CHAPTER - 2

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Moulding sand

Moulding sand is one of the most important materials in production of sand casting because of the following advantages:-

(i) It can withstand high temperature without decomposition.
(ii) In most state it can be easily packed to any shape.
(iii) It permits the gases, air and steam formed in the mould to escape.
(iv) It does not chemically react with the molten metal.

- Sand is formed by breaking up of rocks due to natural forces such as frost, wind, rain and action of heat.

In nature it is found on the bottom and banks of rivers and lakes.

Sand obtained from different localities vary in colour and composition.

Types of Moulding sand

(a) According to the Nature of origin

(1) Natural sand : It is also called green sand and is obtained from natural resources such as river beds.

- Natural molding sands contains sufficient amount of binder materials.
- Natural sands contains binding materials (5-10% clay)
- water or moisture content (5-8%)
- less refractory as compared to synthetic sand.
- lesser cost as compared to synthetic sand.

2) Synthetic sand

- Synthetic molding sand are prepared artificially using basic sand molding constituents (silica sand) in 85-95%, binder 6%-10% and water (2-8%)
- A synthetic sand consists of - Natural sand, binder bentonite and moisture.
- It posses greater refractoriness.
- Thus synthetic sand is a formulated sand. Sand formulation is done in order to aquire certain desired properties not possessed by natural sand.

3) Loam sand [More clay 50%, fine sand, for sweep, skeleton pattern]

- Loam sand contains much more clay as compared to ordinary sand.
- clay content is 50% or so.
- Ingredients of loam sand may be fine sands, finely grounded refractories, clay, graphite & moisture.
- Loam dries hard.

(b) According to the use, moulding sand may be classified as below :-

(i) Green sand : (small sizes) (Moist, 5% water, 15-25% clay, squeeze by hand)

- The green sand is the natural sand containing sufficient moisture in it.
- It is a mixture of silica and 15 to 30% clay with about 8% water. clay and water act as a bonding materials to give strength. Molds made from this sand are known as green sand mould.
- The green sand is used only for simple and rough casting products. It is used for both ferrous and non ferrous metals.
- A green sand mold possesses lower strength and lower permeability.
- Intricate shapes can be produced in green sand molds.
- Green sand mold offer less resistance to the solid shrinkage of casting and thus the casting do not crack or tear while solidifying.

(ii) Dry sand [Less water, More thermal strength, less defects, big casting] more expensive

- When the moisture is removed from green sand, it is known as dry sand.
- The mould produced by dry sand has greater strength, rigidity and thermal stability.
- This sand is used for large & heavy casting.
- They are more expensive and consume more time in making as compared to green sand moulding.

- They posses high permeability as compared to green sand.

(iii) Facing sand [cover pattern, face of mold cavity, Direct content with metal].

- A sand used for facing of the mould is called facing sand.
- It consists of silica sand and clay, without addition of used sand.
- It is used directly next to the surface of the pattern.
- Facing sand comes in direct contact with hot molten metal, therefore it possess high refractoriness and strength. It has very fine grains.
- Facing sand may have a thickness 2 to 3 cm.
- The consists of 25% fresh cast iron, 70% old sand and 5% sea coal.

(iv) Backing sand: [baked facing sand, doesn't contact pattern].

- The backing sand is old and backing sand has black colour and is sometimes known as black sand.
- It is used to back up the facing sand and to fill the whole volume of the box.
- This sand is accumulated on the floor after casting and hence also known as floor sand.
- It does not come in contact with the portion.
- It is an aged sand which cannot produce a strong bond and has possibly changed it grain-shape and colour because continuous use.

(v) Parting sand [Dry silica, between cope & drag, sprinkled on pattern].

- A pure silica sand employed on the faces on the pattern before moulding is known as parting sand.
- When the pattern is withdrawn from the mould, the moulding sand sticks to it
- To avoid sticking, parting sand is sprinkled on the pattern before it is ~~used~~ embeded in the moulding sand. Parting sand is also sprinkled on the contact surface of cope, drag and cheek.
- It is sprinkled on pattern and ~~parting~~ surface for easy removel.

(vi) System sand: The sand employed in mechanical heavy casting and has high strength permeability and refractoriness is known as system sand.

- It is used for machine moulding to fill the whole flask.
- In machine moulding no facing sand is used. The system sand is cleaned and has special additives.

(vii) Core sand: [To make cavity].

- A sand used for making cores is known as core sand.
- It is silica sand mixed with core oil (linseed oil, resin, mineral oil) and other binding materials (~~deter~~ deretrine, corn flour, sodium silicate)
- It has remarkable compressive strength.

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Ingrediants of Moulding sand :

(i) Refractory sand : • Silica sand • Magnesite • Zircon • Dolomite • Sillimanite • Graphite specially sand is the best moulding sand.

(ii) Binders : • Binders hold the sand grains.
• It increases the strength.
• clay binders are most commonly used for binding molding sand.
• clay can be classified as :
(a) Fire clay (b) iron oxide (c) limonite
(d) Bentonite : used to imparts plasticity and green strength.
(e) Kaolinite : for additional plasticity
(f) chemical binders : Resins and Sodium silicate

(iii) Water : • It is added to increase the plasticity and strength of the clay upto certain limit (2-8%).
• The amount of water vary from 2-8%.
• It provides moldability but it reduces strength of the sand mixture.

(iv) Additives :
(a) Coal dust - Improve surface finish and reduce metal penetration
(b) Dextrine and cereal - Increase dry strength.
(c) Iron-oxide - develop hot strength

P.No. - Permeability No.

V = Vol^m of air passing through specimen
H = Height of specimen
P = Pressure of air (g/cm^2)
A = C.S area of specimen (cm^2)
T = time taken for air to pass

(d) Diethyleneglycol : improve casting surface finish.

(e) Silica flour : improve surface finish, hot strength, resist metal penetration etc.

(f) Fuel oil : Improve moldability

(g) Graphite powder : Reduces mold - metal interaction.

Properties of Molding Sand.

(1) Refractoriness : It is the ability of the molding sand to withstand high temperature without breaking down or fusing.

(S.O.) larger grain size.

(2) Permeability : The ability of the moulding sand to allow gases and steam to escape through its pores.

Importance :- Prevent defects like gas porosity or blowholes in the casting.

P.No. = $\frac{V \times H}{P \times A \times T}$

(3) Cohesiveness : Cohesiveness is property of molding sand by virtue which the sand grain particles interact and attract each other within the molding sand. Thus, the binding capability of the molding sand gets enhanced to increase the green strength, dry strength and hot strength property of molding and core sand.

(4) Collapsibility: The ability of the molding sand to breakdown easily after solidification of the casting.

Importance: facilitates easy removal of the casting from the mold and prevents damage to the casting.

(5) Flowability or plasticity: It is the ability of moulding sand to flow on all parts of cope and drags mould box during uniform ramming.

- In general, flowability increases with decrease in grain size of sand.
- Flowability increases as clay and water contents increases.

(6) Adhesiveness: Adhesiveness is a property of molding sand to get the stick or adhere to foreign material such sticking of molding sand with the inner wall of molding box.

(7) Durability: The molding sand should possess the capacity to withstand repeated cycles of heating and cooling during casting operations.

- Molding sand should be reusable.
- Molding sand should be chemically immune to molten metals.
- It should be easy to prepare and control the molding sand.

(8) Co-efficient of expansion :

- Molding sands should posses low co-efficient of expansion.

Cores :- A core can be defined as 'a body of sand placed suitably in the mould to form a internal cavity of desired shape and size in a casting. The use of cores enables to form complex internal cavities in the casting and eliminates much machining.

- core may also be made of metal, plaster of paris, sand or ceramics materials etc.

Uses or purposes / function of cores :-

- To form internal cavities in casting.
- To strengthen or improve mould surface.
- complete moulds of complicated shapes can be prepared of core sand forms, so machining is reduced or even eliminated.
- May be used as a part of the gatting system.
- May be used to locate other cores, as a support for caplets to hold chills or to strengthen the mould.
- cores may be employed to improve the cavity surface finish.
- Cores may be inserted to achieve deep recesses in the casting.
- Cores may be used to form the gating system of large size moulds.

Importance of cores

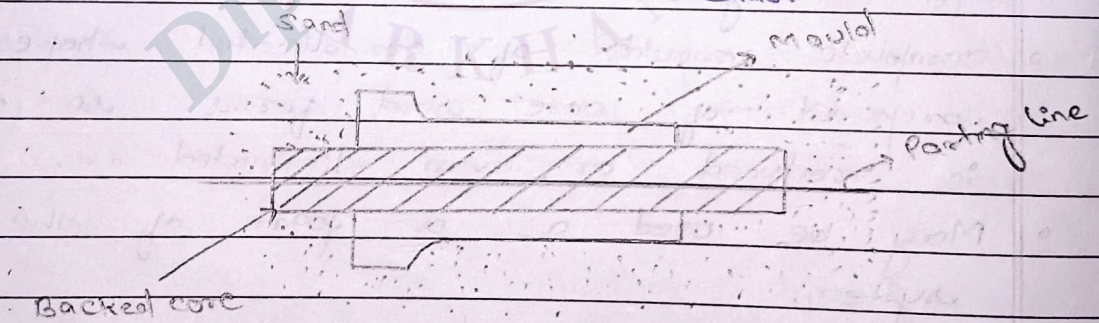
1. Formation of Hollow sections
2. Achieving complex shapes
3. Reducing material usage
4. Enhancing design flexibility.
5. Improving casting Accuracy
6. Supporting Mass production
7. Reducing Post - casting processes
8. Facilitating functional features.
9.

Types of cores:

(a) Horizontal cores (b) vertical core
(c) Hanging and cover core (d) Balanced core.

(a) Horizontal cores:

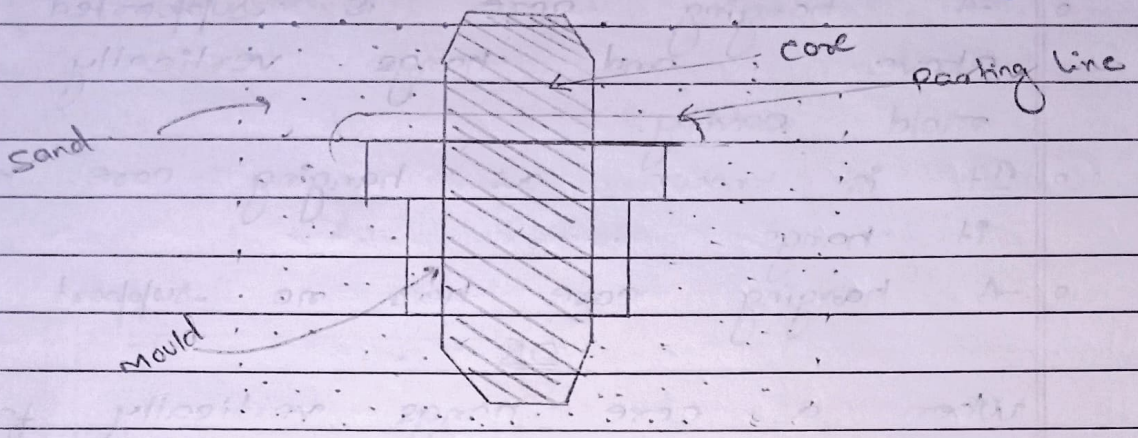
A Horizontal cores is positioned horizontally in the mould, generally at the parting line. it is supported in the mould at its both ends.



(b) vertical core: A vertical core is positioned vertically in the mold with major portion in the mould at its both ends.

- The two ends of a vertical core are supported

in core seats in cope and drag respectively.



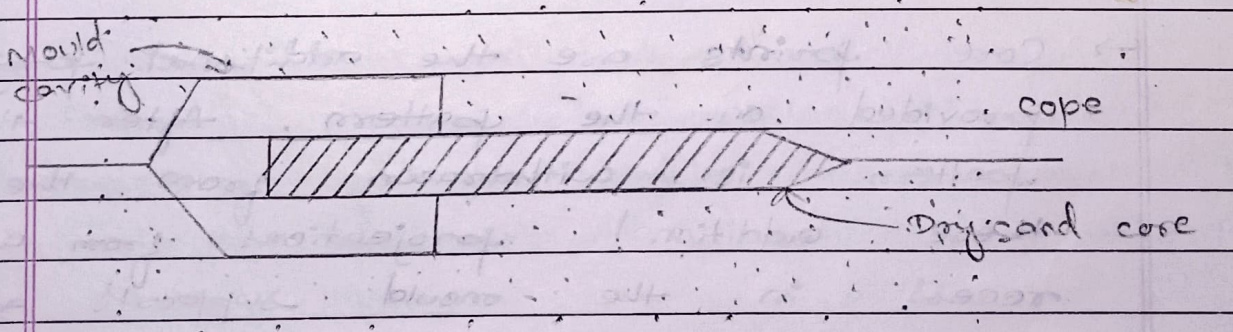
(c) Balanced core : This type of core is used when a blind hole along horizontal axis is required.

i) It is supported at only one end, the embedded portion has sufficient length

ii) If the core is to much long, it is to be supported at both ends (by using chaplets)

OR

- A balanced core is one which is supported and balanced from its one end only
- A balanced core require a long core seats so that the core does not sag or fall into the mold.



(d) Hanging or Cover core

- A hanging core is supported from above and hangs vertically in the mold cavity.
- It is known as hanging core because it hangs.
- A hanging core has no support from bottom.

OR

When a core hangs vertically from the cope without any support on the drag it is called hanging core such core is held in position by means of wires or rods. When a core hangs vertically but has its support on the drag it is called cover core.

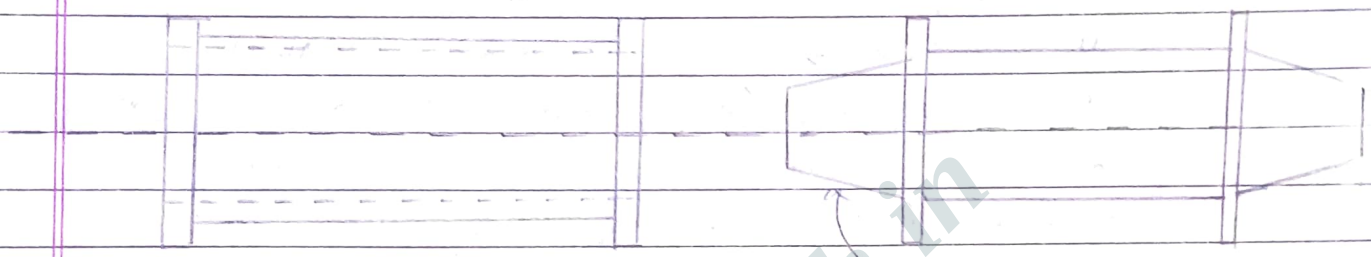
* Core Prints [Provide alignment & location, prevent core movement during casting, ensure proper core positioning]

- Core prints are extra projection provided on the pattern.
- Core prints form core seats in the mould.
- Core seats supports the core against the buoyancy of molten metal.

OR

↳ Core prints are the additional projections provided on the pattern. After the pattern is withdrawn from the mould these additional projections form a recess in the mould supports and locates the core in the proper position

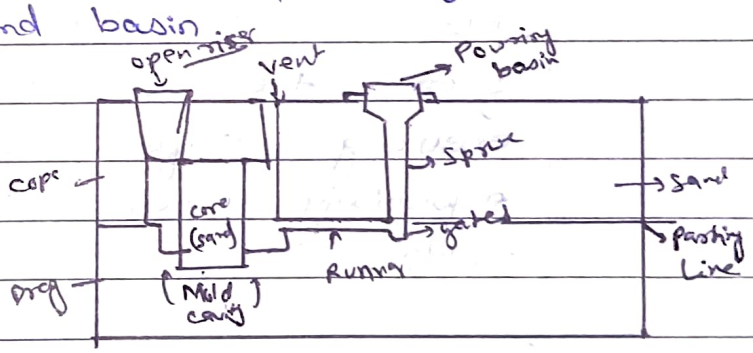
↳ The Core print thus forms a seat for the core in the mould. The size and length of the cores print should be sufficient to support the weight of core during the pouring of molten metal in the mould.



casting to be produced — pattern core prints

Gating System

- Gating system are channels through which molten metal flows into the mold cavity.
- The gating system is composed of
  (a) Pouring cup and basin
  (b) Sprue
  (c) Runner
  (d) Gates
  (e) Riser



(a) Pouring cup and basin :
Pouring basin is desined to reduce the velocity of the liquid metal, which is enter into the sprue to minimize erosion.

↳ it acts as a reserviour
↳ To stop the slag by skimmer / skim core.

(b) Sprue : it is a cylindrical hollow space which is connected betn pouring basin to runner.

(c) Runner : Runner is a critical component of the gating system in metal casting and molding processes. It is the horizontal channel that connects the sprue (the vertical channel through which molten materials ~~enters~~) to the ingates (the entry points into the mold cavity). The runner facilitates the distribution of molten material from the sprue to various parts of the mold, ensuring that the cavity is filled evenly.

Importance of the Runner in casting :-

- (Runner distribute the molten metal or plastic from the sprue to multiples ingates) ensuring uniform filling of the mold cavity especially for complex or multi-cavity molds.

- (A well-designed runner minimizes turbulence in the molten material), preventing air entrapment and reducing the likelihood of defects like porosity ~~on~~ or cold shuts.

- (Runners control the speed and direction of the molten material), ensuring a smooth

flow into the mold cavity without sudden velocity changes that could cause defects.

- To minimize the heat transfer losses of the liquid metal, shape of the runner considered as cylindrical shape.

(d) Gate / Ingate :

- Ingate refers to a critical component in casting and molding processes, specifically within the context of metal casting.
- A Ingate is a channel which connects runner with mold cavity through which molten metal flow to fill the mold cavity.
- The gate should not have sharp edges as they can crack during pouring so that the sand can be caught in the molten metal into the mould cavity.

Importance of gates :-

- The ingates insures a controlled and uniform flow of molten material into the mold cavity. Proper design minimizes turbulence, which can cause defects such as porosity or incomplete filling.
- The ingate reduces the likelihood of defects like cold shuts, air entrapment

or uneven cooling.

- The ingate helps direct molten metal efficiently into the mold cavity, reducing material waste and improving the yield of the casting process.
- A well designed ingate avoids premature solidification or shrinkage defects in critical process.
- Proper placement and sizing of the ingate simplify the removal of excess material after casting, reducing post-processing costs and efforts.

Types of gates :-

(i) Top gate (ii) Bottom gate (iii) Parting line gate

(i) Top gate: A top gate is also sometimes also called as Drop gate because the molten metal just drops on the sand in the bottom of the mould.

↳ In a bottom gate, liquid metal fills rapidly the bottom portion o

↳ In top-gate, a stream of liquid metal impings against the bottom of the mold cavity until a pool is formed and this is kept in a state of agitation until the mold is filled.

(ii) Bottom gate :→ A bottom gate is made in the drag portion of the mold.

↳ In the bottom gate, liquid metal fills rapidly the bottom portion of the mold cavity and rises steadily and gently up the mold walls.

(iii) Parting line gate :

↳ In parting line gates, the liquid metal enters the mold cavity from the skate of the mold (cavity) at the parting line separating cope and drag.

↳ Parting line gate can be made by the pattern itself or it can be cut afterwards.

↳ As regards fluid flow, parting line gates stand in betn top and bottom gates.

(e) Riser : → Riser is a source of extra metal which flows from riser to mold cavity to compensate for shrinkage which takes place in the casting when its starts solidifying.

Functions of Riser :

- Provide extra metal to compensate for the volumetric shrinkage.
- Allow mold gases to escape.
- Provide extra metal pressure in the solidifying mold to reproduce mold details

more exact.

- Riser promote directional solidification.

Types of Riser in casting :-

(i) Top riser or open riser
(ii) Blind Riser or Internal Riser

(i) Open riser :- The open riser is at the top position and is open to the atmosphere during the casting process.

- The liquid metal in the riser is fed to the solidify casting under force of gravity and atmospheric pressure till the top pressure of the riser solidifies.
- An open riser is connected either at the cope or on the side at the parting line.

(ii) Blind Riser :

- A blind Riser is closed at its top.
- An internal or blind riser is made enclosed internally in the mould.
- Gravity is the only feeding force.
- Blind riser has slow heat dissipation and less heat loss as it is an internal part of the mold.
- The riser should be properly vented

- to remove gases from the mould otherwise vaccum created betn top of the riser and liquid metal level.
- The heat from the mould maintains the temperature gradient of the riser and molten metal in it.