MODULE I

FOUNDRY

CASTING

- Casting is a manufacturing process by which the required shape and size of final product is obtained by pouring a molten liquid material into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify.

- The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process.

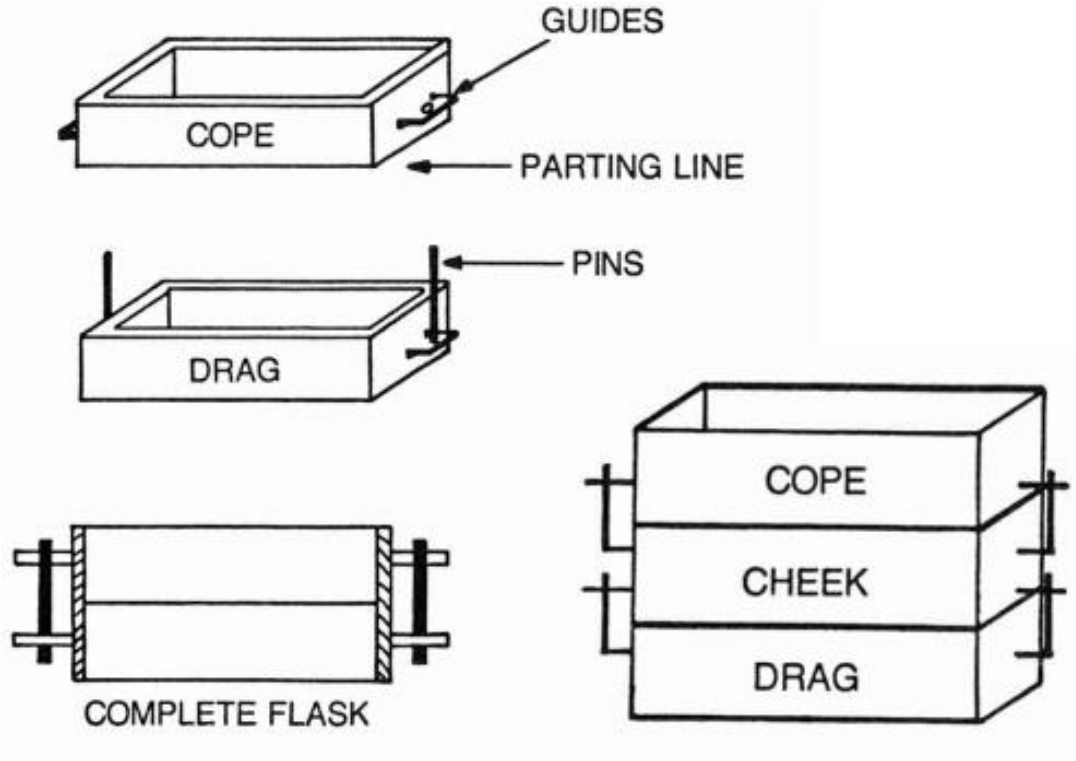
- Casting materials are usually metals.

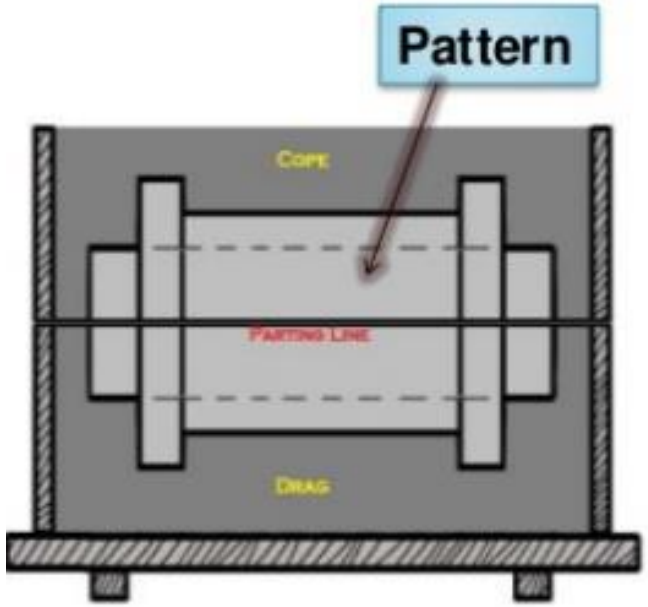
- Almost all metals can be cast.

- Casting is most often used for making complex shapes that would be otherwise difficult to make by other methods.

SAND CASTING TERMS

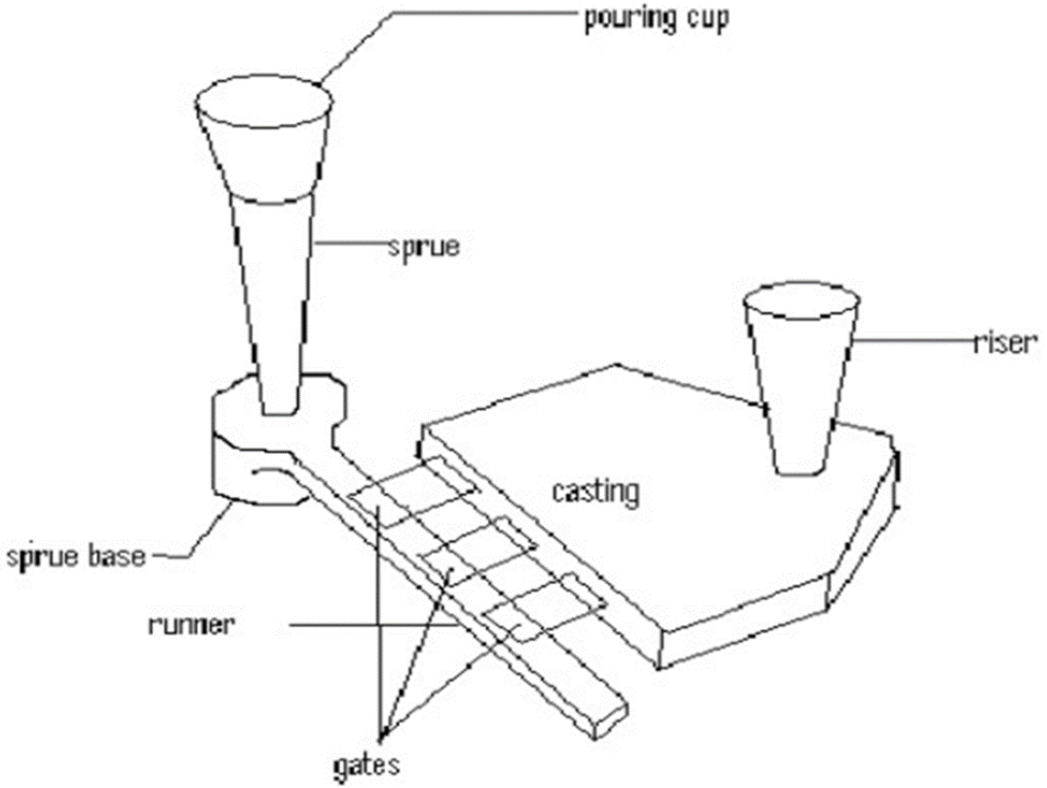
- Flask: A metal or wood frame, in which the mold is formed.
- Drag - lower molding flask,
- Cope - upper molding flask,
- Cheek - Intermediate molding flask used in three piece molding.
- Pattern: It is the replica of the final object to be made. The mold cavity is made with the help of pattern.
- Parting line: This is the dividing line between the two molding flasks that makes up the mold. Pattern





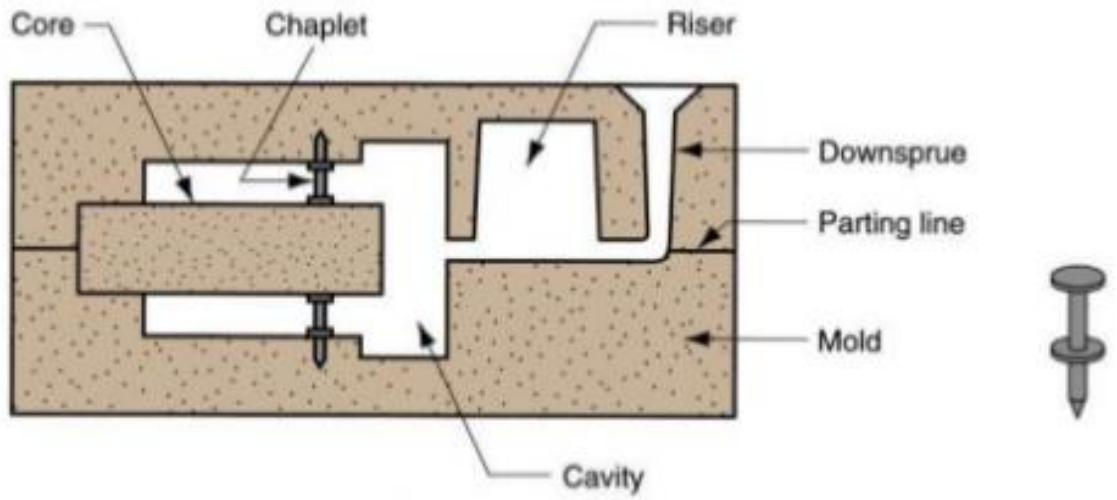
CASTING TERMS

- Pouring basin: A small funnel shaped cavity at the top of the mold into which the molten metal is poured.
- Sprue: The vertical passage through which the molten metal, from the pouring basin, reaches the mold cavity. In many cases it controls the flow of metal into the mold.
- Runner: The channel through which the molten metal is carried from the sprue basin to the gate.
- Gate: A channel through which the molten metal enters the mold cavity.
- Riser: A column of molten metal placed in the mold to feed the castings as it shrinks and solidifies. Also known as feed head.

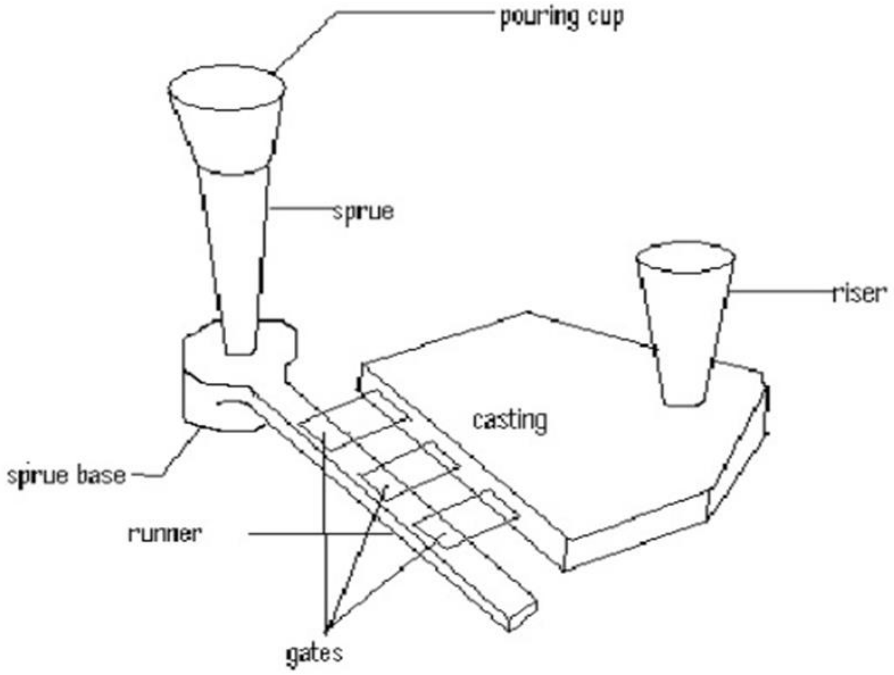


CASTING TERMS

- Core: A separate part of the mold, made of sand and generally baked, which is used to create openings and various shaped cavities in the castings.
- Chaplets: Chaplets are used to support the cores inside the mold cavity to take care of its own weight and overcome the metallostatic force.
- Vent: Small opening in the mold to facilitate escape of air and gases.



Gating system



- The term gating system refers to all passageways through which the molten metal passes to enter the mould cavity.
- It consist of

1) Pouring basin

- A pouring basin makes it easier for the ladle or crucible operator to direct the flow of metal from crucible to sprue.
- Helps maintaining the required rate of liquid metal flow.
- Reduces turbulence at the sprue entrance.

2) Sprue

- The vertical passage through which the molten metal, from the pouring basin, reaches the mold cavity through gates.
- A sprue is tapered with its bigger end at top to receive the liquid metal. The smaller end is connected to runner.

3) Sprue base

- It act as reservoir for molten metal and trap loose sand other desirable particle entering the mould

4) Runner

- It is a passage provided in large casting through which molten metal is carried from the sprue basin to several gates
- It usually provided in the drag portion

5) Gates

- A gate is a channel which connects runner with the mould cavity

6) Risers

- Riser is a passage made in the cope through which molten metal rise after the mould is filled up

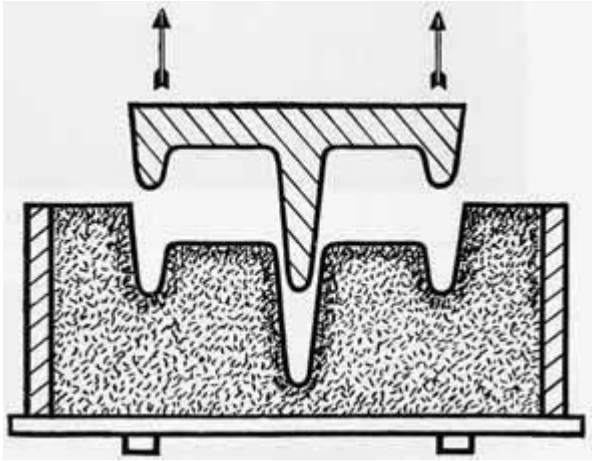
Pattern

A pattern may be defined as a model of desired casting which when molded in sand forms an impression called mould

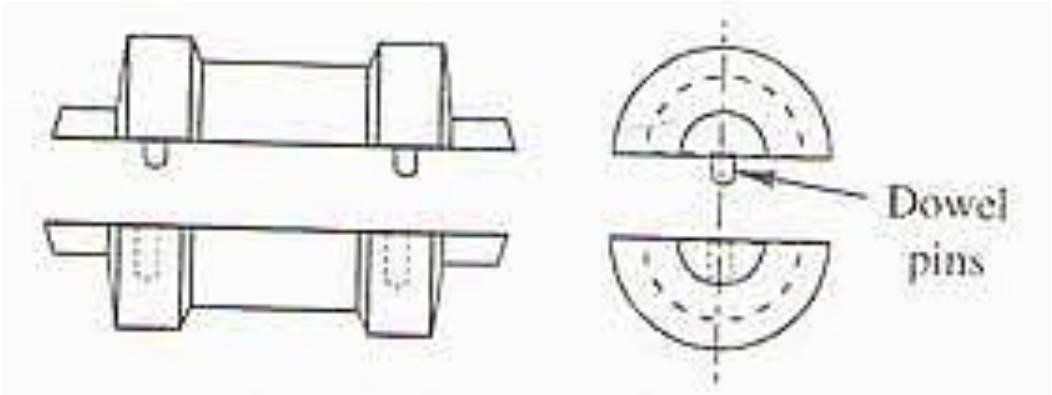
Types of pattern

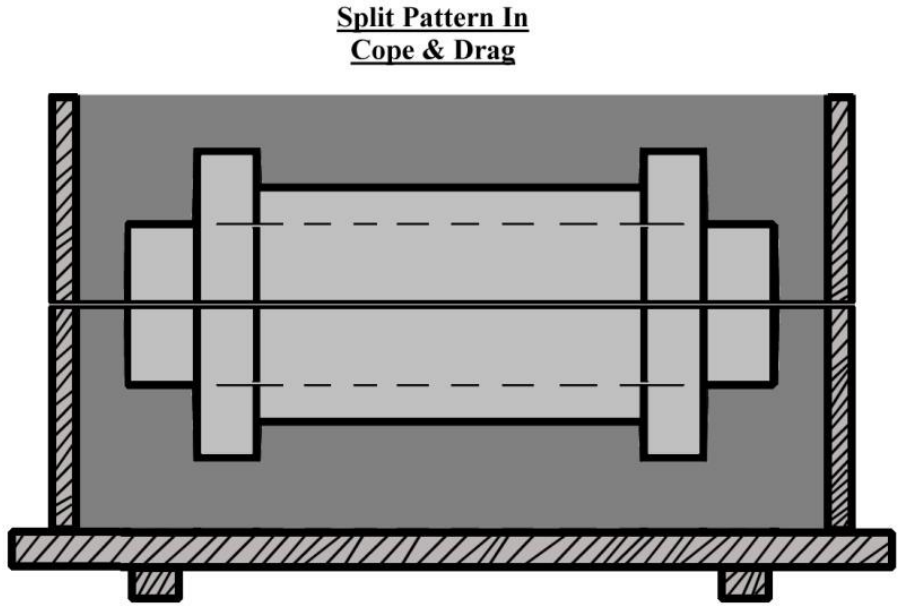
1.Single piece pattern

- This is the simplest type of pattern, exactly like the desired casting.
- For making a mould, the pattern is accommodated either in cope or drag.
- Used for producing a few large castings having simple geometry



2.Spilt pattern



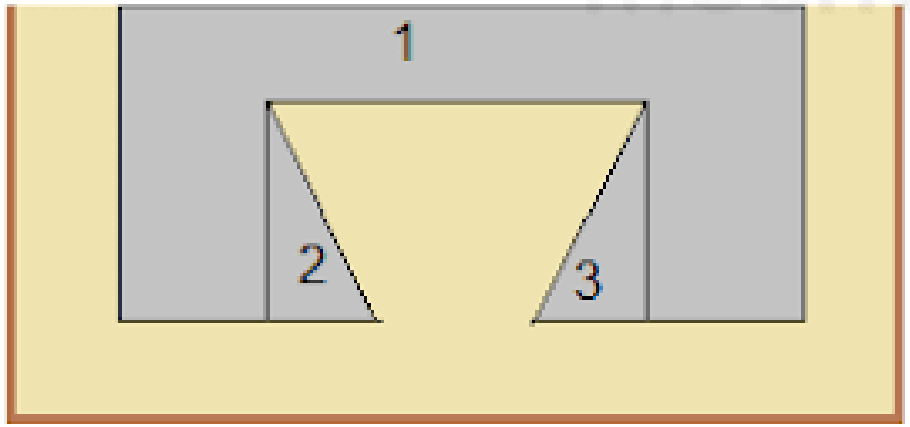


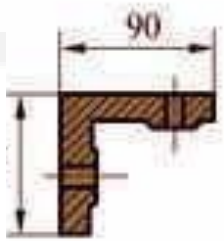
- These patterns are split along the parting plane (which may be flat or irregular surface) to facilitate the extraction of the pattern out of the mould before the pouring operation.

- For a more complex casting, the pattern may be split in more than two parts.

Loose piece pattern:

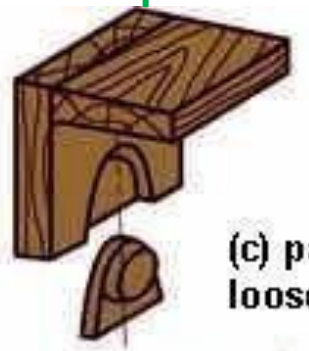
- Certain patterns cannot be withdrawn once they are embedded in the molding sand. Such patterns are usually made with one or more loose pieces for facilitating extract from the molding box and are known as loose piece patterns.
- The main body of the pattern is drawn first followed by loose piece



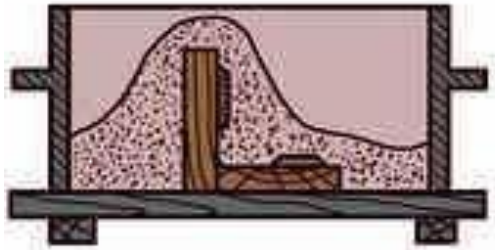


a) drawing

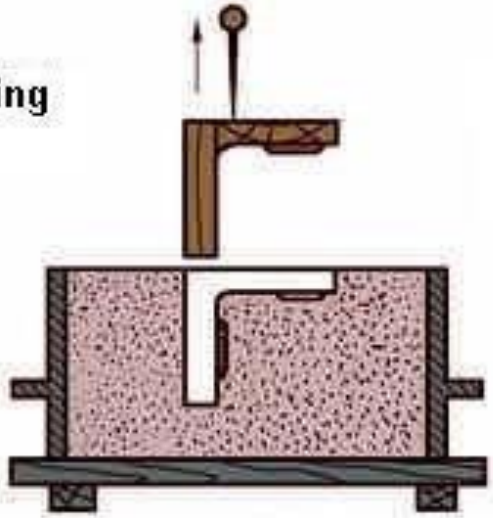
(b) casting



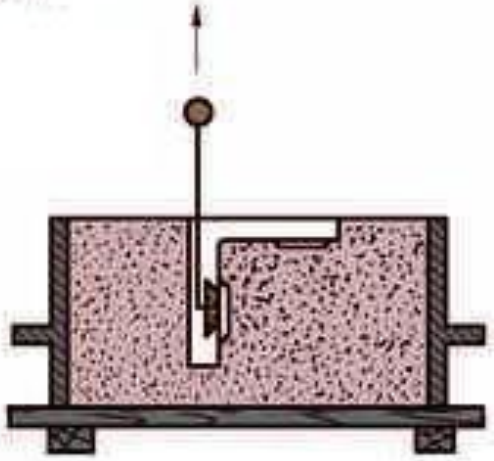
(c) pattern with loose piece



(d) make bottom mold



(e) pull out pattern

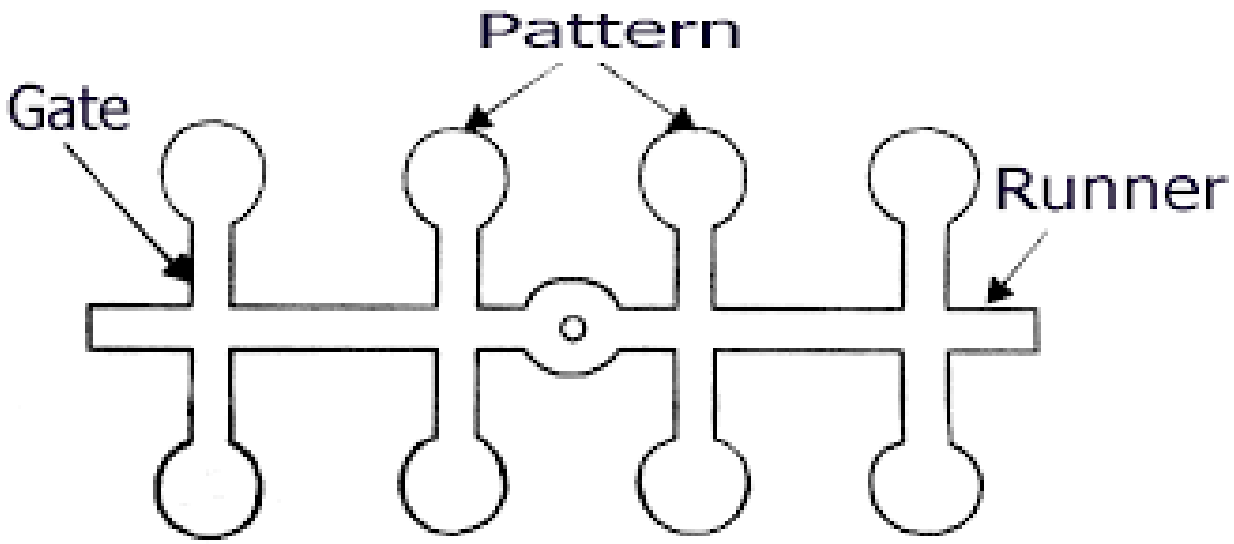


(f) pull out loose piece

Gated pattern:

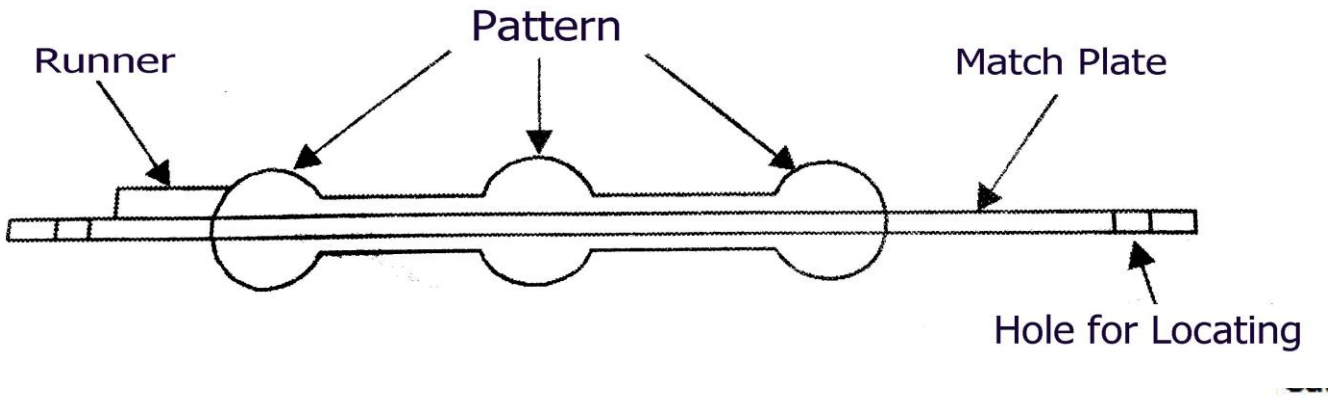
- A gated pattern is simply one or more single piece patterns having attached gates and runners.

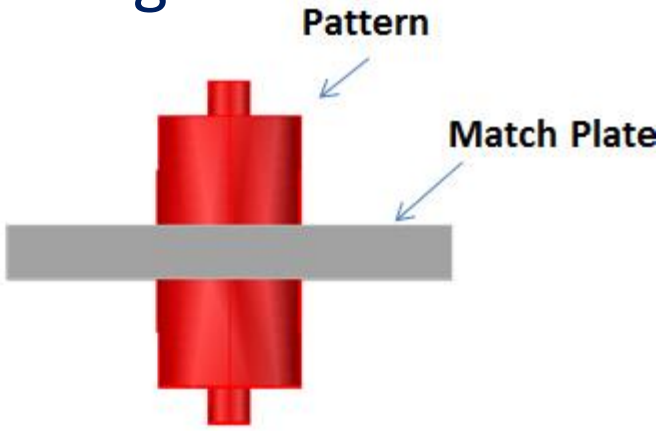
- Because of their higher cost, these patterns are used for producing small castings in mass production systems and on molding machines.



Match plate pattern

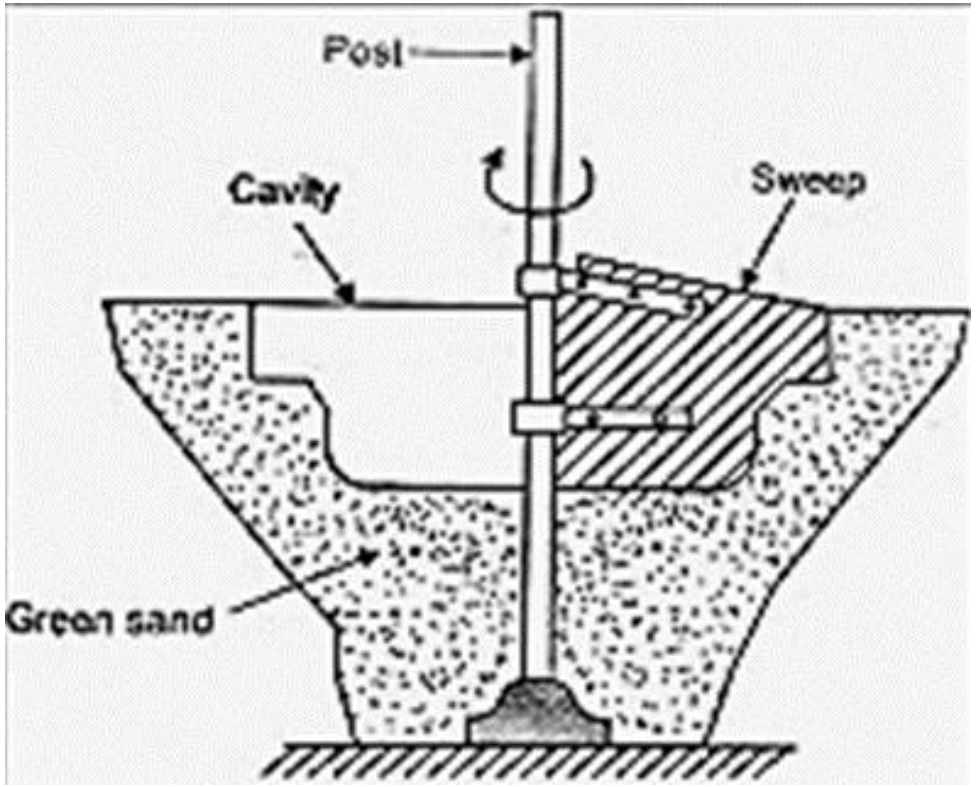
- It consists of a match plate, on either side of which each half of split patterns is fastened.
- The match plate with the help of locator holes can be clamped with the drag.
- After the filling the molding sand, the match plate pattern is removed from the cope and drag.
- Match plate patterns are normally used in machine molding.
- By using this we can eliminate mismatch of cope and drag cavities





Sweep pattern

- It is used for generating large shapes which are axi-symmetrical.
- Making a sweep pattern saves a lot of time, money and labour as compared to making a full pattern



Pattern Material

Wood

It is the most common material used for pattern making because of the following

Advantages:

(i) It is cheap and available in abundance.
(ii) It can be easily shaped into different forms and intricate designs.
(iii) Its manipulation is easy because of lightness in weight.
iv) Good surface finish can be easily obtained by only planning and sanding.

Disadvantages

(i) It wears out quickly due to its low resistance to sand abrasion.
(ii) It is very susceptible to moisture, which may lead to its warping or splitting.
(iii) Its life, owing to the above reasons, is short as compared to other pattern materials.

This confines its use to such cases only when a small number of castings are required

Metals :

- Metals are used with advantage, as pattern material, only when the number of castings to be made is very high and a closer dimensional accuracy is desired.

Advantages

1.They have a much longer life than wooden patterns and eliminate the inherent disadvantages of wood to a great extent.

2.High dimensional accuracy

3. Does not absorb moisture and do not change their shape and size.

Disadvantages:

(i) They are costlier than wood and, therefore, cannot be used with advantage, where a smaller number of castings is to be made.

(ii) Most of them are very heavy and in case of large castings the weight of the pattern always poses a problem in its manipulation.

(iv) A large number of them have a tendency to get rusted

Plaster of parris

- Plaster of parris or Gypsum is used in making small patterns and core boxes involving intricate shapes and closer dimensional control

- **Advantages:**
  - Plaster of Paris or gypsum cement is advantageously used as a pattern material since it can be easily casted into intricate shapes and can be easily worked also.
- **Disadvantages :**
  - A marked feature of this cement is that contrary to the action of metals, it expands on being solidified.

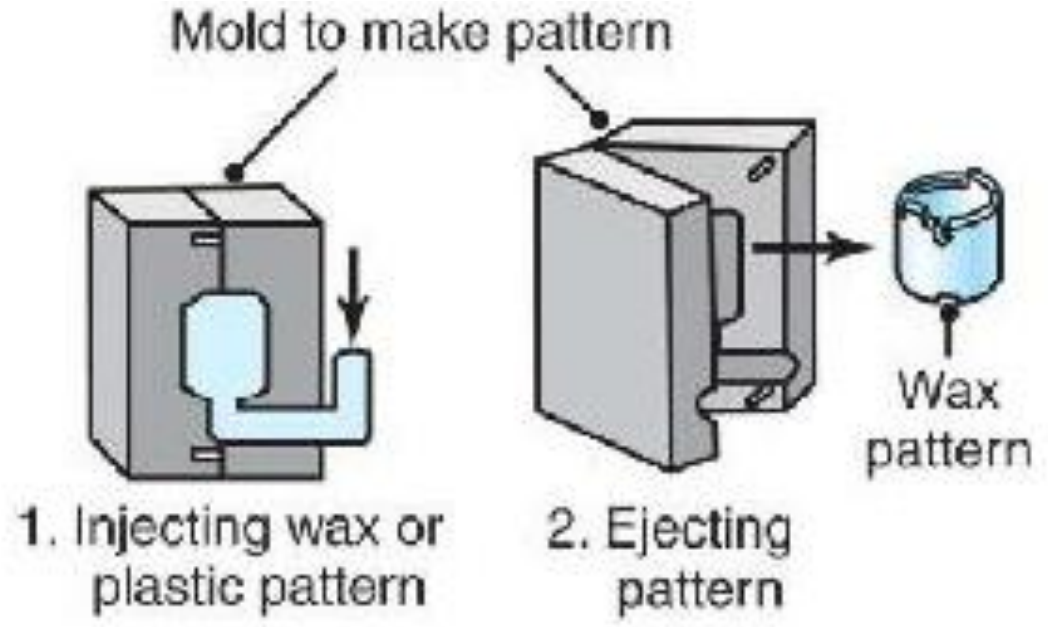
Plastics :

- The plastics used as pattern materials are thermosetting resins.
- For making the pattern, first the moulds are made, usually from plaster of Paris.
- The resin is then poured into these moulds and the two heated. At a specific temperature, the resin solidifies to give the plastic pattern.
- Advantages

1. Lightness in weight.
2. High strength.
3. High resistance to wear.
4. High resistance to corrosion due to moisture.
5. Fine surface finish.
6. Low solid shrinkage.
7. Very reasonable cost.

Wax :

- Wax patterns are exclusively used in investment casting.
- For this a die or metal mould is made in two halves into which the heated wax is poured.
- The die is kept cool by circulating water around it. As the wax sets on cooling, the die parts are separated and the wax pattern taken out



Pattern allowances

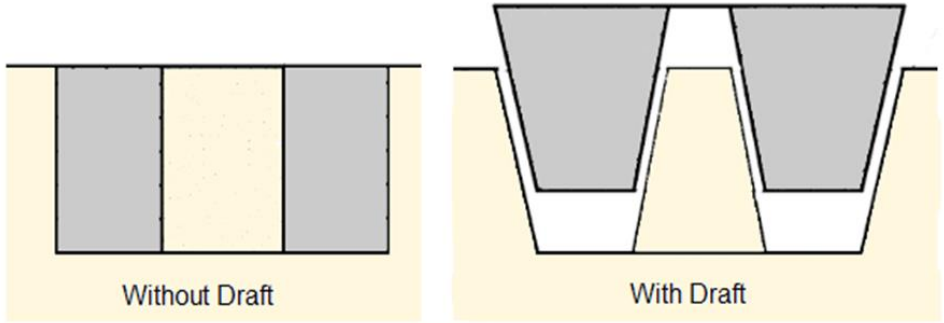
- Allowances are given on pattern to compensate any structural or dimensional change that will happen during casting
- A pattern is always made larger than the required size of the casting considering the various allowances. These are the allowances which are usually provided in a pattern

1.Shrinkage or contraction allowance:

- The various metals used for casting contract after solidification in the mould.
- Allowances provided on pattern material to compensate contraction is known as shrinkage allowances
- Since the contraction is different for different materials, therefore it will also differ with the form or type of metal

2. Draft allowance

- It is a taper which is given to all the vertical walls of the pattern for easy and clean withdraw of the pattern from the sand without damaging the mould cavity.



3. Finish or machining allowance

- The allowance is provided on the pattern if the casting is to be machined.

4. Distortion or camber allowance

- This allowance is provided on patterns used for casting of such design in which the contraction is not uniform throughout.

5.Rapping or shaking allowance

- This allowance is provided in the pattern to compensate for the rapping of mould because the pattern is to be rapped before removing it from the mould.`

Properties Of Molding Sand

1 Adhesiveness

- Adhesiveness is a property of molding sand to get the stick or adhere to foreign material such as sticking of molding sand with the inner wall of molding box.

2 Cohesiveness

- Cohesiveness is property of molding sand by virtue which the sand grain particles interact and attract each other within the molding box .

3 Collapsibility

- After the molten metal in the mould gets solidified, the sand mould must be collapsible so that free contraction of the metal occurs and this would naturally avoid the tearing or cracking of the contracting metal.
- In absence of collapsibility property the contraction of the metal is hindered by the mold and thus results in tears and cracks in the casting. This property is highly required in cores.

4 Dry strength

- As soon as the molten metal is poured into the mould, the moisture in the sand layer adjacent to the hot metal gets evaporated and this dry sand layer must have sufficient strength to its shape in order to avoid erosion of mould wall during the flow of molten metal.
- The dry strength also prevents the enlargement of mould cavity cause by the metallostatic pressure of the liquid metal

5 Flowability or plasticity

- Flowability or plasticity is the ability of the sand to get compacted and behave like a fluid. It will flow uniformly to all portions of pattern when rammed and distribute the ramming pressure evenly all around in all directions.

6 Green strength

- Sand with moisture is green sand and its property to retain shape of mould is green strength

7 Permeability

- Permeability is also termed as porosity of the molding sand in order to allow the escape of any air, gases or moisture present or generated in the mould when the molten metal is poured into it.
- All these gaseous generated during pouring and solidification process must escape otherwise the casting becomes defective.
- The extent of ramming of the sand directly affects the permeability of the mould.
- Permeability of mold can be further increased by venting using vent rods.

8 Refractoriness

- Refractoriness is defined as the ability of molding sand to withstand high temperatures without breaking down or fusing thus facilitating to get sound casting.

Types of Moulding Sands

1. Foundry Green sand:

- It is a sand used in wet condition for making the mould.
- It is a mixture of silica sand with 15-25 percent clay and 6-8 percent water
- Green sand moulds are not dried, when the metal poured in them in the wet condition
- This sand is used for producing small to medium sized moulds which are not very complex

2. Dry sand:

- Dry sand is the green sand that dried or baked after preparing the mould.
- Drying sand gives strength to the mould so that it used for larger castings

3. Loam sand:

- Loam sand containing up to 50 % clay.
- This sand used for moulds for making very heavy castings usually with the help of sweeps and skeleton patterns.

4. Parting sand:

- This sand used during making of the mould to ensure that
  - green sand does not stick to the pattern.
  - The cope and drag parts easily separated for removing the pattern without causing any damage to the mould.
- Parting sand consists of fine grained clay free dried silica sand, sea sand or burnt sand with some parting compounds

5. Facing sand:

- Facing sand is the sand which covers the pattern all around it. The remaining box filled with ordinary floor sand.
- Facing sand forms the face of the mould and comes in direct contact with the molten metal when it poured.
- High strength and refractoriness required for this sand.
- It made of silica sand and clay without the addition of any used sand

6.Core sand:

- Core sand is the sand used for making cores. This is silica sand mixed with core oil. That is why it is also called as oil sand.
- The core oil consists of linseed oil, resin, light mineral oil with some binders.
- For larger cores, sometimes pitch / flour and water used in saving the cost.

Types of Moulding

1. Floor Moulding:

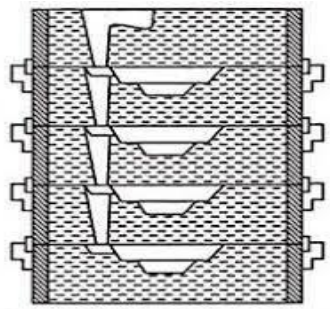
- The moulding done on the floor of the foundry is called floor moulding. In this method, one flask is avoided and the foundry floor itself act as a drag.
- Uses: Floor moulding method is used for all medium and heavy castings of metals, having a considerable depth or area

2. Bench Moulding:

- The moulding done on a bench of a convenient height to the moulder, is called bench moulding. The moulder can work while standing.
- Uses:Bench moulding method is used for identical castings of small size for mass production. It is best suitable for non-ferrous castings and light weight castings of metals, in green sand mould.

3.Stack Moulding:

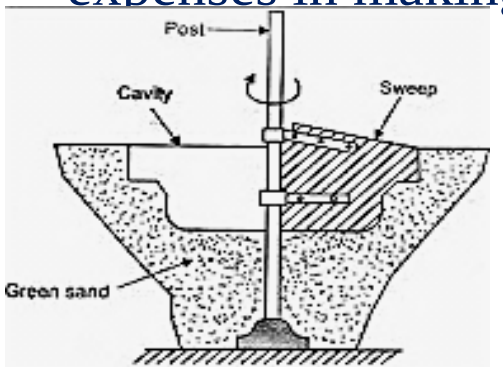
- The moulding done with 10 to 12 flasks at a time and them all have common sprue for feeding all cavities, is called stack moulding.



Uses:Stack moulding method is best suited for producing a large number of small light castings while using a limited amount of floor area in the foundry

4.Sweep Moulding:

- The moulding is done by using a sweep pattern, is called sweep moulding. A sweep that can be rotated around an axis is used for producing a surface of revolution. The casting produced involves less time and reduced expenses in making a full pattern.



- Uses: Sweep moulding is best suited for large size moulds which are symmetrical in shape and particularly of circular sections.

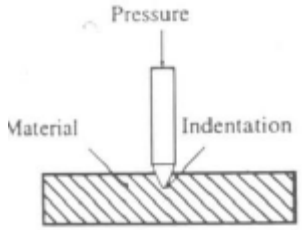
Mechanical Properties

- The properties of materials which are associated with the behaviour of materials under the action of external forces and loads are known as ***mechanical properties***

Strength

- The strength of a material is its capacity to withstand destruction under the action of external loads. The stronger the material the greater the load it can with stand. Since, strength varies according to the type of loading, it is possible to assess tensile, compressive, shear, torsional and bending strength.

Hardness



- Hardness is the ability of a material to resist wear, scratching, abrasion, indentation or penetration by harder bodies.

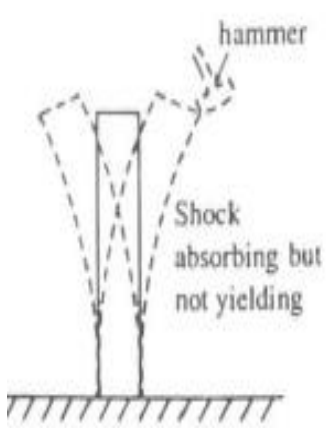
Ductility

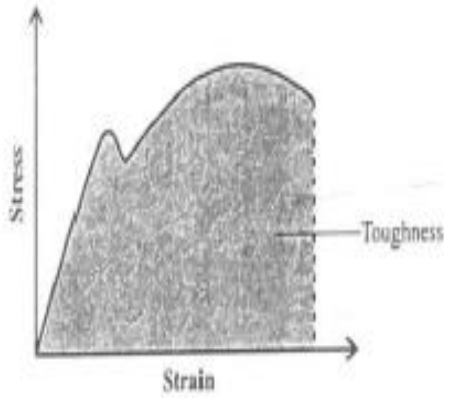
- It is the ability of a material to be drawn from a large section to small section without rupture. Or, it is the property of a material which enables it to draw out in to thin wire. A ductile material must be both strong & plastic.

Brittleness

- Brittleness of a material is the property of breaking without much permanent distortion & appreciable deformation. Concrete, cast iron, glass, etc. are brittle materials.

Toughness

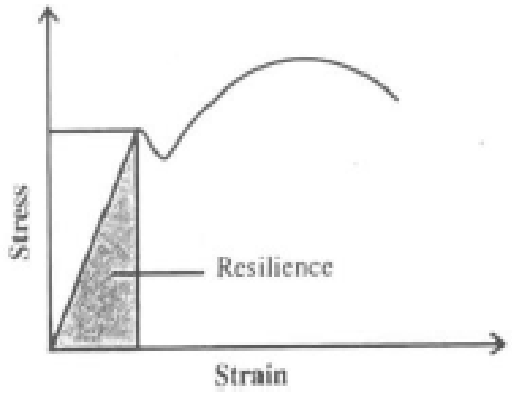




- Toughness is a measure of the amount of energy a material can absorb before fracture or failure takes place. OR
- It is the ability of a material to withstand repeated beading or twisting without fracture. The area under the Stress - Strain curve indicates the toughness.

Resilience

- *It is the capacity of a material to absorb energy elastically*. It is measured by the amount of energy that can be stored per unit volume after being stressed to elastic limit. This property is desirable in materials used for springs. It corresponds to the area under stress-strain curve within elastic limit.



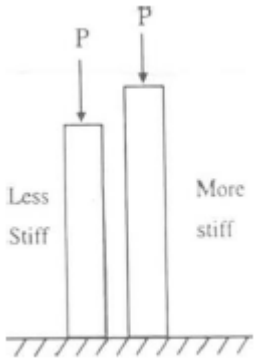
Malleability

- Malleability of a material is its ability to be flattened in to thin sheets without cracking under compressive stress (by hot or cold working). Gold, Aluminum, Copper etc. are malleable metals.

Stiffness

➢ The resistance of a material to elastic deformation or deflection is called stiffness or rigidity..

➢ A material which suffers slight deformation under a load has a high degree of stiffness. For e.g. steel is stiffer than Aluminum.



Fatigue

- The failure of a material caused under repeated or fluctuating loads (stress) is known as fatigue or fatigue failure. Fatigue failure usually occurs abruptly (suddenly) without showing any sign of failure.