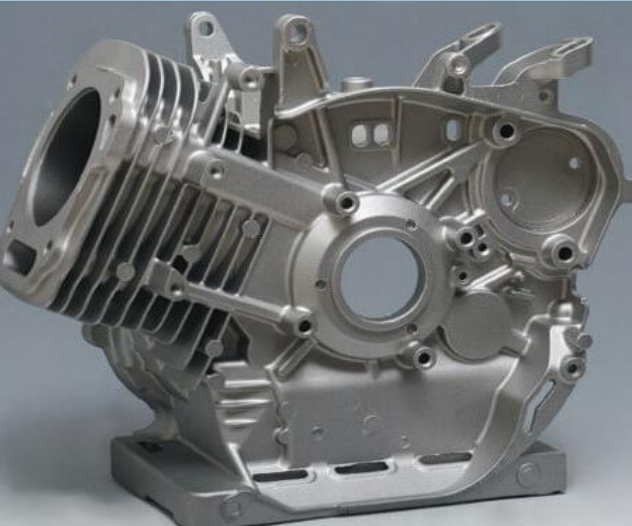
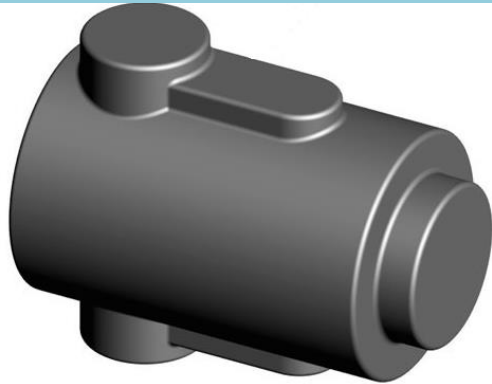


# LECTURE-01: METAL CASTING PROCESSES



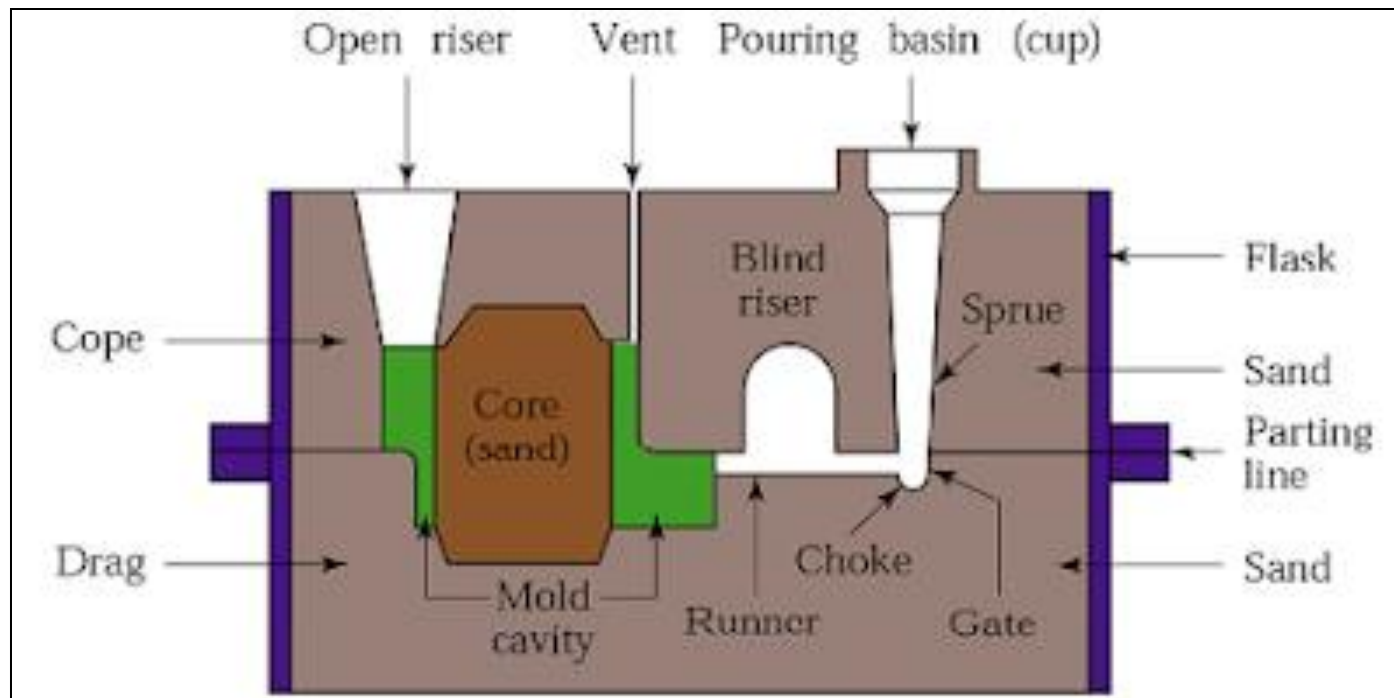
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**DR. NIKHIL R. DHAR**

Professor, IPE Department  
BUET

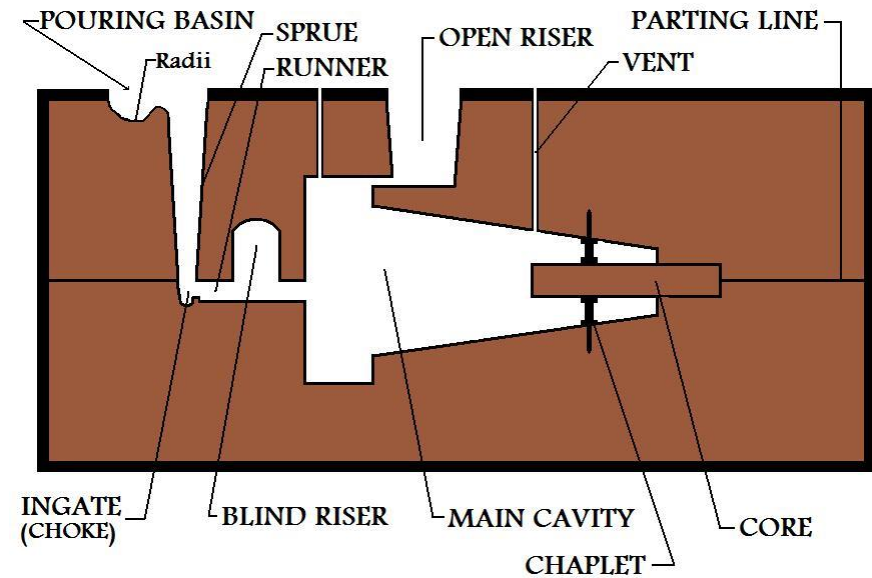
# Introduction

- Casting is the process of production of objects by pouring molten material into a cavity called a **mold** which is the **negative of the object**, and allowing it to cool and solidify. Sand casting is a means of producing rough metal castings using a mold usually made from sand formed around a replica of the object to be cast that is removed once the sand has been compacted.



# Elements of a Gating System

- **Pouring Basin**: This is where the molten metal employed to manufacture the part enters the mold. The pouring basin should have a projection with a radius around it to reduce turbulence.
- **Down Sprue**: From the pouring basin, the molten metal for the casting travels through the down sprue. This should be tapered so its cross-section is reduced as it goes downward.
- **Sprue Base**: The down sprue ends at the sprue base. It is here that the casting's inner cavity begins.
- **Ingate/Choke Area**: Once at the sprue base, the molten material must pass through the ingate in order to enter the inner area of the mold. The ingate (Choke) is very important for flow regulation during the metal casting operation.



Gating System for Casting



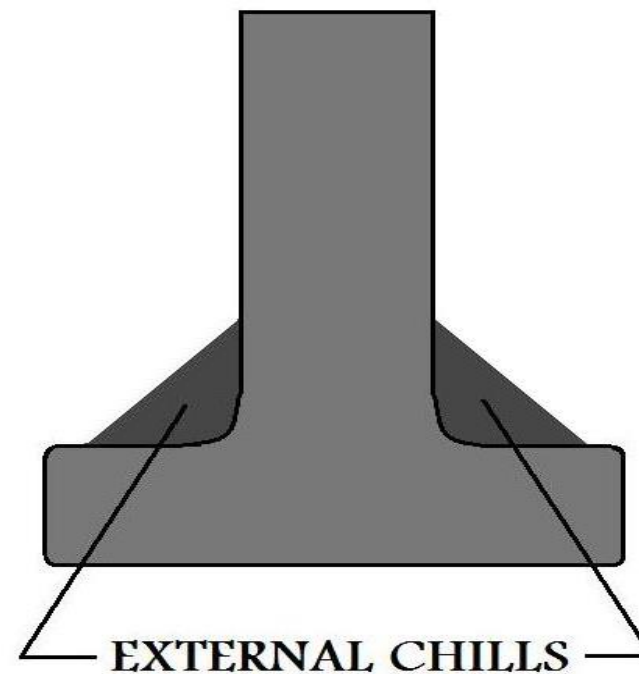
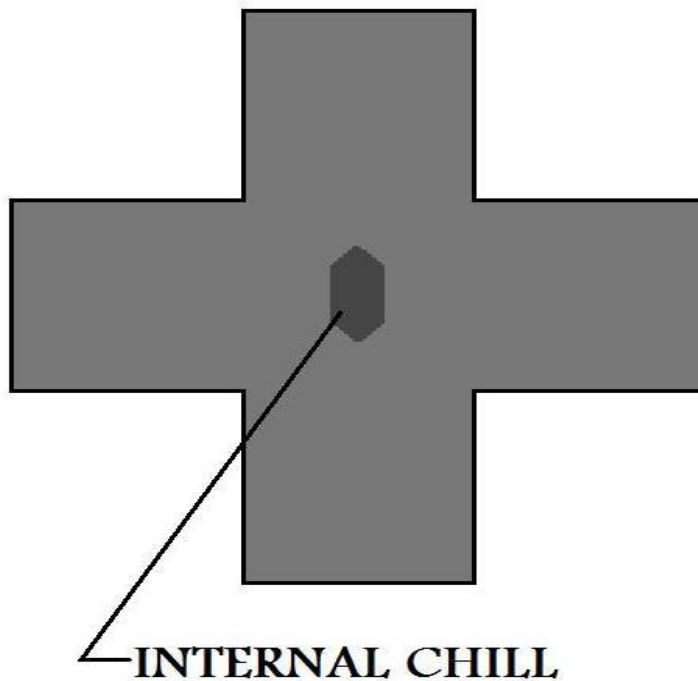
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- **Runners**: Runners are passages that distribute the liquid metal to the different areas inside the mold.
  - **Main Cavity**: The impression of the actual part to be cast is often referred to as the main cavity.
  - **Vents**: Vents help to assist in the escape of gases that are expelled from the molten metal during the solidification phase of the metal casting process.
  - **Risers**: Risers are reservoirs of molten material. They feed this material to sections of the mold to compensate for shrinkage as the casting solidifies. There are different classifications for risers.
    - **Top Risers** : Risers that feed the metal casting from the top.
    - **Side Risers** : Risers that feed the metal casting from the side.
    - **Blind Risers** : Risers that are completely contained within the mold.
    - **Open Risers** : Risers that are open at the top to the outside environment.



- **Chills:** Directional solidification is very important to the manufacture of a part during the metal casting process, in order to ensure that no area of the casting is cut off from the flow of liquid material before it solidifies. To achieve directional solidification within the metal casting, it is important to control the flow of fluid material and the solidification rate of the **different areas of the metal casting**. Chills are small pieces of metal, capable of quick heat absorption. They are placed inside the mold cavity before pouring. **Chills are of two basic types.**
  - Internal chills are located inside the mold cavity and are usually made of the same material as the casting. When the metal solidifies the internal chills are fused into the metal casting itself.



- External chills are located just outside of the casting. External chills are made of a material that can remove heat from the metal casting faster than the surrounding mold material. Possible materials for external chills include iron, copper, and graphite.



# Patterns Materials

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- **Wood**
  - Advantages: (i) Easily available (ii) Cheap (iii) Light in weight (iv) Easy to work and (iv) Good finish.
  - Disadvantages: (i) readily affected by moisture (ii) wear out quickly by sand abrasion (iii) warp badly if not stored properly (iv) less strength, tends to break on miss-handling (v) shape changes when dries out and (vi) does not last long
- **Metals**: Aluminum, Cast iron, Brass, White metal etc.
  - Advantages: (i) no effect of moisture and (ii) no cracking, bending etc. due to improper storing
  - Disadvantages: (i) less easy to shape and work (ii) heavy in weight (iii) costly and (iv) affected by rust or corrosion
- **Plaster-gypsum cement**
- **Plastic compound**
- **Wax**



# Pattern Allowances

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- **Shrinkage Allowance**: Like all materials, metal contracts as it cools. If the pattern were made in the exact dimensions specified for the end-product, the casting would be smaller than required. Shrinkage allowance compensates for the amount that a metal will shrink during cooling. The precise allowance depends on the metal being cast.
- **Draft or Taper Allowance**: The pattern needs to incorporate suitable allowances for draft, which means that its sides are tapered so that when it is pulled from the sand, it will tend not to drag sand out of place along with it. This is also known as taper which is normally between 10 and 30.
- **Distortion Allowance**: it is found that big castings tend to warp or distort during the cooling period due to their size, shape and type of metal. Uneven shrinkage also causes distortion. To overcome this effect, the pattern is made initially distorted in opposite direction. Such an allowances depends on the judgment and experience of the pattern maker who knows the shrinkage characteristics of the metal.



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- **Finishing or Machining Allowance**: The rough surfaces of the casting are to be finished or machined. Therefore, the rough casting must be made bigger than the actual component in size and hence the pattern should also be bigger in size than the actual component.
  - **Shaking or Rapping Allowance**: When the pattern is rapped or shaken for easy removal from the cavity, it is found the cavity in the mold is slightly increased in size. To compensate this increase, the pattern should be initially made slightly smaller. In small and medium sized castings, this allowance can be ignored, but in large sized castings or in those that must fit together without machining or where high precision is required, shaking allowance is provided by making the pattern slightly smaller.



# Types of Pattern

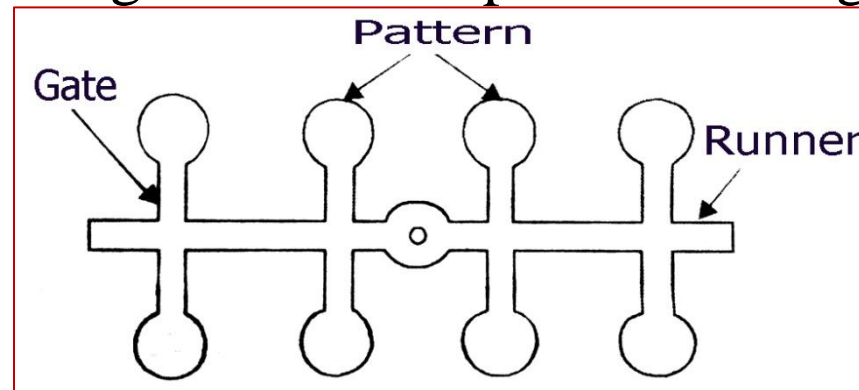
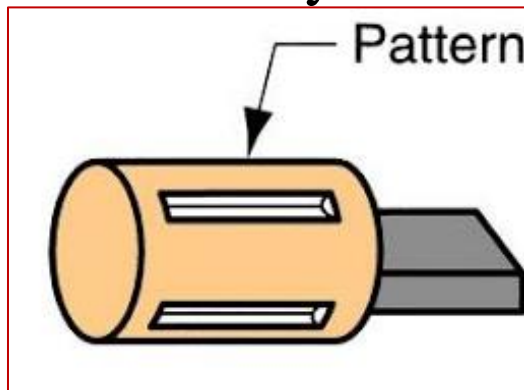
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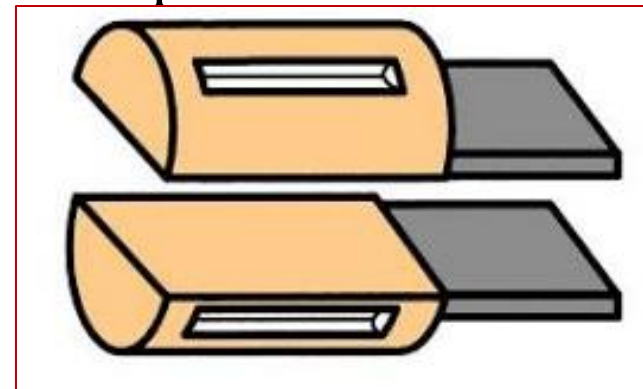
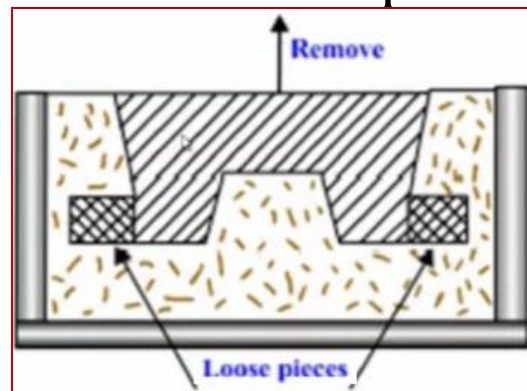
- Variety of patterns are used in casting and the choice depends on the configuration of casting and number of castings required. **The type of pattern selected for a particular casting will depend on the following several conditions:**
  - Shape and size of casting
  - Number of castings required
  - Method of molding used
  - Difficulty of the molding operation.
  - Characteristics of castings
- **Different types of patterns:**
  - Single piece pattern, Split pattern, Loose piece pattern, Gated pattern, Match plate pattern, Sweep pattern, Cope and drag pattern, Skeleton pattern, Shell pattern, and Follow board pattern



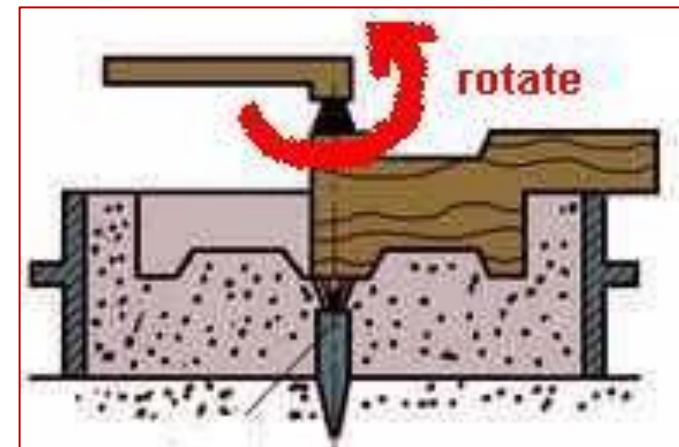
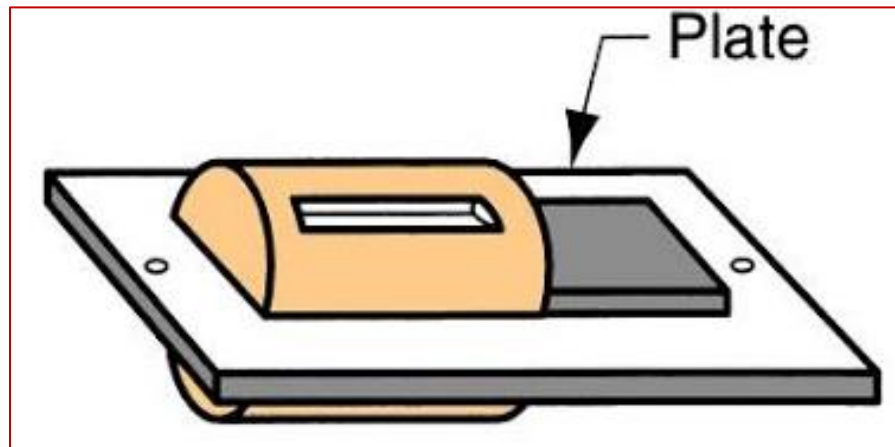
- **Single Piece Pattern**: This type of pattern is made without joints, partings or any loose pieces. The molder has to cut gates and users in the sand mold by hand by which process it is difficult to obtain uniformity in the casting. The single piece pattern is generally used for large casting of simple shape.
- **Gated Pattern**: Gated pattern are used for mass production of small castings. The passage through which the molten metal flows into the mold is called gate. In mass production if the gate is made by hand for every small mold, it will take a lot of time. Therefore, a number of small castings are produced in a single multi-cavity mold by joining a number of patterns through gates.



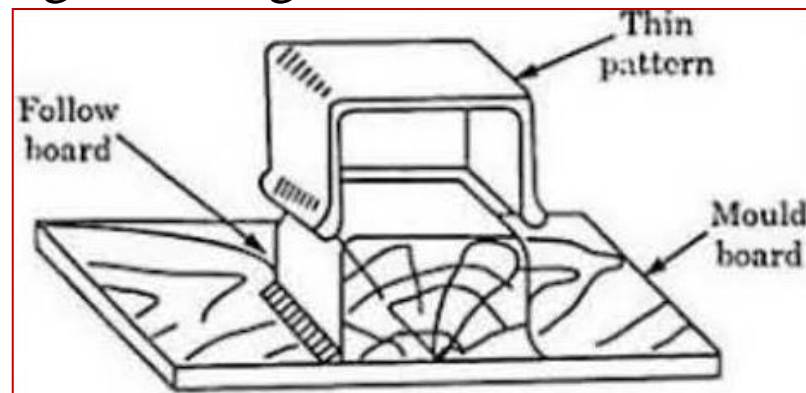
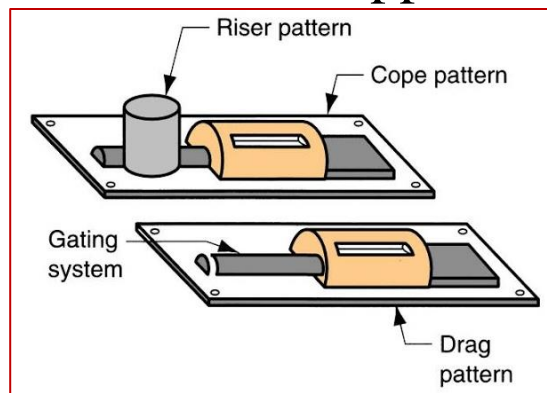
- **Loose Piece Pattern**: Loose piece pattern is made of loose component pieces assembled together by dowel pins. The whole pattern can be removed from the sand mold by taking out all the component pieces one by one. The main piece is usually removed first, after that the separate loose pieces, which may have to be turned or moved before taking out, are removed.
- **Split Pattern**: A split pattern is made in two or more parts joined together by dowel pins. When the casting is of peculiar design and intricate shape, its pattern cannot be made in single piece, because it cannot be withdrawn from the mold. Therefore such a pattern is made split in two or more pieces.



- **Match Plate Pattern**: When split patterns are mounted with one half on one side of a plate and the other half directly opposite on the other side of the plate, the pattern is called match plate pattern. On one plate, called the match plate, many patterns can be mounted.
- **Sweep Pattern**: The sweep pattern are used to prepare mold of symmetrical and regular shapes particularly in large sizes. A sweep pattern consists of a wooden board fixed to metal rod. The outer contour of the board is similar to the contour of the castings.



- **Cope and Drag Pattern**: If the casting is large, the complete mold is too heavy and difficult to handled by a single operator. For such castings the cope and drag patterns are made. The pattern is made in two halves, split on a convenient joint line. The first half is in cope and the other half in drag. After removing the two halves from the molding sand, the cope and drag are then assembled to make the complete mold.
- **Follow Board Pattern**: The pattern having thin sections, tend to get distorted or collapse during ramming. Sagging of thin pattern due to ramming can be easily overcome by constructing a supporting block (follow board) which may fit inside the pattern to serve as a support during ramming.



# Molding Sand

- Molding sand is the principal raw material used in molding because it possesses several major characteristics required for molding. The molding sands classified into **two categories** according to the nature of its origin.
  - **Natural or Green Sand**: It is collected from natural resources like river beds or is dug from pits. It contains the only binder as water. It has the advantages of maintaining moisture content for a long time, wide working range of moisture content and permits easy patching and finishing of molds
  - **Synthetic Sand**: It is an artificial sand prepared in the foundry by mixing clay free sand, binder and other materials as required. Its properties can be easily controlled by mixture content. **Advantages of synthetic sand**
    - Low sand maintenance cost
    - Improved permeability, lower moisture
    - Easier to work on mass production molding
    - Semi-skilled workers can work on machine molding
    - No sand dumping



# Properties of Molding Sand

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- **Refractoriness**: Refractoriness is the property of sand to withstand high temperature of molten metal without fusion or soften. Moulding sands with poor refractoriness may burn when the molten metal is poured into the mould. Usually, sand moulds should be able to withstand up to 1650°C.
- **Permeability**: Permeability is the most important property of the moulding sand. It is the ability of the moulding sand to allow gasses to pass through. Gasses and steam are generated during the pouring of molten metal into the sand cavity. This property depends not only on the shape and size of the particles of the sand but also on the amount of the clay, binding material, and moisture contents in the mixture.
- **Cohesiveness**: Cohesiveness is the property of sand to hold its particles together. It may be defined as the strength of the moulding sand. This property plays a vital role in retaining intricate shapes of the mould. Insufficient strength may lead to a collapse in the mould particles during handling, turning over, or closing. Clay and bentonite improves the cohesiveness.



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- **Adhesiveness**: Adhesiveness is the property of sand due to which the sand particles sticks to the sides of the moulding box. Adhesiveness of sand enables the proper lifting of cope along with the sand.
  - **Plasticity**: Plasticity is the property of the moulding sand by virtue of which it flows to all corners around the mould when rammed, thus not providing any possibility of left out spaces, and acquires a predetermined shape under ramming pressure.
  - **Flow-Ability**: low-ability is the ability of moulding sand to free flow and fill the recesses and the fine details in the pattern. It varies with moisture content.
  - **Collapsibility**: Collapsibility is the property of sand due to which the sand mould collapse automatically after the solidification of the casting. The mould should disintegrate into small particles of moulding sand with minimum force after the casting is removed from it.



# Types of Moulding Sand

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- **Green Sand**: The green sand is the natural sand containing sufficient moisture in it. It is mixture of silica and 15 to 30% clay with about 8% water. Clay and water act as a bonding material 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.
- **Dry Sand**: 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 and heavy castings.
- **Loam Sand**: Loam sand is a mixture of 50 percent sand and 50 percent clay. Water is added in sufficient amount. It is used for large and heavy moulds e.g., turbine parts, hoppers etc.
- **Facing Sand**: A sand used for facing of the mould is known as 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 the hot molten metal; therefore it must have high refractoriness and strength. It has very fine grains.



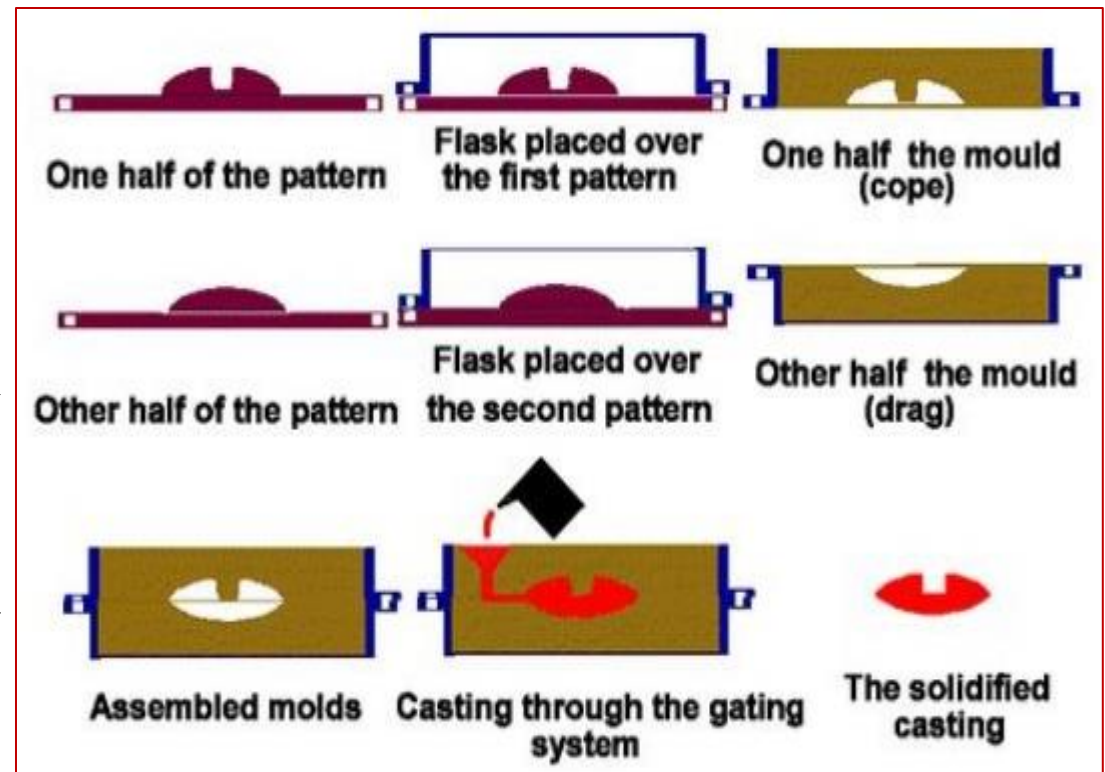
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- **Parting Sand**: A pure silica sand employed on the faces of the pattern before moulding is known as parting sand. When the pattern is withdrawn from the mould, the moulding sand sticks to it. To avoid sticking, parting sand is sprinkled on the pattern before it is embedded in the moulding sand. Parting sand is also sprinkled on the contact surface of cope, drag and cheek.
  - **Backing or Floor Sand**: The backing sand is old and repeatedly used sand of black color. 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.
  - **System Sand**: The sand employed in mechanical heavy castings 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.
  - **Core Sand**: 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 (dextrine, corn flour, sodium silicate). It has remarkable compressive strength.



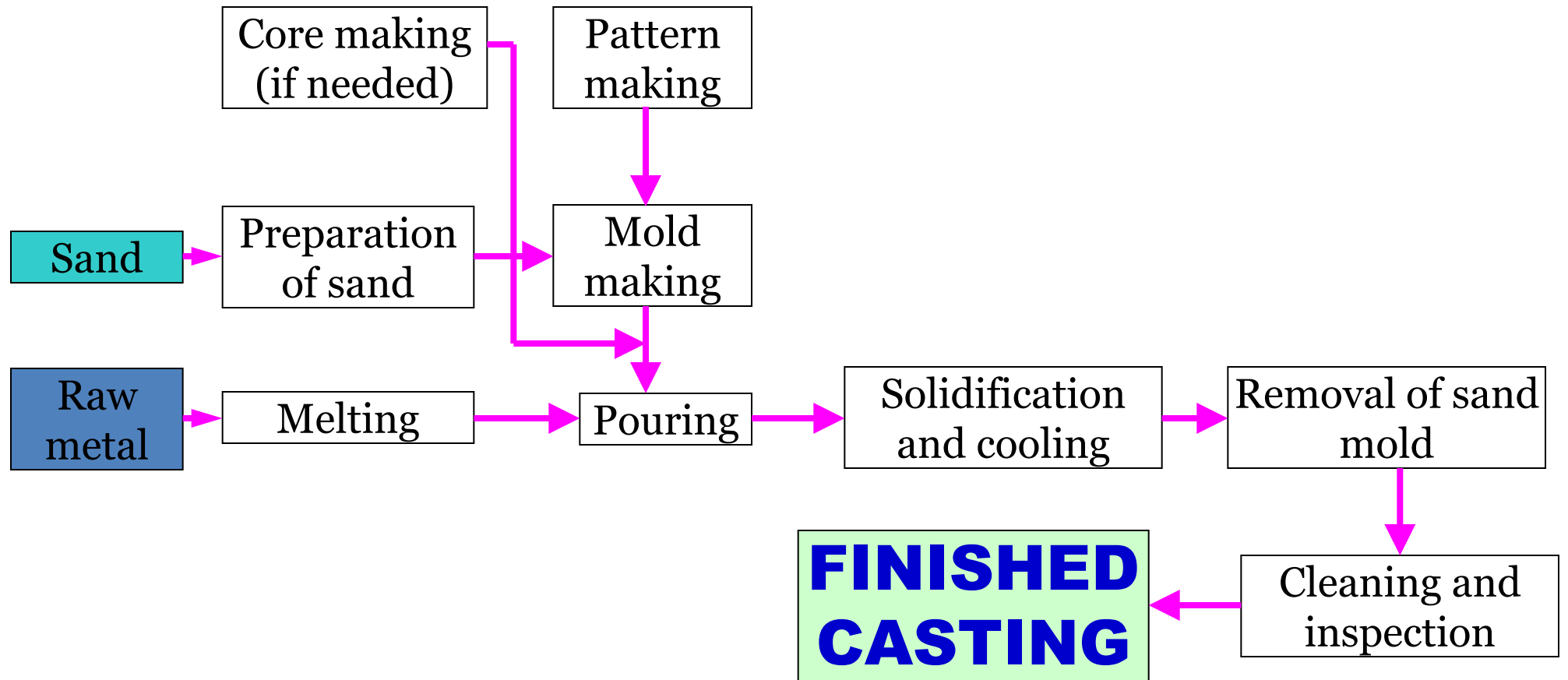
# Casting Processes

- A sand casting or a sand molded casting is a cast part produced by forming a mold from a sand mixture and pouring molten liquid metal into the cavity in the mold. The mold is then cooled until the metal has solidified. In the last stage the casting is separated from the mold. There are six steps in this process:.

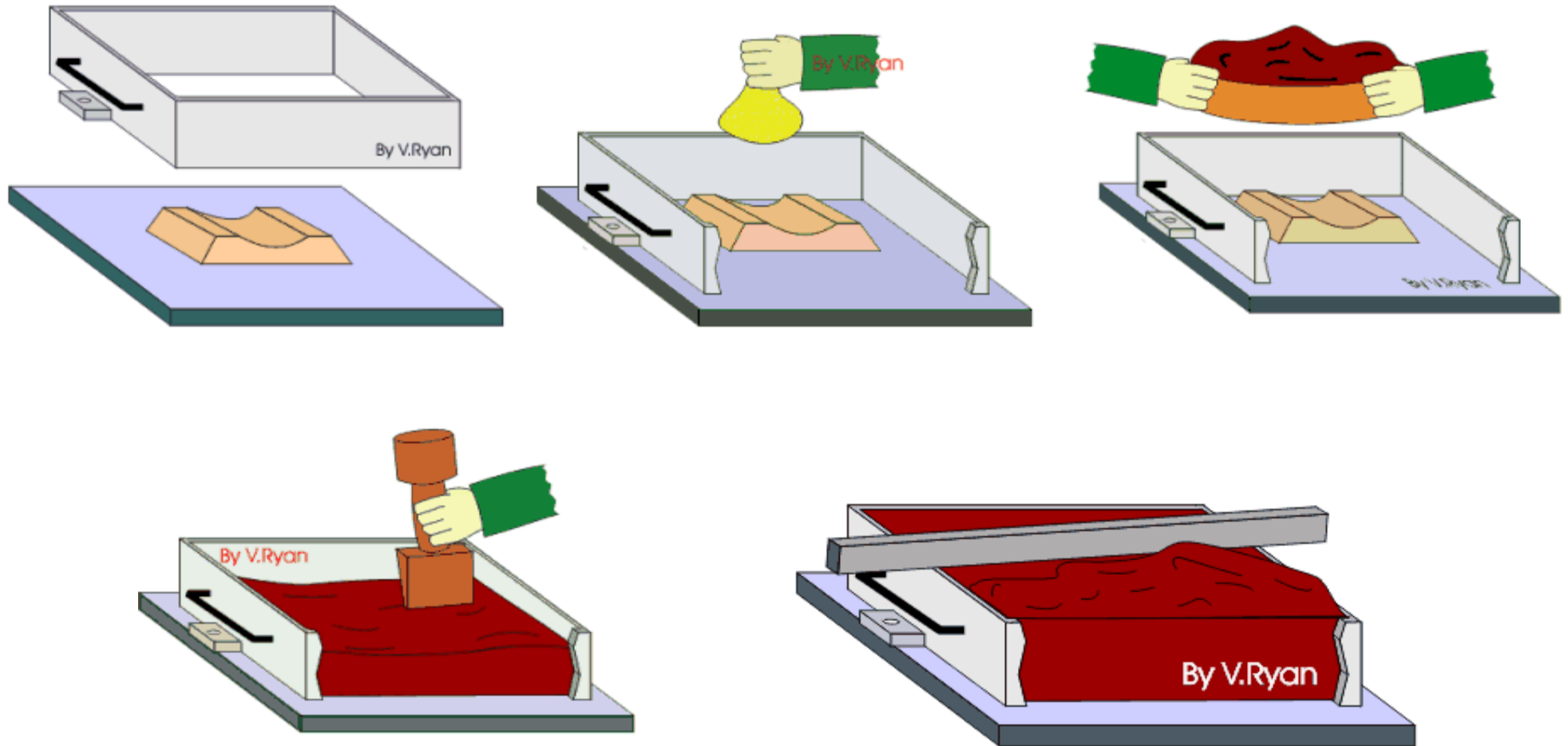
- Place a pattern in sand to create a mold.
- Incorporate a gating system.
- Remove the pattern.
- Fill the mold cavity with molten metal.
- Allow the metal to cool.
- Break away the sand mold and remove the casting.



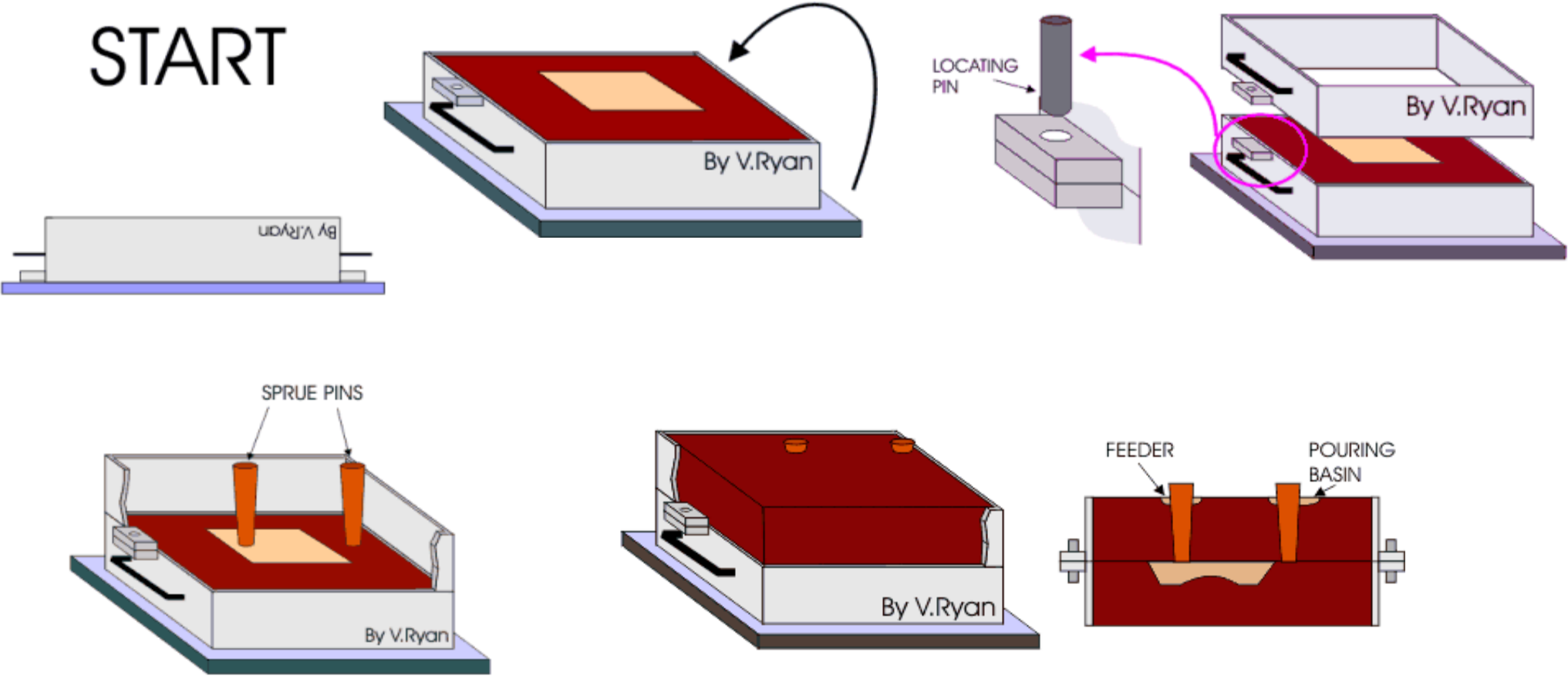
# Steps in Sand Casting

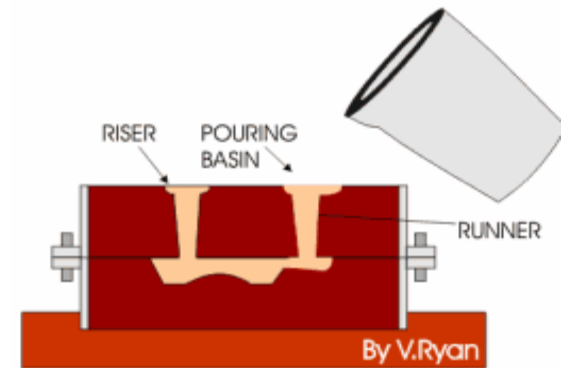
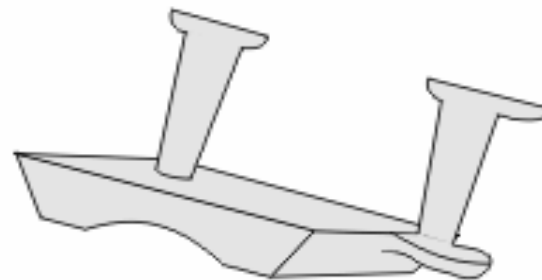
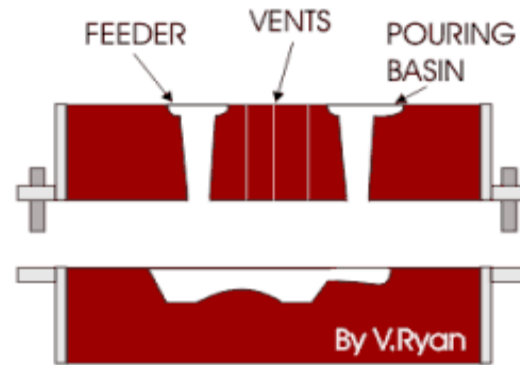
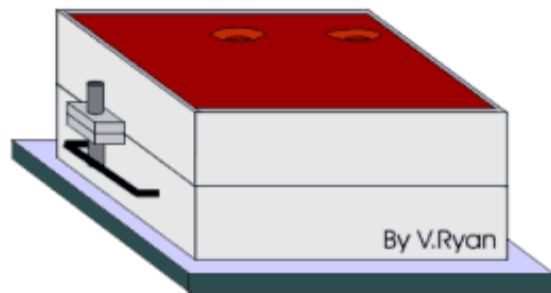
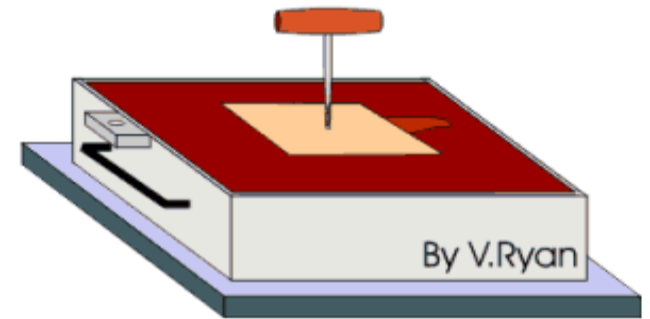
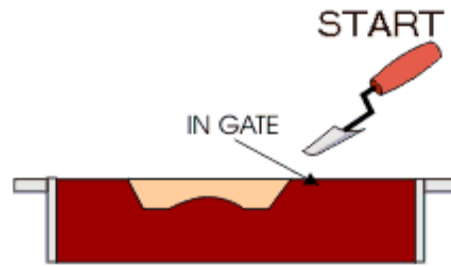
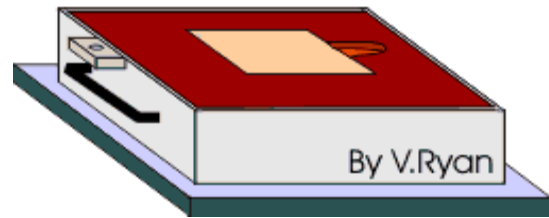


# Animation of Sand Casting Step



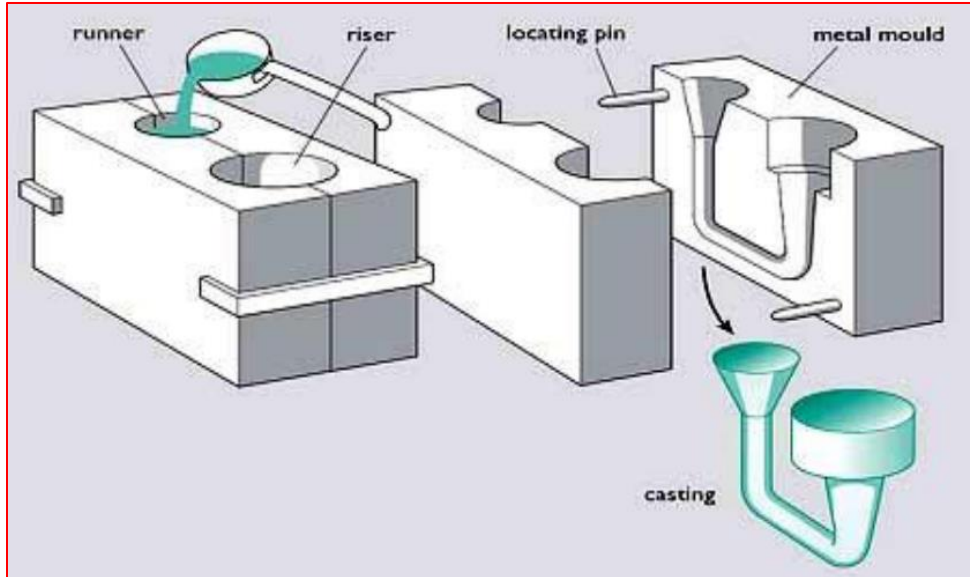
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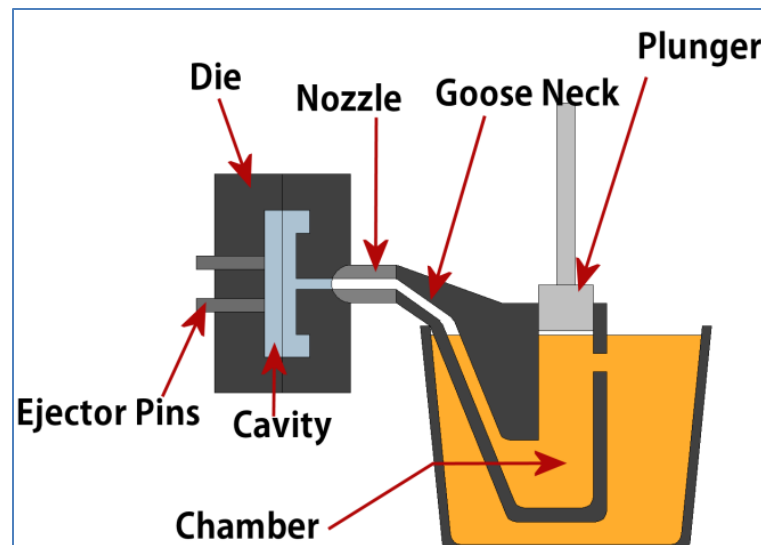


# Die Casting

- **Gravity-Die Casting:** Following Figure, is similar to sand casting except that the mould is machined from solid metal, usually cast iron. This means that the mould and cavity are permanent. Being metal, the mould can be machined accurately and, having good thermal conductivity, it allows the casting to cool quickly. The surface finish is better than can be produced by sand casting, but as metal moulds are required, product sizes are generally smaller than those possible with sand casting. **Typical products include bicycle cranks and engine pistons.** Of course, the metal being cast must have a lower melting point than the mould metal.



- **Pressure-Die Casting**: It is a development of gravity-die casting in which the molten metal is injected into a steel mould under pressure; it is the metal equivalent of injection molding. Again, the metal being cast must have a lower melting point than the mould material. Pressure-die casting is quicker than sand and gravity die casting and because the fluid is under pressure, finer surface details can be replicated. It is commonly used for **door handles, electric iron bases and hollow sections** requiring fine detail such as carburetor bodies.



Break Drum Aluminum  
Pressure Die Casting



Pressure Die Casting  
Engine block



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## ■ Advantages of Die Casting:

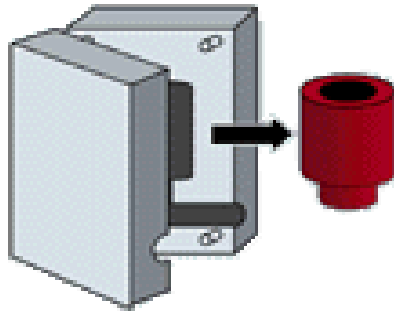
- Cost of castings is relatively low with high volumes.
- High degree of design complexity and accuracy.
- Excellent smooth surface finish.
- Suitable for relatively low melting point metals ( $871^{\circ}\text{C}$ ) like lead, zinc, aluminum, magnesium and some copper alloys.
- High production rates.

## ■ Disadvantages of Die Casting:

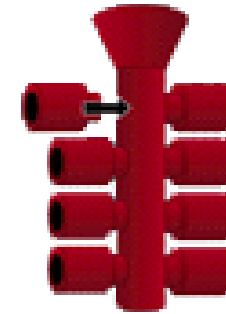
- Castings must be smaller than 600 mm and the thickest wall section should be kept below 13 mm
- High initial cost (Cost of moulds and machine set up)
- A large production volume is required to make the process cost effective
- Some porosity is common with die casting
- Die casting is limited to high fluidity metals (Zinc, Aluminum, Magnesium, Copper, Lead and Tin)



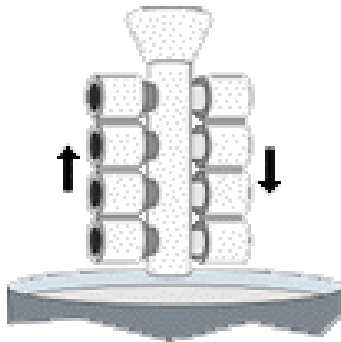
# Investment or Lost-Wax Casting



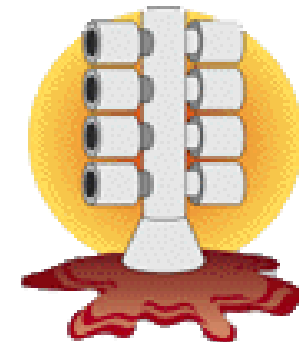
1. **WAX INJECTION:** Wax replicas of the desired castings are produced by injection molding. These replicas are called patterns.



2. **ASSEMBLY:** The patterns are attached to a central wax stick, called a sprue, to form a casting cluster or assembly.

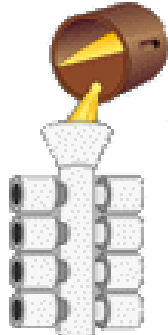


3. **SHELL BUILDING:** The shell is built by immersing the assembly in a liquid ceramic slurry and then into a bed of extremely fine sand. Up to eight layers may be applied in this manner.

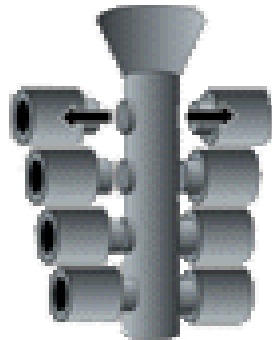


4. **DEWAX:** Once the ceramic is dry, the wax is melted out, creating a negative impression of the assembly within the shell.

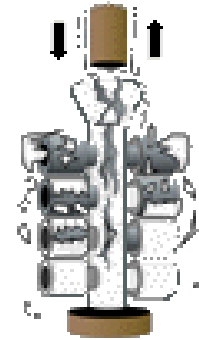




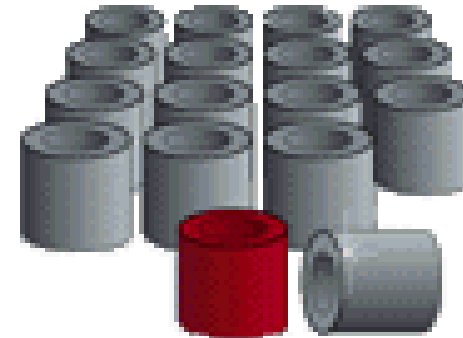
5. **CONVENTIONAL CASTING:** In the conventional process, the shell is filled with molten metal by gravity pouring. As the metal cools, the parts and gates, sprue and pouring cup become one solid casting.



7. **CUT OFF:** The parts are cut away from the central sprue using a high speed friction saw.



6. **KNOCKOUT:** When the metal has cooled and solidified, the ceramic shell is broken off by vibration or water blasting.



8. **FINISHED CASTINGS:** After minor finishing operations, the metal castings-identical to the original wax patterns-are ready for shipment to the customer.



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- Advantages of Investment or Lost-Wax Casting

- Excellent accuracy and flexibility of design.
- Useful for casting alloys that are difficult to machine.
- Exceptionally fine finish.
- Suitable for large or small quantities of parts.
- Almost unlimited intricacy.
- Suitable for most ferrous / non-ferrous metals.
- No flash to be removed or parting line tolerances.

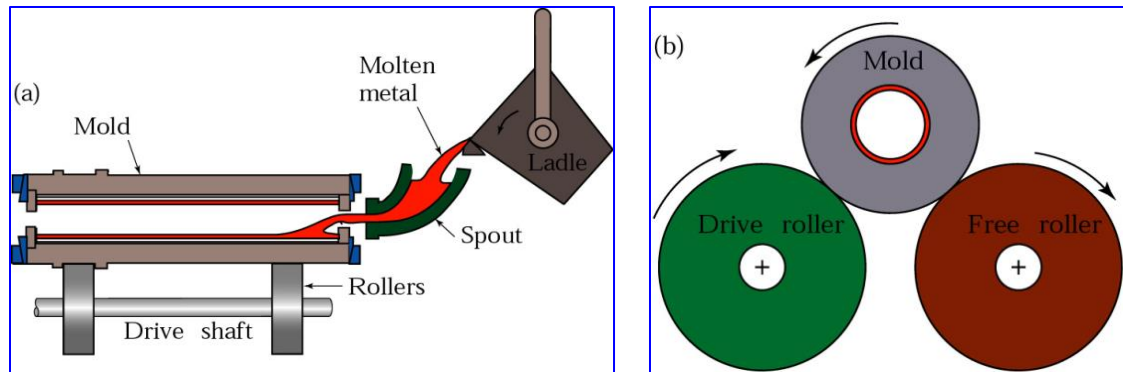
- Disadvantages of Investment or Lost-Wax Casting

- Limitations on size of casting.
- Higher casting costs make it important to take full advantage of the process to eliminate all machining operations.



# Centrifugal Casting

- A permanent mold made of metal or ceramic is rotated at high speed (300 to 3000 rpm). The molten metal is then poured into the mold cavity and due to centrifugal action the molten metal conform to the cavity provided in the mould. Castings are known for their higher densities in the outer most regions. The process gives good surface finish. Applications: pipes, bushings, gears, flywheels etc.

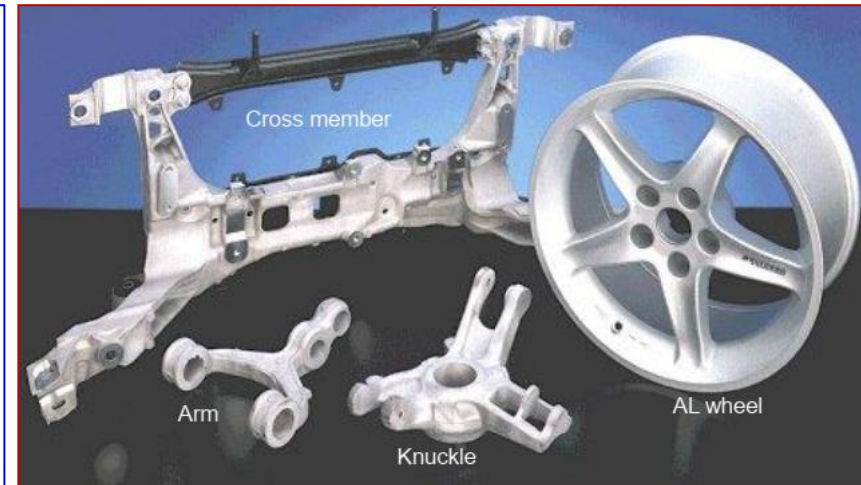
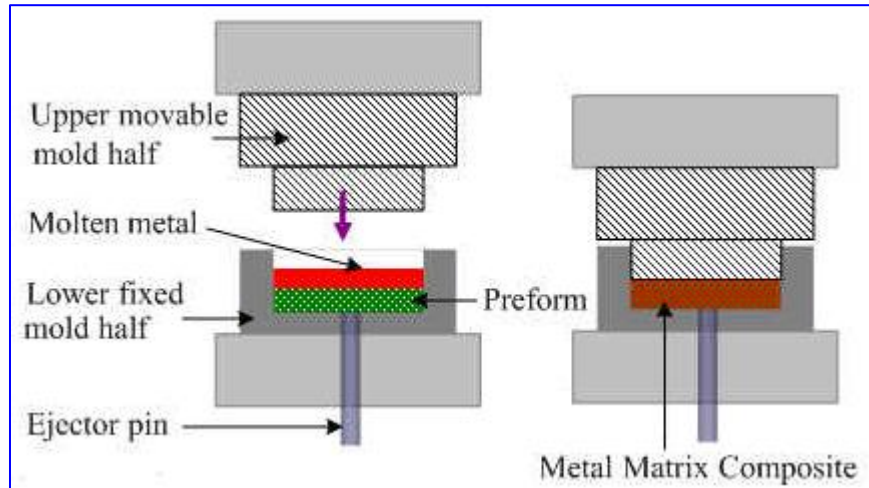


Schematic illustration of the centrifugal casting process. Pipes, cylinder liners, and similarly shaped parts can be cast with this process.



# Squeeze Casting

- Squeeze casting, also known as liquid metal forging, is a combination of casting and forging process. The molten metal is poured into the bottom half of the pre-heated die. As the metal starts solidifying, the upper half closes the die and applies pressure during the solidification process. The amount of pressure thus applied is significantly less than used in forging, and parts of great detail can be produced. Coring can be used with this process to form holes and recesses. **The porosity is low and the mechanical properties are improved. Both ferrous and non-ferrous materials can be produced using this method.**



# Comparison of Casting Process

Casting Processes	Advantages	Limitations
Sand Casting	<ul style="list-style-type: none"> <li>■ Almost any metal can be cast</li> <li>■ No limit on size and shape</li> <li>■ Low equipment cost</li> <li>■ Economical for low volume production</li> </ul>	<ul style="list-style-type: none"> <li>■ Coarse finish</li> <li>■ Dimensional accuracy not so good</li> <li>■ Finishing required</li> <li>■ Low production rate</li> </ul>
Investment Casting	<ul style="list-style-type: none"> <li>■ Almost any metal can be cast</li> <li>■ Good surface finish &amp; dimensional accuracy</li> <li>■ Fairly high production rate</li> <li>■ Intricate shapes can be cast</li> <li>■ Low finishing cost</li> </ul>	<ul style="list-style-type: none"> <li>■ Limitation on part size</li> <li>■ Expensive pattern and mold</li> <li>■ High labor cost</li> </ul>
Die Casting	<ul style="list-style-type: none"> <li>■ Excellent surface finish</li> <li>■ Excellent dimensional accuracy</li> <li>■ High production rate</li> <li>■ Complex shape can be cast</li> <li>■ Little or no finishing cost</li> </ul>	<ul style="list-style-type: none"> <li>■ Limitation on part size</li> <li>■ High cost of die</li> <li>■ Generally limited to casting of non-ferrous metals</li> </ul>
Centrifugal Casting	<ul style="list-style-type: none"> <li>■ High production rate</li> <li>■ Good dimensional accuracy and surface finish</li> </ul>	<ul style="list-style-type: none"> <li>■ Expensive set-up</li> <li>■ Good for production of cylindrical parts only</li> </ul>



# Casting Defects

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- It is an unwanted irregularities that appear in the casting during metal casting process. There is various reason or sources which is responsible for the defects in the cast metal. Here in this section we will discuss all the major types of casting defects. Some of the defects produced may be neglected or tolerated and some are not acceptable, it must be eliminated for better functioning of the parts. Defects may occur due to one or more of the following reasons:
  - Fault in design of casting pattern
  - Fault in design on mold and core
  - Fault in design of gating system and riser
  - Improper choice of molding sand
  - Improper metal composition
  - Inadequate melting temperature and rate of pouring



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- Casting defects can be categorized into five types
    - Gas Porosity: Blowholes, open holes, pinholes
    - Shrinkage Defects: shrinkage cavity
    - Mold Material Defects: Cut and washes, swell, drops, metal penetration, rat tail
    - Pouring Metal Defects: Cold shut, misrun, slag inclusion
    - Metallurgical Defects: Hot tears, hot spot.



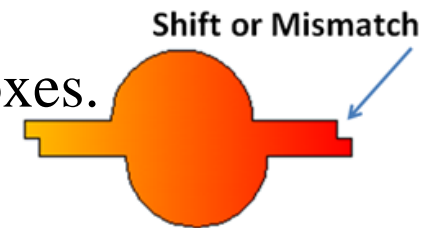
- **Shift or Mismatch**: The defect caused due to misalignment of upper and lower part of the casting and misplacement of the core at parting line.

- **Cause:**

- Improper alignment of upper and lower part during mold preparation.
- Misalignment of flask

- **Remedies**

- Proper alignment of the pattern or die part, molding boxes.
- Correct mountings of pattern on pattern plates.
- Check the alignment of flask.



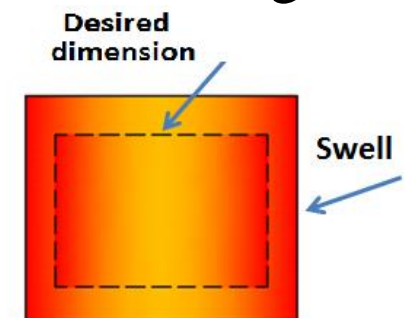
- **Swell**: It is the enlargement of the mold cavity because of the molten metal pressure, which results in localized or overall enlargement of the casting.

- **Causes**

- Defective or improper ramming of the mold.

- **Remedies**

- The sand should be rammed properly and evenly.



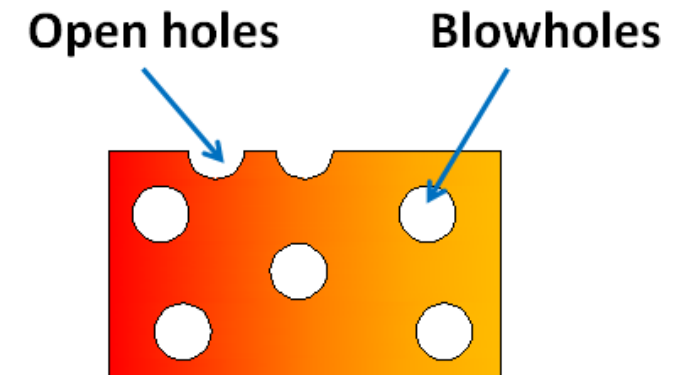
- **Blowholes:** When gases entrapped on the surface of the casting due to solidifying metal, a rounded or oval cavity is formed called as blowholes. These defects are always present in the cope part of the mold.

- Causes

- Excessive moisture in the sand.
- Low Permeability of the sand.
- Sand grains are too fine.
- Too hard rammed sand.
- Insufficient venting is provided.

- Remedies

- The moisture content in the sand must be controlled and kept at desired level.
- High permeability sand should be used.
- Sand of appropriate grain size should be used.
- Sufficient ramming should be done.
- Adequate venting facility should be provided.



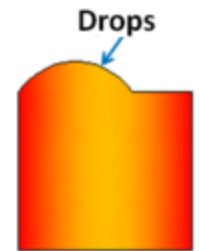
- **Drop:** Drop defect occurs when there is cracking on the upper surface of the sand and sand pieces fall into the molten metal.

- Causes

- Soft ramming and low strength of sand.
- Insufficient fluxing of molten metal. Fluxing means addition of a substance in molten metal to remove impurities. After fluxing the impurities from the molten metal can be easily removed.
- Insufficient reinforcement of sand projections in the cope.

- Remedies

- Sand of high strength should be used with proper ramming.
- There should be proper fluxing of molten metal, so the impurities present in molten metal is removed easily before pouring it into the mold.
- Sufficient reinforcement of the sand projections in the cope.



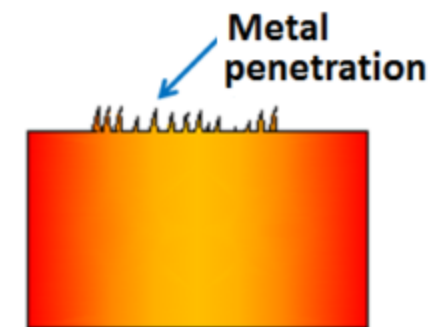
- **Metal Penetration**: These casting defects appear as an uneven and rough surface of the casting. When the size of sand grains is large, the molten metal fuses into the sand and solidifies giving us metal penetration defect.

- **Causes**

- It is caused due to low strength, large grain size, high permeability and soft ramming of sand. Because of this the molten metal penetrates in the molding sand and we get rough or uneven casting surface.

- **Remedies**

- This defect can be eliminated by using high strength, small grain size, low permeability and soft ramming of sand.



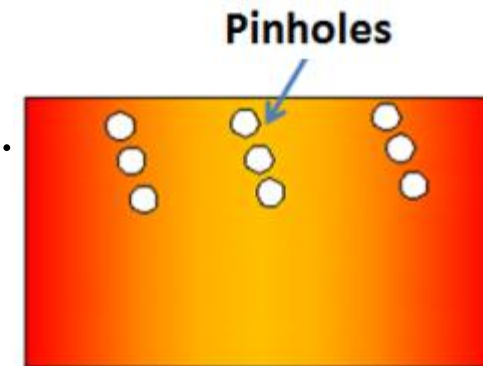
- **Pinholes**: They are very small holes of about 2 mm in size which appears on the surface of the casting. This defect happens because of the dissolution of the hydrogen gases in the molten metal. When the molten metal is poured in the mold cavity and as it starts to solidify, the solubility of the hydrogen gas decreases and it starts escaping out the molten metal leaves behind small number of holes called as pinholes.

- **Causes**

- Use of high moisture content sand.
- Absorption of hydrogen or carbon monoxide gas by molten metal.
- Pouring of steel from wet ladles or not sufficiently gasified.

- **Remedies**

- By reducing the moisture content of the molding sand.
- Good fluxing and melting practices should be used.
- Increasing permeability of the sand.
- By doing rapid rate of solidification.



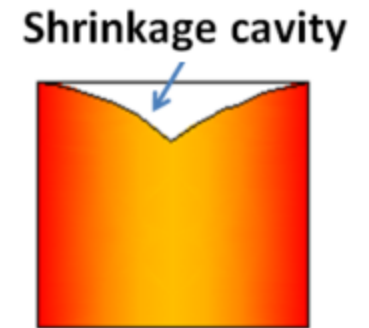
- Shrinkage Cavity: The formation of cavity in the casting due to volumetric contraction is called as shrinkage cavity.

- Causes

- Uneven or uncontrolled solidification of molten metal.
- Pouring temperature is too high.

- Remedies

- This defect can be removed by applying principle of directional solidification in mold design.
- Wise use of chills (a chill is an object which is used to promote solidification in a specific portion of a metal casting) and padding.



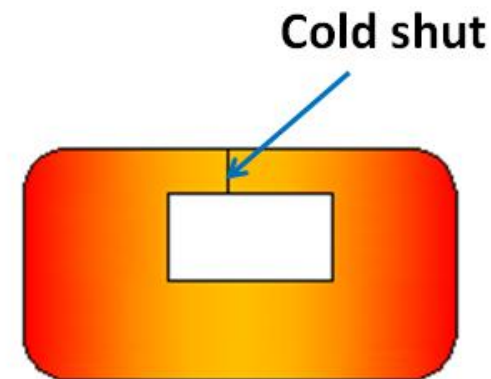
- **Cold Shut**: It is a type of surface defects and a line on the surface can be seen. When the molten metal enters into the mold from two gates and when these two streams of molten metal meet at a junction with low temperatures than they do not fuse with each other and solidifies creating a cold shut (appear as line on the casting). It looks like a crack with round edge.

- **Causes**

- Poor gating system
- Low melting temperature
- Lack of fluidity

- **Remedies**

- Improved gating system.
- Proper pouring temperature.



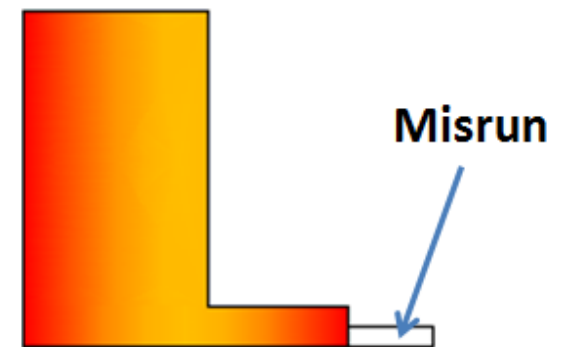
- **Misrun**: When the molten metal solidifies before completely filling the mold cavity and leaves a space in the mold called as misrun.

- **Causes**

- Low fluidity of the molten metal.
- Low temperature of the molten metal which decreases its fluidity.
- Too thin section and improper gating system.

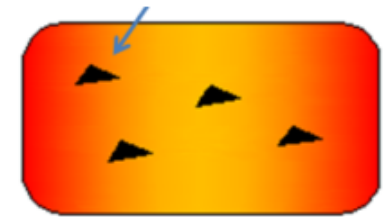
- **Remedies**

- Increasing the pouring temperature of the molten metal increases the fluidity.
- Proper gating system
- Too thin section is avoided.



- **Slag Inclusion**: This defect is caused when the molten metal containing slag particles is poured in the mold cavity and it gets solidified.

Slag Inclusion



- **Causes**

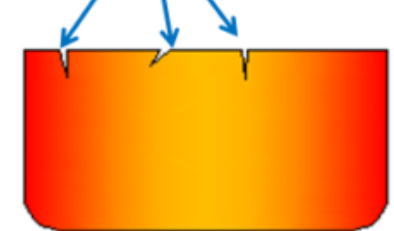
- The presence of slag in the molten metal

- **Remedies**

- Remove slag particles from the molten metal before pouring it into the mold cavity.

- **Hot Tears or Hot Cracks**: when the metal is hot it is weak and the residual stress (tensile) in the material cause the casting fails as the molten metal cools down. The failure of casting in this case is looks like cracks and called as hot tears or hot cracking.

Hot tears



- **Causes**

- Improper mold design.

- **Remedies**

- Proper mold design can easily eliminate these types of casting defects.
- Elimination of residual stress from the material of the casting.



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- **Hot Spot or Hard Spot**: Hot spot defects occur when an area on the casting cools more rapidly than the surrounding materials. Hot spot are areas on the casting which is harder than the surrounding area. It is also called as hard spot.
    - **Causes**
      - The rapid cooling an area of the casting than the surrounding materials causes this defect.
    - **Remedies**
      - This defect can be avoided by using proper cooling practice.
      - By changing the chemical composition of the metal.
  - **Sand Holes**: It is the holes created on the external surface or inside the casting. It occurs when loose sand washes into the mold cavity and fuses into the interior of the casting or rapid pouring of the molten metal.
    - **Causes**:
      - Loose ramming of the sand.
      - Rapid pouring of the molten metal into the mold results in wash away of sand from the mold and a hole is created.
      - Improper cleaning of the mold cavity.



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- Remedies
    - Proper ramming of the sand.
    - Molten metal should be poured carefully in the mold.
    - Proper cleaning of the molten cavity eliminates sand holes.
  - Dirt: The embedding of particles of dust and sand in the casting surface, results in dirt defect.
  - Causes:
    - Cursing of mold due to improper handling and Sand wash (A sloping surface of sand that spread out by stream of molten metal).
    - Presence of slag particles in the molten metal.
  - Remedies:
    - Proper handling of the mold to avoid crushing.
    - Sufficient fluxing should be done to remove slag impurities from molten metal.



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- Honeycombing or Sponginess: It is an external defect in which there is a number of small cavities in close proximity present in the metal casting.
    - Causes:
      - It is caused due to dirt and scurf held mechanically in the suspension of the molten metal.
      - Due to imperfect skimming in the ladle.
    - Remedies:
      - Prevent the entry of dirt and scurf in the molten metal.
      - Prevent sand wash.
      - Remove slag materials from the molten metal by proper skimming in the ladle.
  - Warpage: It is an accidental and unwanted deformation in the casting that happens during or after solidification. Due to this defect, the dimension of the final product changes.



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- Causes:

- Due to different rates of solidification of different sections. This induces stresses in adjoining walls and result in warpage.
- Large and flat sections or intersecting section such as ribs are more prone to these casting defects.

- Remedies

- It can be prevented by producing large areas with wavy, corrugated construction, or add sufficient rib-like shape, to provide equal cooling rates in all areas.
- Proper casting designs can reduce these defects more efficiently.

- Fins: A thin projection of metal, not considered as a part of casting is called as fins or fin. It is usually occurs at the parting of the mold or core section.



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- Causes:

- Incorrect assembling of mold and cores.
- Insufficient weight of the mold or improper clamping of the flask may produce the fins.

- Remedies:

- Correct assembly of the mold and cores.
- There should be sufficient weight on the top part of the mold so that the two parts fit together tightly.



