It should be able to resist the erosive action of the molten metal being poured.

A mould should resist metal penetration into the walls.

1.15.1 Steps in Mould Making

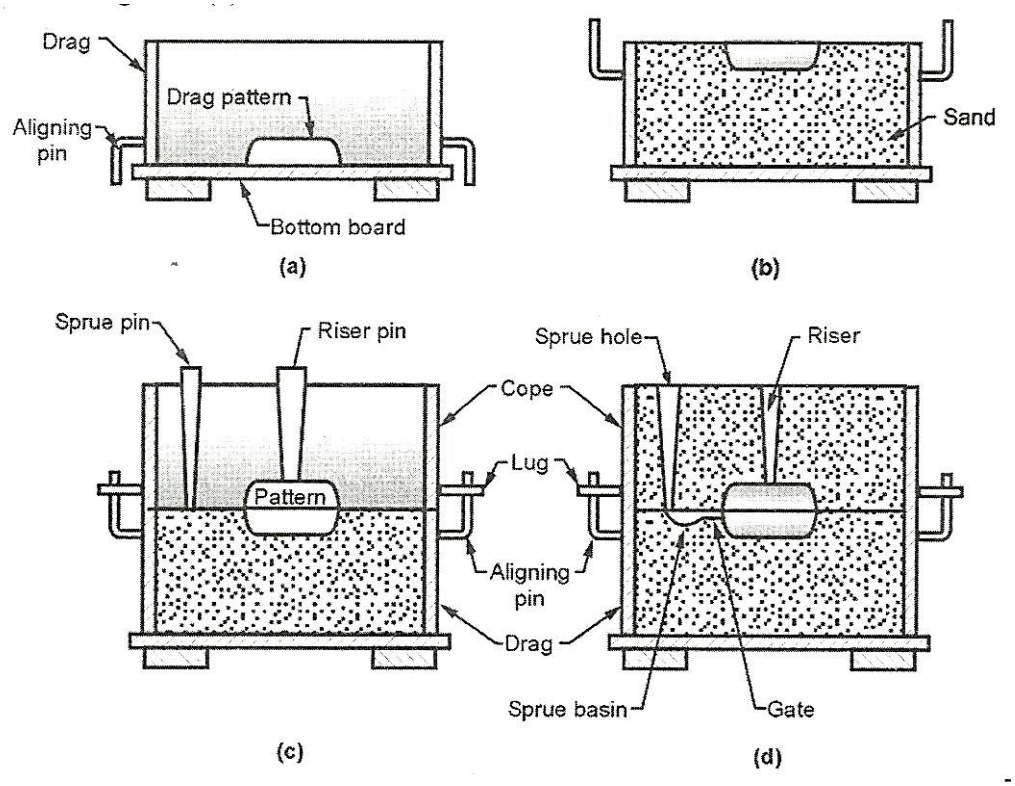

Figure 1.32 Making a mould

Steps involved in making a sand mould are as follows:

1. Select a suitable moulding box which can accommodate mould cavity, risers and gating system.
2. Place the drag half of the box on the moulding board with the aligning pins pointing downwards.
3. Place the drag pattern with parting surface down on the bottom board. Refer Figure 1.32 (a).
4. Sprinkle the facing sand all around the pattern carefully so that the pattern does not stick to the moulding sand.
5. Fill the drag half with moulding sand and ram the sand uniformly in the moulding box around the pattern.
6. Strike off the excess sand to bring it to the same level of the flask, hence drag half is completed.
7. Sprinkle parting sand over the top of the drag half and roll it over the drag. Refer Figure 1.32 (b).

8. Place the cope pattern on the drag pattern and align by using dowel pins.
9. Place cope half over the rammed drag half.
10. Sprinkle parting sand all around the cope pattern.
11. Erect sprue and rise pins to form suitable sized cavities for molten metal pouring as shown in figure 1.32 (c).
12. Fill the cope with sand and ram it.
13. Remove sprue and riser pins and vent the cope with vent wire.
14. Sprinkle parting sand over the top of the core surface and roll over the cope on the bottom board.
15. Remove both the cope and drag pattern and repair the mould, if necessary.
16. Cut the gate connecting the sprue basin with the mould cavity.
17. Apply mould coating by a swab.
18. In case of dry sand mould, bake the mould.
19. If required, set the cores in the mould.
20. By inverting cope over the drag close the mould.
21. Finally, clamp the cope with drag and the mould is ready for pouring. Refer Figure 1.32 (d).

1.16 Moulding Processes

There are different ways of classifying moulding process. Some of the common ways are as follows:

1. As per the method used

i) Floor moulding ii) Bench moulding
iii) Pit moulding iv) Machine moulding

2. As per the mould materials

i) Sand Moulding

a) Green sand moulding b) Dry sand moulding
c) Loan moulding d) Shell moulding
e) Cement banded sand moulding f) Core sand moulding
g) Skin dried sand moulding h) Carbon-dioxide moulding

ii) Plaster moulding

iii) Metallic moulding

1.16.1 Floor Moulding

When mould size is large, moulding work is carried out on foundry floor.

This method is mainly used for medium and large sized casting.

The mould has its drag portion in the floor itself and cope portion may be rammed in a box and inverted on the floor.

By this method both green and dry sand mould can be made.

In floor moulding, venting of moulds sometimes creates problem.

Hence, a bed of coke may be laid in the bottom of the mould which is later connected to the atmosphere by using two vent pipes, erected by the sides of the mould.

This method is used for producing parts such as wheels, pulleys, cylinder covers, ribbed plates, etc.

1.16.2 Bench Moulding

When mould size is small and light in weight, moulding work is carried out on a bench.

By this method, both green and dry sand mould can be made.

Both cope and drag are rammed on the bench itself.

Moulds for both i.e. ferrous and non ferrous casting are made on the bench mould.

1.16.3. Pit Moulding

Casting which are so large that they cannot be made in flasks are moulded in pit dug on the floor.

By this method, very big jobs can be handled and cast easily.

It is called as pit moulding because the mould is prepared in a pit form.

The mould has its drag part in the pit and a separated cope is rammed.

The depth of drag in pit moulding is so large that the moulder can enter the drag and prepare it.

A pit is of square or rectangular shape.

Gates, runner pouring basin, sprue, etc. are made in the cope itself.

Cope and drag are then assembled and sometimes a crane is used for closing the mould.

Pit moulding can be a slow process.

1.16.4 Green Sand Moulding

It is the most widely used moulding process.

The green sand is used for moulding process which consists of silica sand, clay, water and other additives.

Green sand mixture contains 10 to 15% clay binder, 3 to 6% water and remaining silica sand.

Green sand mixture is prepared and mould is made by packing the sand around the pattern.

Cope and drag are assembled and the molten metal is poured when the mould cavity is neither dried nor backed.

This method is mostly preferred for making small and medium casting and suitable for non-ferrous casting.

The parts like railing and gates, moulding boxes, grills, weights, etc. can be mad by this method.

1.16.5 Dry sand moulding

This method is almost similar to green sand moulding except that the composition of sand constituents is different in this case.

While preparing dry sand mixture, special binding materials like resin, clay or molasses are added to give strong bond to the sand.

Hence, the dry sand mould possesses high strength.

Dry sand moulds are more permeable than green sand moulds.

Casting produced by this method possesses clean and smooth surfaces.

As compared to green sand moulding, this method produces casting with fewer defects.

Dry sand moulding provides better overall dimensional accuracy to the moulds.

But the main disadvantage of this method is, it requires more labour and consumes more time in completing the mould and mould baking is also an extra work.

Due to high cost and time consuming process, it is not used in mass production.

It is used for producing parts like larger rolls, gear housing, machinery components, etc.

1.16.6 Loam Moulding

It is a very different method of moulding.

In this, a rough structure of component is made by hand using bricks and loam sand.

The sand used is known as loam sand or loam mortar.

Then the desired shape is given to the made structure with the help of strickle and sweeps, hence pattern is not required.

After preparing the mould, it is backed to give strength.

This method is mostly used for producing large casting in very small numbers.

It enables to save time, labour and material because use of pattern is avoided.

But not used widely because, it takes time for preparing the mould and skilled moulder is required.

It is used for producing parts like cylinders, round bottom kettles, gears, huge bells, etc.

1.17 Gating System

Gating is the term applied to the method of forming channels in the sand through which the molten metal travels from the sprue hole to the mould and out of the mould to the riser.

Gating system refers to all channels by means of which molten metal is delivered to the mould cavity.

Since the way in which liquid metal enters the mould has a decided influence on the quality and soundness of a casting.

The different passages for molten metal are carefully designed and produced.

Figure 1.33 shows the various components of gating system which is composed of:

(a) Pouring cups and basins (b) Sprue (c) Runner

(d) Gates (e) Riser, etc.

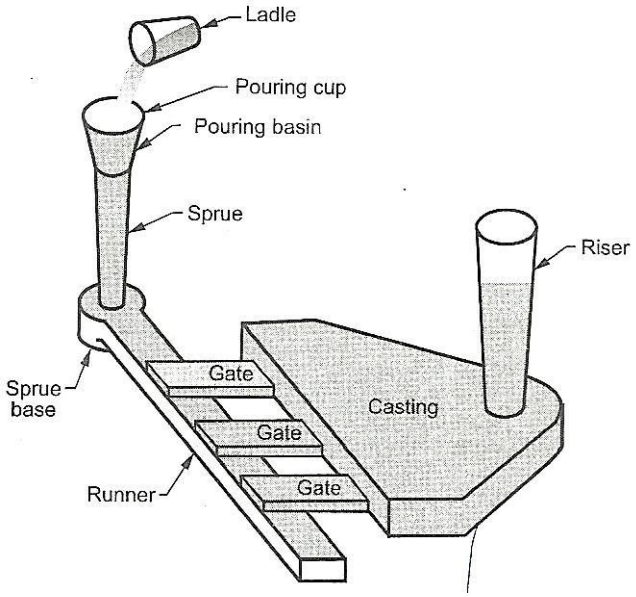

Figure 1.33 Components of Gating System

1.17.1 Pouring Cups and Basins

Pouring cups:

A pouring cup is a funnel shaped cup which forms the top portion of the sprue.

It makes easier for the ladle or crucible operator to direct the flow of metal from crucible to sprue.

Pouring basins:

The molten metal is not directly poured into the mould cavity.

It is poured into a pouring basin which acts as a reservoir from which it moves smoothly into the sprue.

It prevents the slag from entering the mould cavity.

It holds back the slag and dirt, which floats on the top and allows only the clean metal to enter into the sprue.

The basin is cut in various shapes into the cope directly.

1.17.2 Sprue

Sprue is the channel through which the molten metal is brought into the parting plane where it enters the runner and gates.

The sprue may be square or round and is generally tapered downwards, to avoid aspiration of air and metal damage.

Sprues upto 20 mm diameter are round in section, whereas larger sprues are generally rectangular.

In a rectangular sprue, there is less turbulence.

1.17.3 Runner

In large casting, molten metal is generally carried from the sprue base to several gates around the cavity through a passage called as **runner.**

Depending upon the shape of the casting, the runner may be located in the cope or drag part.

To avoid aspiration and turbulence, it should be streamlined.

1.17.4 Gates

A gate is a channel which connects runner with the mould cavity, through which molten metal flows to fill the mould cavity.

The location and size of the gates are so arranged that, they can feed liquid metal to the casting at a rate consistent with the rate of solidification.

More than one gate is employed to feed a fast freezing casting.

The gate should not have sharp edges as they may break during pouring and thus carried with the molten metal into the cavity.

The gates should be located where they can be easily removed without damaging the casting.

The major types of gates are as follows:

(a) Parting line gates (b) Top gates

(c) Bottom gates (d) Side gates

(a) Parting line gates :

These gates enter the mould cavity along the parting line separating the cope and drag portions of the mould. Refer Figure 1.34.

These gates are the simplest in nature and construction.

Such gates are commonly used and are found to give satisfactory service except when the mould is very deep.

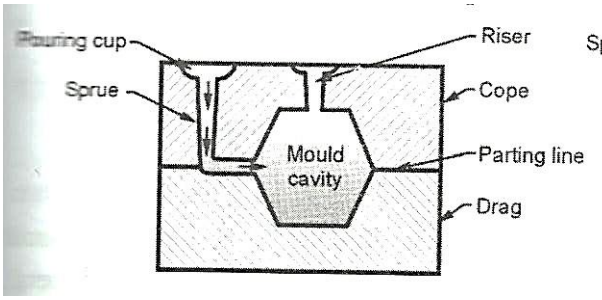

Fig. 1.34 Parting line gate

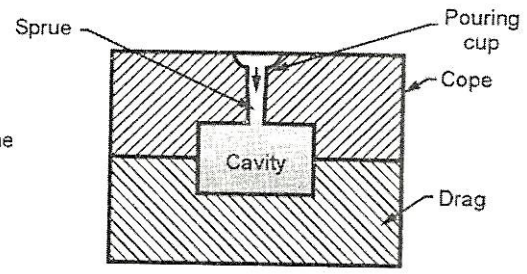

Fig. 1.35 Top gate

(b) Top gates :

Top gate is also called as drop gate because the molten metal just drops on the sand in the bottom of the mould. Refer. Figure 1.35.

A top gate simplifies the moulding with low consumption of additional metal.

There is lot of turbulence in this system.

Also, the dropping liquid metal stream erodes the mould surface.

It is not favourable for non-ferrous casting.

Top gates are further classified as:

Pencil gate	Edge gate	Gate with strains core
Finger gate	Ring gate	Wedge gate

(c) Bottom gates

A bottom gate is provided in the drag half of the mould. Refer Figure 1.36.

In this, liquid metal fills rapidly the bottom portion of the mould cavity and rises steadily and gently up the mould walls.

Bottom gates provide less turbulence and erosion in the mould cavity.

It is not used in large and deep casting because the metal cools gradually as it rises up.

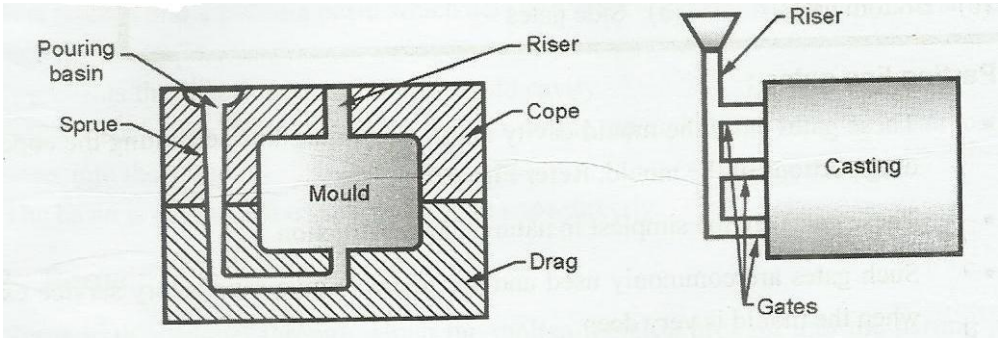

Fig. 1.36 Bottom gate

Fig. 1.37 Side gate

(d) Side gates

Side gates are provided on either left or right side of the casting.

Hence, the metal enters into the mould cavity from sides.

It enters near the bottom first, and then as the level of the metal rises in the mould the incoming molten metal starts entering near the surface of the rising metal. Refer Figure 1.37.

1.17.5 Riser or Feeder Head

A riser is a passage of sand made in the cope to permit the molten metal to rise above the highest point in the casting after the mould cavity is filled up. Refer Figure 1.33.

This metal in the riser compensates the shrinkages as the casting solidifies. The functions of risers are as follows:

- To feed metal to the solidifying casting, so that shrinkage cavities are go rid of.
- It permits the escape of air and mould gases as the mould cavity is being filled with the molten metal.
- It promotes directional solidification.
- Also, it shows that the mould cavity has been completely filled or not.

A casting solidifying under the liquid metal pressure of the riser is comparatively sound. There are two types of risers i.e. open riser and blind riser. An open riser has its top surface exposed to atmosphere, where the blind riser is a cavity in a round shape formed either on the top or side of the casting.

1.18 Moulding Machines

Moulding machine is used for mass production. Since the hand moulding is a slow process, it can be only used for making few castings. For producing more castings, moulding is done by using moulding machines. It reduces the labours but it increases the quality of the mould.

Moulding machines will do the following operations:

1. Ramming the moulding sand
2. Rapping the pattern for easy removal
3. Removing the pattern from the sand

The following types of moulding machines are generally used

1. Jolting machine.
2. Squeezing machine.
3. Sand slinger.

1.18.1 Jolting Machine

In Jolting machine, the pattern is placed in the flask on the table. The flask is filled up with moulding sand. The table with flask is raised to about 80 mm and suddenly dropped. The table will be operated pneumatically or hydraulically. The sudden dropping of table from a height makes the sand pack evenly around the pattern. This type of machine is mainly used for ramming horizontal surfaces on the mould. The operation is noisy because of jolting.

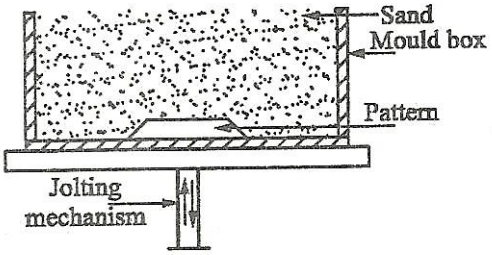

Figure 1.38 Jolt Machine

1.18.2 Squeezing Machine

In a squeezing machine, the moulding sand in the flask is squeezed between the machine table and a squeezer head. A top squeezer machine is shown in Figure 1.39. The mould board is clamped on the table. The flask is placed on the mould board. The pattern is placed inside the flask. The sand is filled up and leveled. The table is raised by the table lift mechanism against the squeezer head. The platen enters the sand frame and packs the sand tightly. After squeezing the flask, the table comes down to the starting position.

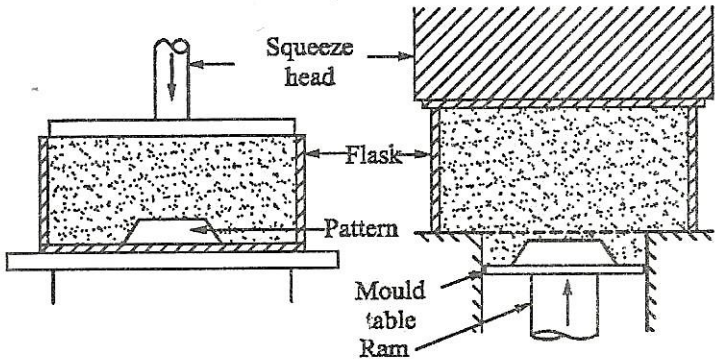

Figure 1.39 Top and Bottom Squeezing Machine

The main limitation of this machine is that the sand is rammed more densely on the top of the mould than the sand near the pattern.

1.18.3 Bottom Squeezer Machine

Here, the pattern is placed on the mould table. The mould table is clamped on the ram. The flask is placed on a frame and is filled with sand. The table with the pattern is raised up

against the squeezer head. Thus, the flask with the pattern is squeezed between the squeezer head and the table. Then the table returns to its original position.

1.18.4 Sand Slinger

Moulding process is performed by using a sand slinger, as shown in Figure 1.40. In this, the pattern is placed on a board. The flask is placed over it. Now, the slinger is operated. The slinger has an impeller which can be rotated with different speeds. When the impeller rotates, it will throw a stream of sand at greater velocity into the flask. Hence, the sand is packed in the flask.

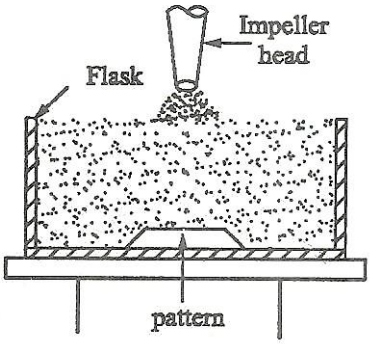

Figure 1.40 Sand Slinger

The slinger can be moved to pack the sand uniformly around the pattern. The density of sand is controlled by the speed of the impeller. In this method, the ramming will be uniform with good strength. It is used for large and medium size moulds.

1.19 Melting Furnaces

Various types of melting furnace are used in the foundry shop. The type of furnace used depends upon the type of metal and the quantity of metal to be melted. The metal melting furnaces used in foundries are:

1. Blast furnace – For smelting iron to produce pig iron
2. Cupola furnace – For cast iron
3. Open hearth furnace – For steel
4. Crucible furnace – For non-ferrous metal
    a) Pit type furnace
    b) Coke fired stationary furnace
    c) Oil fired tilting furnace
5. Pot furnace
6. Electric furnace
    a) Direct are furnace
    b) Indirect are furnace
    c) Induction furnace