FOUNDRY

Introduction

Foundry or casting is a process of forming metallic products by melting metal, pouring it into a preformed cavity known as mould and allowing it to solidify. Generally moulds are made from sand. In foundry patterns are used to form impression in moist sand. The cavity generated in sand by pattern is known as mould and metallic product made by pouring metal in the sand mould and solidifying it is known as casting. Some time cores are placed in the mould to form internal pockets. The cores are made by core sand in the core box and baking in a oven.

Basic Steps in foundry/Casting

The basic steps for casting are :

1. Pattern and core box making
2. Mould and core making
3. Melting and pouring
4. Cleaning of casting
5. Inspection of casting

Pattern and core box making : A pattern may be defined as a model or replica of casting . Patterns are designed & fabricated with provisions for moulding, coring and machining and are used to form impression in damp sand. For the casting having pockets, patterns are modified with core prints so as to have space for placement of core. Hence prior to moulding it is necessary to have a pattern and core box. depending upon the type of casting.

Mould and core making : Patterns are used to form impression in the damp sand known as mould. For cavities and pockets cores are placed in the mould. The cores are made by moulding core sand in core box with proper reinforcement and then baking in a oven.

Melting and pouring : When moulds are ready the melt is prepared by heating metal to be cast in a suitable furnace. The molten metal is then poured in the mould. The moulds are then allowed to cool so that metal in the mould gets solidify.

Cleaning of casting : When the process of solidification is complete, the castings are taken out by breaking moudls. The attachments to the castings are then cut and sand adhering to the surface is cleaned. The casting a re then offered for inspection.

Inspection of casting : The castings are susceptible many defects are inspected prior to use or machining.

Pattern & Core box Making

Work material

(a) Pattern materials

Following materials are very commonly used for making pattern:

Wood : Pine, teak & mahogany.
Metal: Cast iron, mild steel, aluminiun alloy, brass & Bronzes.
Plastic : Thermosetting resin such as phenolic resin plastics.
Plaster : Quick setting cements
Wax or Mercury ; Used in investment casting.

Selection of pattern materials

Following points are considered for selection of pattern material :
1. Number of casting to be produced
2. Type of mouling process.
3. Degree of accuracy & surface finish required.
4. Minimum section thickness.
5. Cost of pattern.

Wood is commonly used for making pattern on account of low cost, excellent workability, light in weight, availability & better surface finish.

(b) Estimate of material

In considerations of above points the material for pattern is identified. The estimate is made based on the drawing of pattern ascertaining size and quantity of material required.

(c) Cost of material

Based on the material estimate the cost is worked out

THIRD

Pattern Making Tools

Wood is most common material used for making pattern in foundry. Hence all carpentry tools are required for making wooden pattern. In addition to carpentry tools a pattern maker also need a contraction scale for marking and tools to layout drawing.

For metallic pattern facilities for machining with special machine tools are required.

Pattern Allowances

The shape and size of a Pattern differ from casting on account of allowances incorporated for shrinkage, machining, draft, shake and distortion. The allowances are necessary to get the casting in nearest size with provisions for machining and requirements of making mould.

Shrinkage Allowances

The metal to be cast shrinks significantly when cooled from pouring temperature. The loss of volume, when temperature falls from pouring to liquidus temperature and liquidus to solidus temperature are taken care by proper gating system and design of risers.

The contraction thereafter until the temperature reaches to room temperature when metal is in solid state is known as solid contraction. The allowance given to compensate solid shrinkage is known as contraction or shrinkage allowance. In shrinkage allowance the size of pattern is increased depending upon the metal to be cast. Contraction scale has been designed in consideration with amount of shrinkage to different metals is used for marking by the pattern maker. Since we increase size. this is considered a positive allowance. For cast iron it is 10 mm/metre.

Draft Allowances

For easy withdrawal of pattern from mould, all vertical surfaces are tapered inside. The amount of taper or draft depends on type of surface i.e. external or internal and size of pattern. It is a positive allowance varies from 10 to 20 mm per/metre for external surfaces. The 60 mm/metre draft is generally given on small inner surfaces. This is also appositive allowance.

Machining Allowances

To compensate loss of metal due to machining, the surfaces of the casting to be machines are given extra layer of metal. This is known as machining allowance. As size is increased hence it is also a positive allowance. The thickness of layer provided for machining varies from 3 to 20 mm depending upon size of casting.

Rapping or shake Allowances

The pattern is rapped or shake before withdrawing it from mould, to have some clearance from adjoining moulding sand. This increases the size of mould, which is significant in medium and large size casting. Hence size of pattern is reduced. For small casting it is negligible. The allowance given on pattern to compensate the increase in the mould due to shake is known as shake allowance.

Distortion Allowances

To take care for distortion due to heat stresses.

Types of Patterns

Name	Brief Description	Specific use
Solid or single piece	These pattern are made in one piece without joint, parting or loose piece. Flat face solid pattern can be withdrawn in one piece leaving its impression in drag. While symmetrical pattern are moulded using dummy or false mould.	For moulds of simple shape castings.
Split of two piece	These pattern are made in two pieces by splitting at parting line. The two pieces are joined together by dowels for proper alignment.	For mould of cylindrical & spherical shape casting.
Multi-piece piece	With moulding needs sometimes patterns are made in two or more pieces known as multi-piece pattern.	For mould of a casting of complicated shape.
Match plate	In match plate pattern one half of split pattern is mounted on one side of a plate and other half directly opposite on other side of plate. One or more numbers of pattern can be mounted on plate with gates and runner on drag side. Match plate act as paring line can be of wood or metal patterns are made from metal	For making large numbers of mould on moulding machines
Cope and drag	In case of large size casting the cope and drag part of mould are made independently. A plate is been used to avoid difficulty in alignment of cope & drag.	Handling medium & large size casting & to achieve high rate of production.
Loose piece	Loose-piece patterns are required when pattern cannot be removed in one piece. The main pattern is removed first then other pieces are removed by creating space to withdraw them. The part lines is fixed on more than one plane	Intricate casting such as dovetail shapes of slides.

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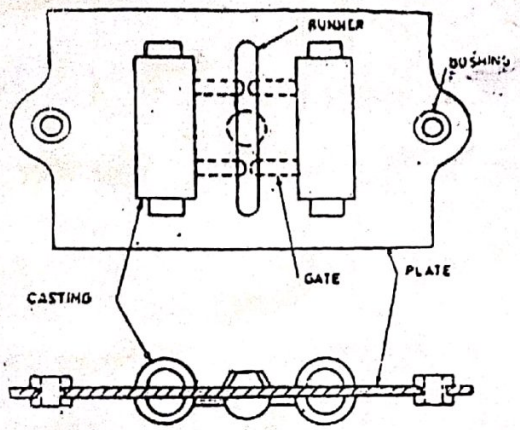
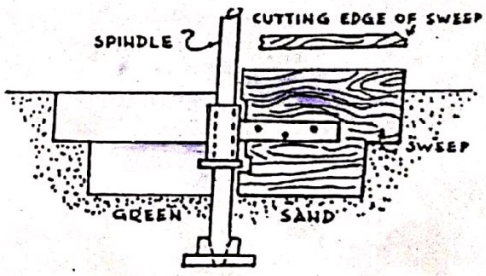
5

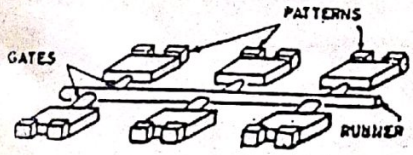
TYPES OF PATTERN



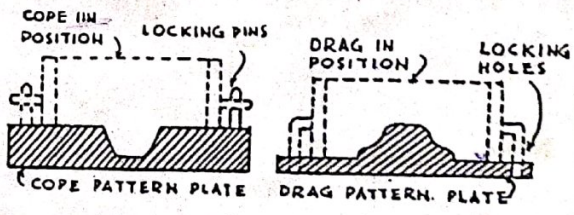
Match Plate Pattern



Sweep Pattern

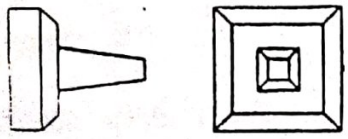


Gated Pattern

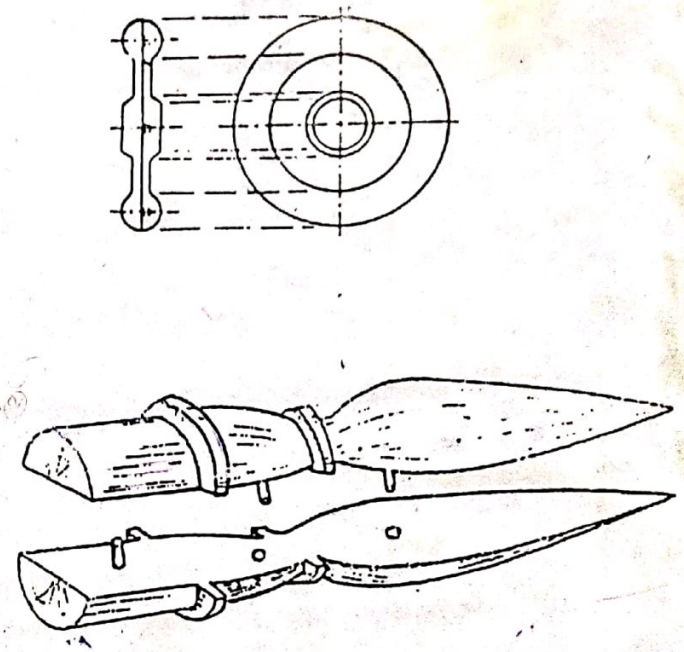


Cope and Drag Pattern

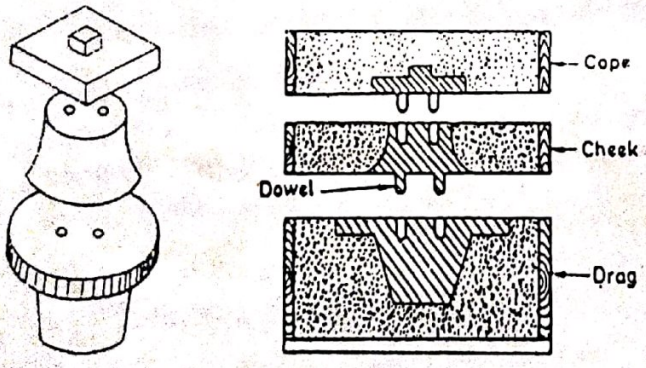
TYPES OF PATTERN



Single Piece of Solid Pattern



Two Piece or Split Pattern



Three Piece Pattern

Multi Piece or Loose Piece Pattern

MOULDING AND CORE MAKING

Introduction

A mould may be defined as the impression of pattern in the moulding sand. In foundry when pattern is ready, it is been placed on board and using moulding box, its impression is taken by filling and ramming of moulding sand. The area used for making mould is known as moulding section.

Work material

(a) Selection of Mould material

The main constituents of moulding sand are **sand, binders and additives.**

Sand : Sand with high silica content is used for making mould. The chemical composition of sand gives an idea of the impurities like lime, manganese, iron oxides, etc. The excess amount of impurities is not desirable as they lower the fusion temp. Selection of sand is done based on its ability to thermal & chemical stability and shape & size of grains.

Binders : Binders are used to keep sand particles attached to each others and with moulding box. The popular inorganic binders are fire clay, limonite and betonite. Dextrin, molasses, cereal binders, linseed oil and phenol formaldehyde are some of the organic binders used as binder. The linseed oil is a best binder. Inorganic binders are cheap and organic binders cost more.

Additives : Additives are the material mixed to the moulding sand to develop some special property. Coal dust, corn flour, dextrin, sea coal, pitch, wood flour, cereals and fuel oil are used as additives.

(b) Estimate of material

Sand, binder and additives are identified depending upon the type, quality & quantity castings. Estimate is made depending on composition of sand.

(c) Cost of Mould

Depends upon the cost of moulding material, type of mould and size of casting.

Preparation of Mouliding Sand

Silica is a high fusing material used for making mould due to its thermal stability and excellent workability. The sand taken from river beds contains reasonable amount of clay and moisture is used for making mould known as **nautral sand**. The relatively clay free sand when mixed with known amount of binder and additives is known as **synthetic sand**. Synthetic sands are better on account of better control on the properties.

Moisture is added to make sand adhesive known as **tempering of sand**. New and used sand is **conditioned** by adding binder and additives. The sand is mixed properly so as to distribute the ingredients uniformly. Mullers are used for mixing sand in large quantity.

Properties of Good Mouling sand

The properties of a good moulding sand are :

High Refractoriness : Refractoriness is property of sand to withstand high temperature. It depends upon silica or quartz content. The sand having high silica content is considered better. It also depends on shape and size of grains.

High Permeability : Permeability is the ability of sand to allow air, steam, and hot gases to escape from the mould during pouring of molten metal. It depends upon size and shape of grain, moisture and clay content, and ramming conditions.

High Green Strength : Green strength is the property of sand to as to make a stable mould and to handle it. It depends upon cohesiveness and adhesiveness of sand i.e. ability of sand grain to form bond with adjoining grain and to attach with mould box walls respectively.

High Dry Strength : The ability of sand to avoid erosion when comes in contact with metal is known as dry strength. It should be high to prevent enlargement of mould also.

High Flowability : It is the capability of sand to behave like fluid so that, it flow to all areas when rammed.

High Collapsibility : The mould must collapsible to allow free contraction of metal during cooling.

High Reusability : For economy, the sand must be reusable.

Green Sand

It is a natural sand or a mixture of silica sand, clay and water. In one of the composition it contains silica sand with 20 to 30% clay and 6 to 8 % moisture. The sand is properly mixed and tempered before use. To improve the properties coal dust, carbon blacking and talc is also added to it.

Dry Sand

This sand is used for making dry sand mould. It differs in composition from green sand. It uses flour, resin, molasses for binding. One of the composition may contain 13 part flour sand, 8 part new sand and 1 part horse manure or saw dust. The other composition may be with 1 to 2% organic binder.

LOOM SAND

Loom Sand

Loam sand is used for making loam sand mould. The sand is prepared by mixing sand and clay in equal proportion with sufficient amount of water to form slurry.

Core Sand

The core placed in mould must be from highly refractory material as its major portion is covered by molten metal. It must be strong also to sustained thrust forces by the molten metal. Best composition can be adding 1 to 2% linseed oil to sand of high silica content.

Types of mould

Moulds may be classified asunder :

Based on the type of sand

Green sand mould

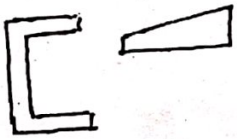
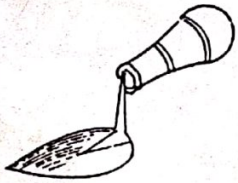
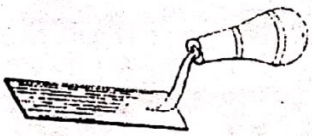
These moulds are made using green sand. For better casting the moulds are dried by leaving them for some time or using skin dry techniques. Although it increases the cost still the mould made by green sand are cheap. Green sand is used for making mould of small and medium size casting.

Dry sand mould

These moulds are made by using dry sand. They are made in similar way as the green sand mould except dried in oven before casting. The backing improves strength of mould and castings are less susceptible to internal defects. The casting made by dry sand mould, have better strength, finish and dimensional accuracy. The cost of mould is more on account of backing of mould and handling of mould is difficult. The size of oven restrict the size of mould. These mould are used for making small size casting.

Loam Sand Mould

Large casting of symmetrical shape are made by loam sand. The mould is made of brick work and its rough inner surface are lines by slurry of loam sand. Using sweep pattern the impression of casting is made in the mould. The mould and its cover is then backed.

 Sketch Swab	 Sketch Sprue pins
 Sketch Sprue cutters	 Sketch Gate cutter
 Sketch soft brush	 Clamps and wedges
 TROWEL	 TROWEL

Gated	These patterns are designed for production multi-cavity moulds. A group of patterns with attached gate former is known as gated pattern	For production of multi cavity mould for small size casting.
Sweep	For large symmetrical casting, moulds are made by rotating a sweep board having shape corresponding to the shape of casting. Sweep eliminates the expensive pattern.	For making mould for large symmetrical casting by loam moulding process.
Skeleton	To cut down cost of pattern some times skeleton is made using cut size timber. The frame is then filled with sand having clay or loam. The cope & drag are made separately.	For making mould for very large size casting.
Segmental	For a large ribbed casting, a segment is used for making mould. This type of pattern is known as segmental pattern.	For making mould of large casting having ribs.
Follow board	Solid patterns can be used for moulding using a board having similar cavity to accommodate pattern partially.	Small casting to avoid splitting of pattern and to increase production