WORKSHOP

DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

OF

Foundry shop

INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD

OBJECTIVES

The objectives of Foundry Shop is-

- ✓ To understand the sand mould casting technique.
- ✓ To understand the implementations of different hand tools.
- ✓ To practice various steps of sand mould casting such as pattern making, mould making, and gating system.

OUTCOMES

The expected outcomes of foundry shop are that the students will be able:-

- To apply principles of sand mould casting for mould making.
- To apply these learning to improve the performance of cast products.
- To practically relate to concepts of foundry technology and foundry shop.

Tutorial Assignments

- To prepare a pattern for sand mould casting
- To prepare mould in cope and drag by sand mould casting technique.
- To prepare a gating system.

INTRODUCTION

FOUNDRY SHOP

Foundry is one of the manufacturing process by which a desired shape of metal is obtained by heating up to its molten state (liquid state), and pouring into mould cavity. After some time metal is allowed to cool and solidify. The solidified piece of metal is known as casting. it is the oldest, the most versatile and most flexible process for metal forming. The fundamental principle of making casting consists of introduction metal in to a cavity of mould of the desired shape and allowing the molten to solidity.

An effective of melting or various metals in suitable furnace is always carried out in a foundry in a shop. The various melting operating carried out in the foundry are in actually re-melting processes in different type of furnaces and the poured at suitable temperature into previously made mould to given the foundry product called casting.

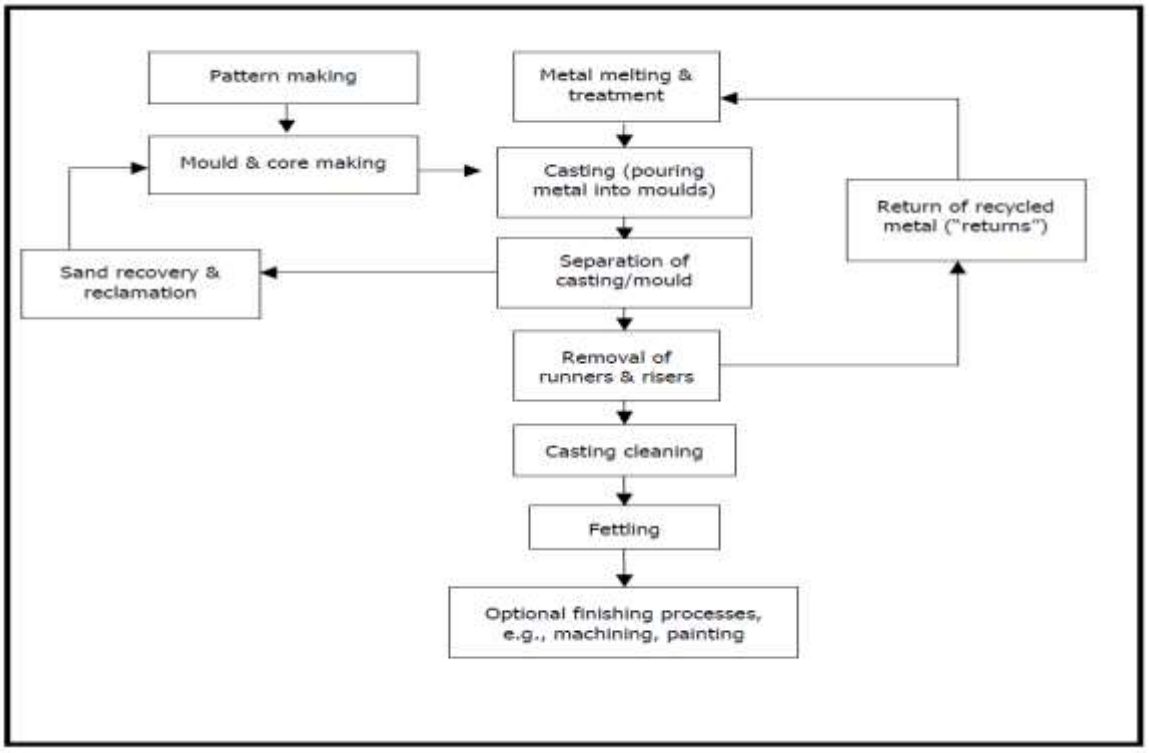


Figure show the flow chart diagram of a typical foundry process

PATTERN

A pattern is a model or the replica of the object (to be casted). It is embedded in molding sand and suitable ramming of molding sand around the pattern is made. The pattern is then withdrawn for generating cavity (known as mold) in molding sand. The process of making a pattern is called pattern making and the person who makes the pattern is kwon as pattern maker.

COMMON PATTERN MATERIALS

The common materials used for making patterns are wood, metal, plastic, plaster, wax or Mercury.

TYPES OF PATTERN

The types of the pattern and the description of each are given as under.

1. One piece or solid pattern 2. Two pieces or split pattern 3. Cope and drag pattern 4. Three-piece or Multi- piece pattern 5. Loose piece pattern 6. Match plate pattern 7. Follow board pattern 8. Gated pattern 9. Sweep pattern 10. Skeleton pattern 11. Segmental or part pattern

1. Single-piece or solid pattern: Solid pattern is made of single piece without joints, partings lines or loose pieces. It is the simplest form of the pattern. Typical single piece pattern is shown in Fig. 1.1.

2. Two-piece or split pattern: When solid pattern is difficult for withdrawal from the mold cavity, then solid pattern is split in two parts. Split pattern is made in two pieces which are joined at the parting line by Means of dowel pins. The splitting at the parting line is done to facilitate the

withdrawal of the pattern. A Typical example is shown in Fig. 1.2

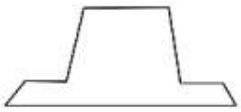


Fig. Single Piece Pattern

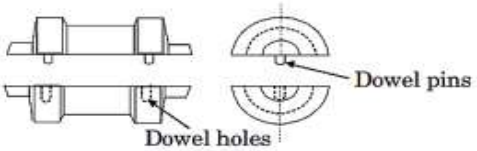


Fig. Two Piece Pattern

MOLDING SAND

The general sources of receiving molding sands are the beds of sea, rivers, lakes, granular elements of rocks, and deserts. Molding sands may be of two types namely natural or synthetic. Natural molding sands contain sufficient binder. Whereas synthetic molding sands are prepared artificially using basic sand molding constituents (silica sand in 88-92%, binder 6-12%, water or moisture content 3-6%) and other additives in proper Proportion by weight with perfect mixing and mulling in suitable equipment

Binder:

In general, the binders can be either inorganic or organic substance. The inorganic group includes clay sodium silicate and port land cement etc. In foundry shop, the clay acts as binder which may be Kaolinite, Ball Clay, Fire Clay, Limonite, Fuller's earth and Bentonite. Binders included in the organic group are dextrin, molasses, cereal binders, linseed oil and resins like phenol formaldehyde, urea formaldehyde etc. Organic binders are mostly used for core making. Among all the above binders, the bentonite variety of clay is the most common. However, this clay alone cannot develop bonds among sand grins without the presence of moisture in molding sand and core sand

Additives:

Additives are the materials generally added to the molding and core sand mixture to develop some special property in the sand. Some common used additives for enhancing the properties of molding and core sands are discussed as under.

1. Coal dust: Coal dust is added mainly for producing a reducing atmosphere during casting.

2. Corn flour: It belongs to the starch family of carbohydrates and is used to increase the collapsibility of the molding and core sand

3. Dextrin: Dextrin belongs to starch family of carbohydrates that behaves also in a manner similar to that of the corn flour. It increases dry strength of the molds.

4. Sea coal: Sea coal is the fine powdered bituminous coal which positions its place among the pores of the silica sand grains in molding sand and core sand

5. Wood flour: This is a fibrous material mixed with a granular material like sand; its relatively long thin fibers prevent the sand grains from making contact with one another.

6. Silica flour: It is called as pulverized silica and it can be easily added up to 3% which increases the hot strength and finish on the surfaces of the molds and cores

KINDS OF MOULDING SAND

Molding sands can also be classified according to their use into number of varieties which are described below.

1. **Green sand:** Green sand is also known as tempered or natural sand which is a just prepared mixture of silica sand with 18 to 30 percent clay, having moisture content from 6 to 8%. The clay and water furnish the bond for green sand. It is fine, soft, light, and porous. Green sand is also known as tempered sand. It denotes well prepared foundry sand which contains just enough moisture to give it sufficient band. The moulds in this sand are known as green sand moulds. The contains in green sand are:

River Sand	93%	Bentonite	3.5%
Dextrin	0.5%	Water	3.0%

2. Dry sand: Green sand that has been dried or baked in suitable oven after the making mold and cores is called dry sand. It possesses more strength, rigidity and thermal stability.

3. Loam sand: Loam is mixture of sand and clay with water to a thin plastic paste. Loam sand possesses high clay as much as 30-50% and 18% water.

4. Facing sand: Facing sand is just prepared and forms the face of the mould. It is directly next to the surface of the pattern and it comes into contact molten metal when the mould is poured. Initial coating

around the pattern and hence for mold surface is given by this sand. This sand is subjected severest conditions and must possess, therefore, high strength refractoriness.

5. Backing sand: Backing sand or floor sand is used to back up the facing sand and is used to fill the whole volume of the molding flask.

6. Parting sand: Parting sand without binder and moisture is used to keep the green sand not to stick to the pattern and also to allow the sand on the parting surface the cope and drag to separate without clinging

7. Core sand: Core sand is used for making cores and it is sometimes also known as oil sand. This is highly rich silica sand mixed with oil binders such as core oil which composed of linseed oil, resin, light mineral oil and other bind materials.

PROPERTIES OF MOULDING SAND

The basic properties required in molding sand and core sand are described as under

1. 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. It is a highly important characteristic of molding sands. Refractoriness can only be increased to a limited extent

2. Permeability: It 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

3. Cohesiveness: It is property of molding sand by virtue which the sand grain particles interact and attract each other within the molding sand

4. 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 the mould. For this, the sand grains must be adhesive, i.e. they must be capable of attaching themselves to another body

5. 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

6. Flowability or plasticity: It 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

7. Adhesiveness: It is property of molding sand to get stick or adhere with foreign material such sticking of molding sand with inner wall of molding box

8. 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.

HAND TOOLS USED IN FOUNDRY SHOP:

Hand riddle: It consists of a screen of standard circular wire mesh equipped with circular wooden frame. It is generally used for cleaning the sand for removing foreign material such as nails, shot metal, splinters of wood etc. from it. Even power operated riddles are available for riddling large volume of sand.

Shovel: It consists of a steel pan fitted with a long wooden handle. It is used in mixing, tempering and conditioning the foundry sand by hand. It is also used for moving and transforming the molding sand to the container and molding box or flask.

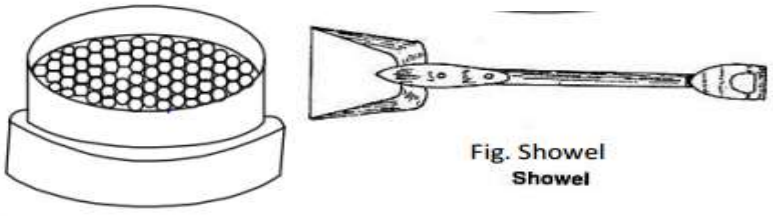


Fig. Showel

Showel

Rammers: Rammers are shown in Fig. These are required for striking the molding sand mass in the molding box to pack or compact it uniformly all around the pattern.

Sprue pin: It is a tapered rod of wood or iron which is placed or pushed in cope to join mold cavity

while the molding sand in the cope is being rammed.
Trowels: These are used for finishing flat surfaces and comers inside a mould. Common shapes of trowels are shown as under. They are made of iron with a wooden handle.
Lifter: A lifter is a finishing tool used for repairing the mould and finishing the mould sand. Lifter is also used for removing loose sand from mould.

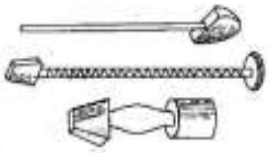


Fig. Rammers


Fig. Sprue Pin


Trowels

Strike off bar: It is a flat bar, made of wood or iron to strike off the excess sand from the top of a box after ramming. It's one edge made beveled and the surface perfectly smooth and plane.

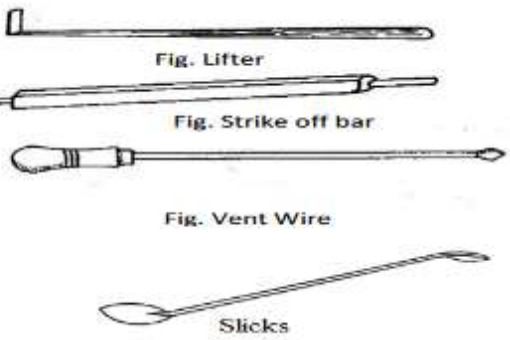


Fig. Lifter

Fig. Strike off bar

Fig. Vent Wire

Slicks

Vent wire: It is a thin steel rod or wire carrying a pointed edge at one end and a wooden handle or a bent loop at the other. After ramming and striking off the excess sand it is used to make small holes, called vents, in the sand mould to allow the exit of gases and steam during casting
Slicks: They are also recognized as small double ended mold finishing tool which are generally used for repairing and finishing the mold surfaces and their edges after withdrawal of the pattern.


Fig. Gate Cutter

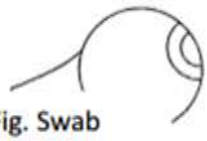
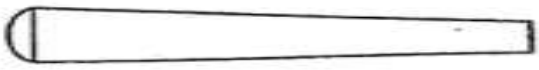
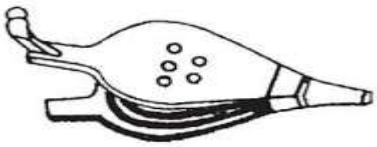


Fig. Swab

Sprue Pin: It is a tapered wooden pin, used to make a hole in the cope through which the molten metal is poured into the mould.



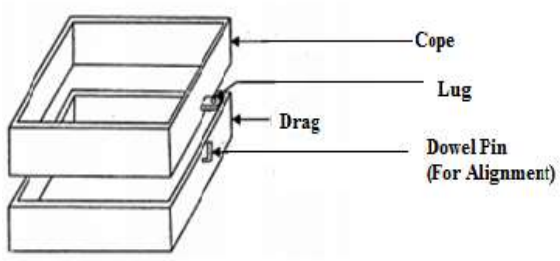
Bellows: Bellows gun is shown in Fig. It is hand operated leather made device equipped with compressed air jet to blow or pump air when operated. It is used to blow away the loose or unwanted sand from the surfaces of mold cavity.



Draw spike: Draw spike is shown Fig. It is a tapered steel rod having a loop or ring at its one end and a sharp point at the other. It may have screw threads on the end to engage metal pattern for it withdrawal from the mold.

MOULDING BOX:

Moulding box is also called moulding flask. It is frame or box of wood or metal. It is made of two parts cope and drag as shown in figure.



Aim: To prepare a sand mold, using the given single piece pattern.

Raw material required: Moulding sand, Parting sand, facing sand, baking sand, single piece solid pattern, bottom board, moulding boxes etc.

Tools Required:

1. Molding board	2. Drag and cope boxes	3. Molding sand	4. Parting sand
5. Rammer	6. Strike-off bar	7. Bellows	8. Riser and sprue pins
9. Gate cutter	10. Vent rod	11. Draw spike	12. Wire Brush

Sequence of operations:

1. Sand preparation
2. Placing the mould flask (drag) on the moulding board/ moulding platform
3. Placing the pattern at the center of the moulding flask
4. Ramming the drag
5. Placing runner and riser
6. Ramming the cope
7. Removal of the pattern, runner, riser
8. Gate cutting

Procedure:

Mould Making:

1. First a bottom board is placed either on the molding platform or on the floor, making the surface even.
2. The drag molding flask is kept upside down on the bottom board along with the drag part of the pattern at the center of the flask on the board.
3. Dry facing sand is sprinkled over the board and pattern to provide a non-sticky layer.
4. Freshly prepared molding sand of requisite quality is now poured into the drag and on the pattern to a thickness of 30 to 50 mm.
5. Rest of the drag flask is completely filled with the backup sand and uniformly rammed to compact

the sand.
6. After the ramming is over, the excess sand in the flask is completely scraped using a flat bar to the level of the flask edges.
7. Now with a vent wire which is a wire of 1 to 2 mm diameter with a pointed end, vent holes are in the drag to the full depth of the flask as well as to the pattern to facilitate the removal of gases during casting solidification. This completes the preparation of the drag.
8. Now finished drag flask is rolled over to the bottom board exposing the pattern.
9. Using a slick, the edges of sand around the pattern is repaired
10. The cope flask on the top of the drag is located aligning again with the help of the pins of the drag box.
11. Sprue of the gating system for making the sprue passage is located at a small distance of about 50mm from the pattern. The sprue base, runners and in-gates are also located as shown risers are also placed. Freshly prepared facing sand is poured around the pattern.
12. The moulding sand is then poured in the cope box. The sand is adequately rammed, excess sand is scraped and vent holes are made all over in the cope as in the drag.
13. The sprue and the riser are carefully withdrawn from the flask
14. Later the pouring basin is cut near the top of the sprue.
15. The cope is separated from the drag any loose sand on the cope and drag interface is blown off with the help of the bellows.
16. Now the cope and the drag pattern halves are withdrawn by using the draw spikes and rapping the pattern all around to slightly enlarge the mould cavity so that the walls are not spoiled by the withdrawing pattern.
17. The runners and gates are to be removed or to be cut in the mould carefully without spoiling the mould.
18. Any excess or loose sand is applied in the runners and mould cavity is blown away using the bellows.
19. Now the facing paste is applied all over the mould cavity and the runners which would give the finished casting a good surface finish.
20. A dry sand core is prepared using a core box. After suitable baking, it is placed in the mould cavity.
21. The cope is placed back on the drag taking care of the alignment of the two by means of the pins.
22. The mould is ready for pouring molten metal. The liquid metal is allowed to cool and become solid which is the casting desired.

Result: The required mould cavity is prepared using the given Single /solid Pattern.

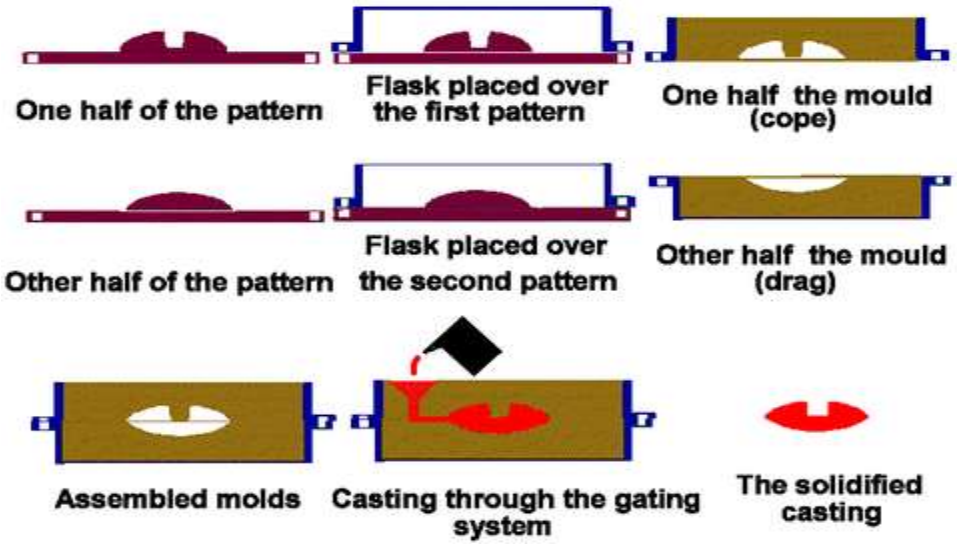


Figure shows the stepwise procedure of sand mould casting process

Gating system:-

The gating system (sprue and gates) serves as the path by which molten metal flows into the pattern cavity and feeds the shrinkage which develops during casting solidification. Proper design of the gating system is critical in meeting two important requirements.

- Short flow paths and fast metal flow prevents casting misruns due to premature solidification.
- Relatively heavy sections which will solidify more slowly require direct gating contact to provide molten metal for feeding shrinkage during solidification. Schematic diagram of gating system is illustrated below:-

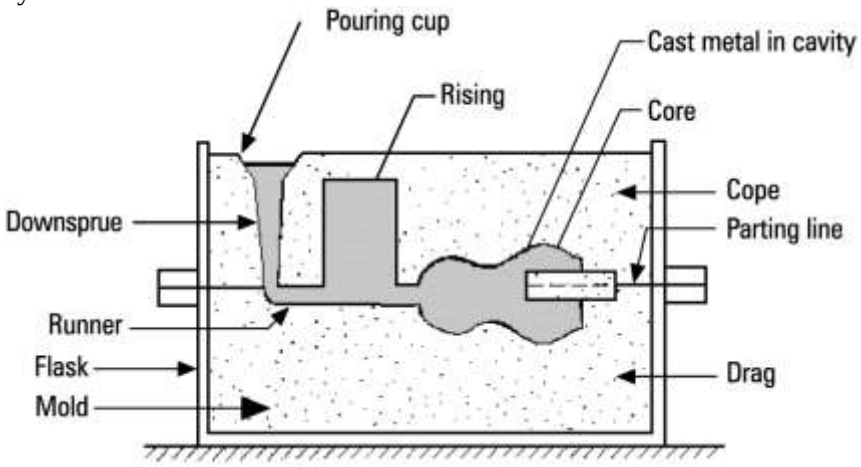


Figure: Elements of Gating system

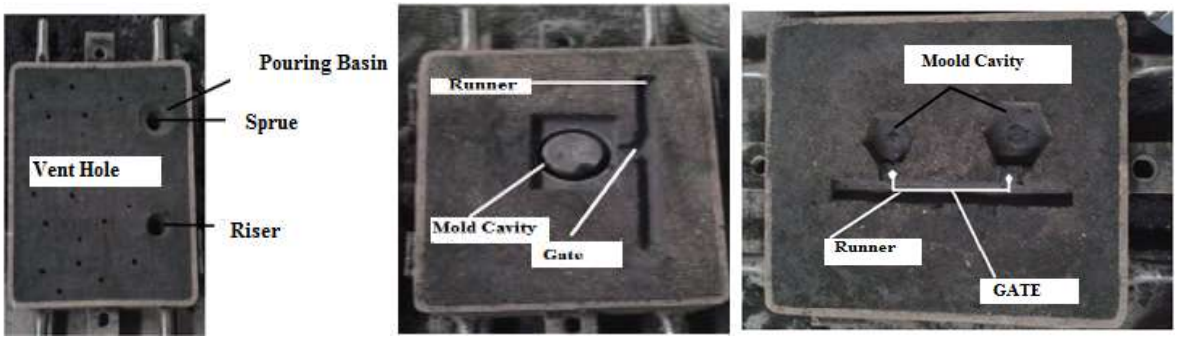


Figure: Gating system and prepared mould in cope and drag

Precautions:

- Do not attempt to touch recently molten metal (even with gloves) until they have cooled.
- People wearing nylon-topped shoes should wear a pair of leather spats when furnace work is going on.
- Leave molten material in mould for some days.

References:

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