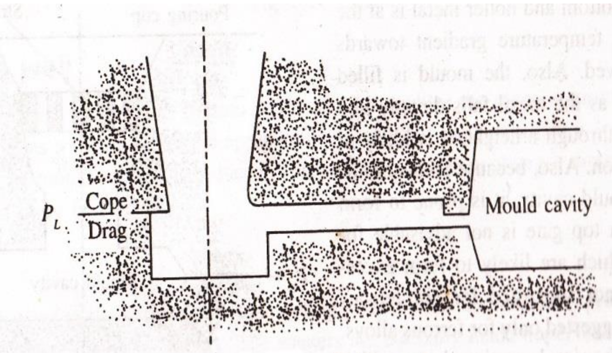
2.Bottom gate :-



Bottom gate

when molten enters the molud cavity slowly as shown in figure. It would not cause any molud erosion. In bottom gate system the metal flows from down i.e., from drag portion and enters from the base of the cavity. This system is generally used for large sized casting and when compared to top gate there is no scoring and splashing of metal occurs in bottom gate, little turbulence of metal and good casting surface is obtained. It has some disadvantages like directional solidification is difficult and involves greater complexity of the mould.

3.parting gate :-

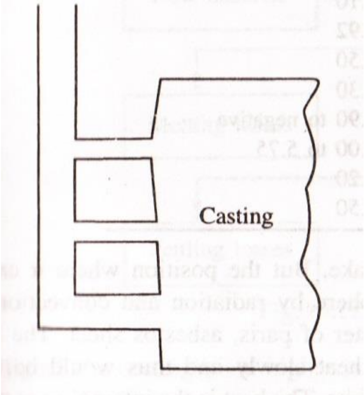


Parting gate

This is most widely used gate in sand casting. parting gate is considered as the best from top and bottom gating systems. Here the metal enters the mould at the parting plane when part of the casting is in the cope and a part in the drag as shown in figure. For the mould cavity in the drag it is a top gate and for the cavity in the cope it is a bottom gate. This is also simple and most economical in preparation.

However, if the drag portion of the mould cavity is deep, it is likely to cause mould erosion.

4.step gate:-



Step gate

step gates are used for heavy and large castings. The molten metal enters the mould cavity through a number of ingates. Which are arranged in vertical steps. The size of ingates are normally increased from top to bottom such that metal enters the mould cavity from the bottom. This ensures a gradual filling of the mould without any mould erosion and produces a sound casting.

Gating Design:-

Also called the ingates. Gates are the openings through which the molten metal enters the molten cavity. The shaped and the cross section of the ingate should be such that it can readily be broken off after casting Solidification and also allow the metal to enter quietly into the mould cavity.

The liquid metal that runs through the various channels in the mould obeys the Bernoulli's theorm which states that the total energy head remaing constant at any section.

h+—+— = constant

Where h=potential head,

P=pressure,

V=liquid velocity,

W=specific weight of liquid,

G=gravitational constant on earth 9.8 m/s

Another law of fluid mechanics, which is useful in understanding the gating system behaviour. That is

Q=A =A

Where,

Q=rate of flow

A=area of cross section

V=velocity of metal flow.

Gating ratios:-

The gating ratio refers to the proportion of the cross sectional areas b/w the sprue, runner and ingates and is generally denoted as sprue area runner area: ingate area.

Depending on the choke area there can be two types of gating systems.

1. Non –pressurised
2. Pressurised

1.Non pressurised gating system:-

Gating ratio 1:2:3 comes under non-pressurised system. This reads to unsound casting as the gate is not fully filled (or) occupied by metal.

2.pressurised gating system:-

Gatting ratio 4:3:2 comes under pressurised system. Because ,the areas are so arranged that a back pressure is maintained on the metal.

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