

Casting is a manufacturing process in which a liquid metal is usually poured into a mould, which attains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is known as casting, which is ejected or broken out of the mould to complete the process.

### Classification of Casting Techniques:

#### ① Expendable Moulds (Temporary Moulds)

- Sand Moulding
- Shell Moulding.
- Investment Moulding.
- Full Moulding.
- $CO_2$  Moulding.

#### ② Permanent Moulds.

- Centrifugal
- Die Casting.
- Slush Casting.
- Squeeze Casting.

#### ③ Continuous Casting.

## Steps in Preparing a Casting.

Casting Process comprises the following steps:

- 1) Making a pattern.
- 2) Preparing Moulding Sand.
- 3) Preparing a Mould and core making.
- 4) Melting the metal.
- 5) Pouring the metal into the mould.
- 6) Cooling / Solidification.
- 7) Removing the solidified casting from the mould.
- 8) Fettling / Finishing.
- 9) Heat treatment.
- 10) Testing and Inspection.

## CLASSIFICATION OF CASTING PROCESS

PROCESS	ADVANTAGES	DISADVANTAGES	EXAMPLES
SAND CASTING	many metals, sizes, shapes, cheap	poor finish & tolerance	engine blocks, cylinder heads
SHELL MOULD CASTING	better accuracy, finish, higher production rate	limited part size	connecting rods, gear housings
EXPENDABLE PATTERN CASTING	Wide range of metals, sizes, shapes	patterns have low strength	cylinder heads, brake components
PLASTER MOULD CASTING	complex shapes, good surface finish	non-ferrous metals, low production rate	prototypes of mechanical parts
CERAMIC MOULD CASTING	complex shapes, high accuracy, good finish	small sizes	impellers, injection mold tooling
INVESTMENT CASTING	complex shapes, excellent finish	small parts, expensive	jewellery
PERMANENT MOULD CASTING	good finish, low porosity, high production rate	Costly mold, simpler shapes only	gears, gear housings
DIE CASTING	Excellent dimensional accuracy, high production rate	costly dies, small parts, non-ferrous metals	gears, camera bodies, car wheels
CENTRIFUGAL CASTING	Large cylindrical parts, good quality	Expensive, few shapes	pipes, boilers, flywheels



# SHELL MouldING / SHELL Mould CASTING:

Expendable mould casting process.

\* Pattern Creation: A two piece metal pattern is created in the shape of the desired part, typically from iron or steel.

\* Moulding Material

- Fine Grain Silica.
- Phenolic Resins [Phenol formaldehyde, Urea formaldehyde]
- Alcohol

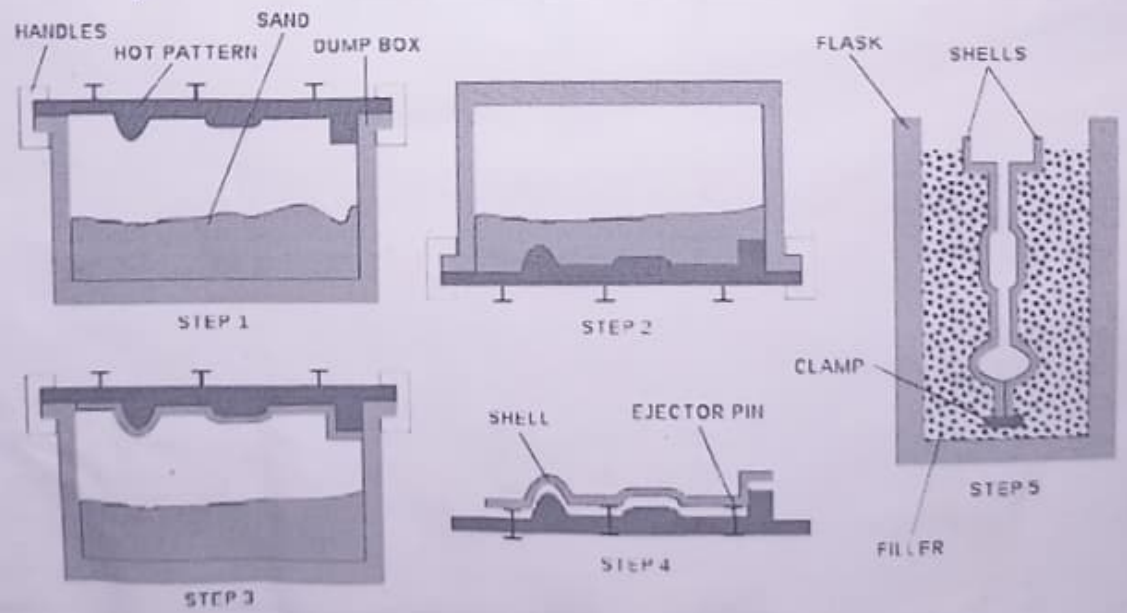
\* Mould Creation

- Each pattern half is heated to 175-370°C and coated with a lubricant to easy removal.
- Heated pattern is clamped to a dump box, which contains a mixture of sand and a resin binder.
- The box [dump box] with pattern are inverted for a short time.
- When sand mixture comes in contact with hot pattern, it causes a initial shell.
- The thickness of this shell is about 6mm to 18mm.
- Shell creation takes 5 to 20 seconds [Dwell time]
- Invert the dump box and separate shell.

\* Mould assembly

- Two shell halves are joined together and securely clamped to form the complete shell mould.
- If any cores are required, they are inserted prior to closing the mould.

- \* Pouring
- \* Cooling.
- \* Casting removal



- \* Pouring
- \* Cooling
- \* Casting Removal.

### Advantages

- Used for small to medium parts casting.
- Surface finish obtained is excellent.
- Good dimensional accuracy / Very close Tolerance.
- Used for both ferrous and non-ferrous metals, most commonly using cast iron, carbon steel, alloy steel, stainless steel, Aluminium alloys, copper alloys.

### Applications

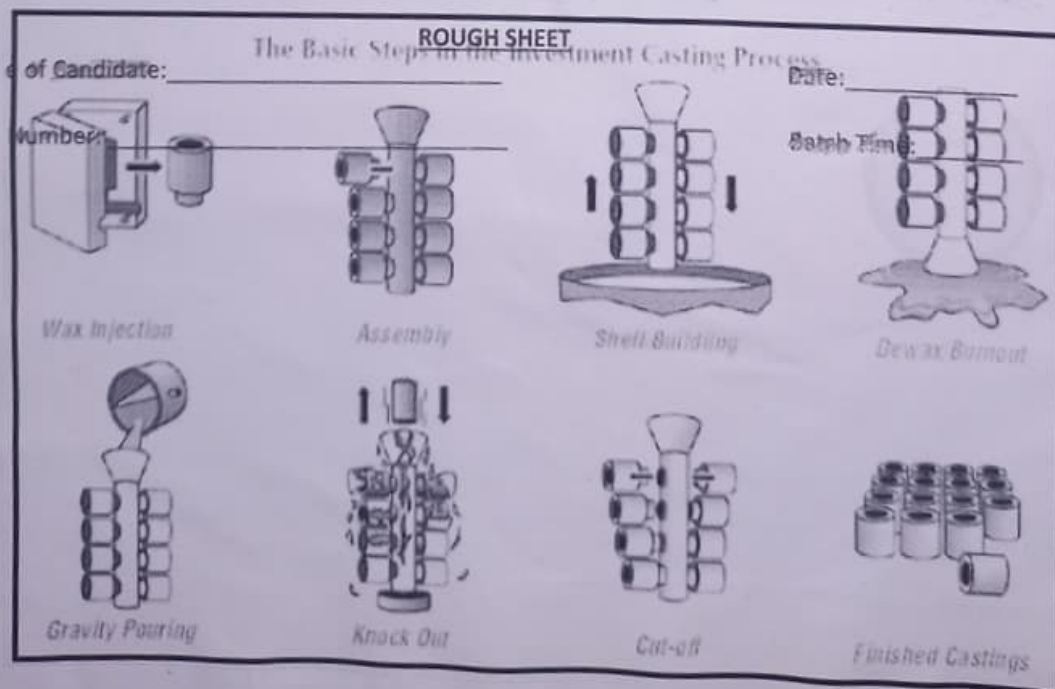
Small pipes, Cam shafts, Bushings, Gear housings, Cylinder heads, Connecting rods, Rocker arm and valves etc.

### ③ INVESTMENT CASTING / LOST WAX PROCESS / PRECISION CASTING.

- Both one of the oldest & most advanced of the metallurgical art.

#### \* Pattern Making

- Manufacture Wax Pattern by Master die.
- Allowances [wax, ceramic coating and Metal Shrinkage]





Assembly

- Several Wax Pattern Combine for a single casting.
- central sprue [Wax bar], Pouring Cup also present in the combination.
- It creates wax pattern tree.

\* Shell Building / Stuccoing Process:

- Wax pattern assembly is dipped into a slurry of refractory coating material.
- Refractory Dip assembly in a Refractory slurry.

↓  
[fine Grained Silica, Water, Ethyl silicate Sol<sup>n</sup>]

- Assembly is next sprinkled with silica sand.
- Achieve Required Ceramic coating and permitted to dry.

\* Dewax

- Assembly is allowed to harden in air.
- Assembly turned upside down (inverted) and heated  $90-175^{\circ}\text{C}$ .
- Wax flow out from mould [Ceramic mould]
- Ceramic mould further heated  $550-1100^{\circ}\text{C}$ , to eliminate any left over wax, contaminants and drive water out.

\* Metal Casting Pouring:

- Preheat the mould about  $150^{\circ}\text{C}$  to  $1000^{\circ}$  for ferrous alloys and  $650^{\circ}$  for aluminium alloys.
- Pour the molten metal into cavity and allow to solidify.

\* Casting Removal:

- Remove moulding sand by vibrators or abrasive/water jet machining from casting.
- Gate & runners are cut from the casting.

Advantages

- High dimensional accuracy of  $\pm 0.08\text{mm}$ .
- Used for ferrous and non-ferrous materials.
- Complex shape can be produced.
- Smooth surface produce.
- Better for Environment.

Disadvantages

- Expensive, Used for Small parts, Slow process, High raw materials.

Applications

Aerospace industry, Surgical Instruments, Military Equipments, 3D-Printing, Automotive industry.

#### ④ FULL Moulding

- Also known as Lost Foam Process, Evaporative Pattern Casting Process / Cavityless Moulding.

##### \* Pattern Creation

A pattern is made from polystyrene foam, PVC etc.

##### \* Mould

- pattern is inserted in the moulding sand.
- Runner, riser and gate are arranged with it.

##### Casting

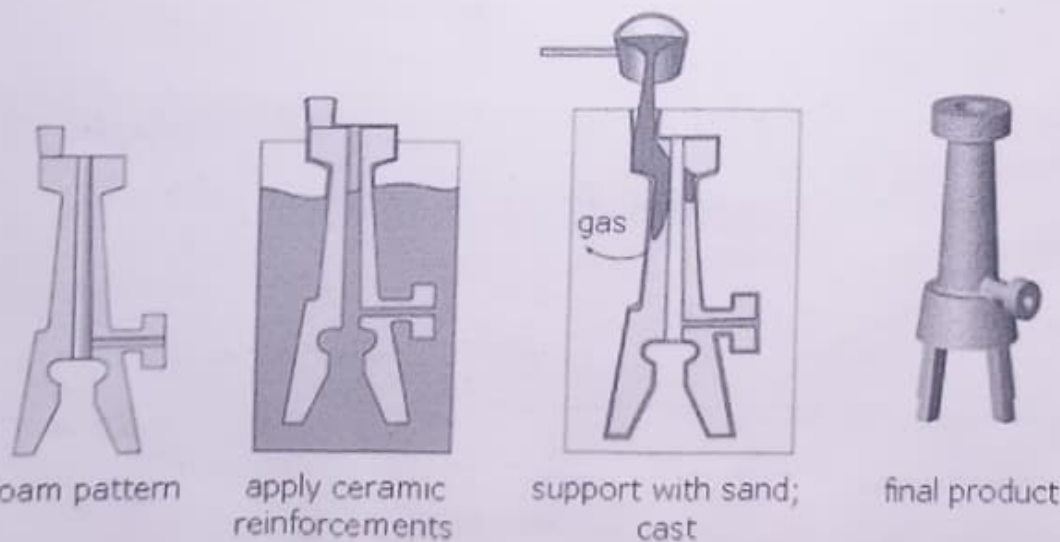
- Molten metal is poured into the mould, which vaporizes the foam allowing the metal to fill the entire mould.
- Allow to solidify the material.
- Remove the moulding sand and finished casting produced.

##### Advantages

- Dimensionally accurate.
- No draft requires.
- No parting line, No flash is formed [good surface finish]
- Time saving.

##### Application

Motor casting, Tool.

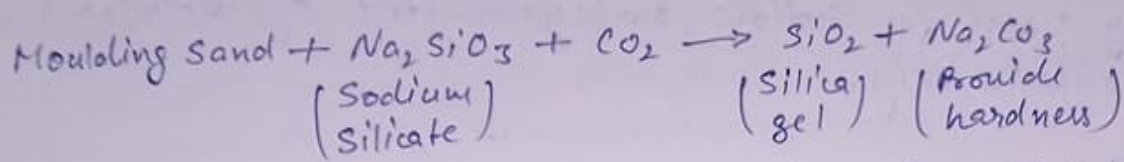




## CO<sub>2</sub> Moulding :

The process is basically a hardening process for moulds and cores.

- Mould is prepared by adding sodium silicate into moulding sand. ~~It will react~~ (3-5%)
- ~~It~~ CO<sub>2</sub> gas will be supplied to mould for sufficient time. It will react with sodium silicate and produce silica gel which is having better bonding strength properties.
- Due to this strength & hardness of mould increased.



Strength of mould will depend on time of supplying CO<sub>2</sub> gas to the mould known as CO<sub>2</sub> gassing time.

### Application

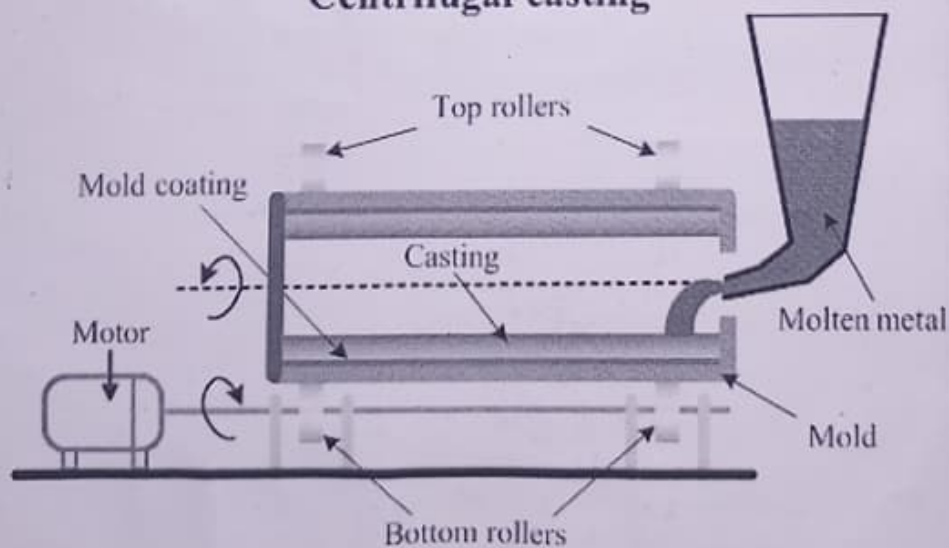
Used to prepare large size mould like machine tool beds, Gear box housing, Gear blank etc.

## PERMANENT Moulds

### CENTRIFUGAL CASTING :

- It is typically used to cast thin-walled cylinders. It is used to cast such materials as metal, glass and concrete.
- To produce hollow cylinder shape of object in mass production without using the core this technique can be used.

### **Centrifugal casting**





- Liquid metal will be enter into the mould which under rotation.
- Due to centrifugal force high density pure metal can be forced away from the centre & less density impurities can be collected towards the centre.
- Due to centrifugal force and fast rate of cooling fine grain structure with high density can be produced.
- Casting yield is 100 %.
- Accuracy & Surface finish is very high.
- Generally used for hollow axisymmetric cylindrical shaped objects only.

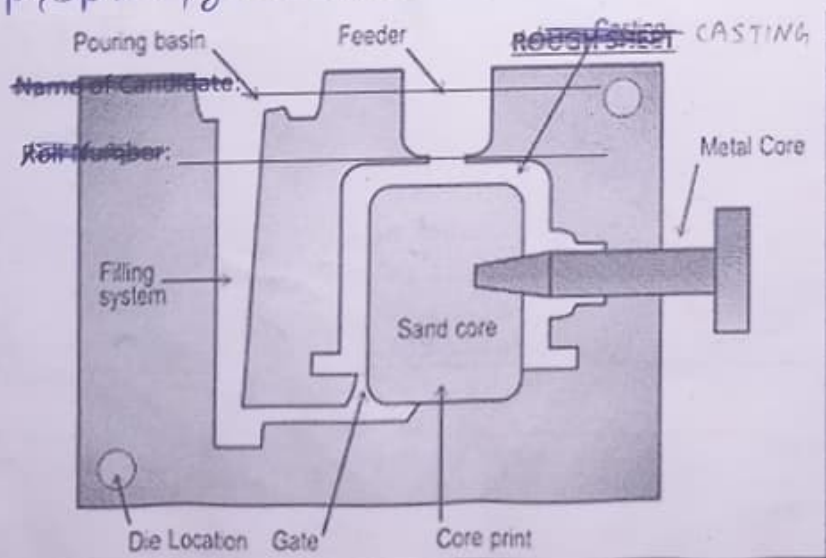
### DIE CASTING :

It is a metal casting process in which molten metal forced under pressure into mould cavity.

Die Casting { Gravity die Casting. } Hot Chamber  
 { Pressure die casting } Cold Chamber.

### Gravity die Casting.

- Molten metal is poured into the mould under gravity.
- Moulds are made up of gray cast iron, alloy steels or non ferrous alloys.
- Inner surface of the moulds are coated with refractory.
- Mould is made in two halves.
- Pouring cup, sprue, gates & riser are built in mould halves.



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Application

Carburetor bodies, Refrigeration castings, oil pump bodies, Connecting rods, Typewriter segments etc.

### HOT CHAMBER DIE CASTING:

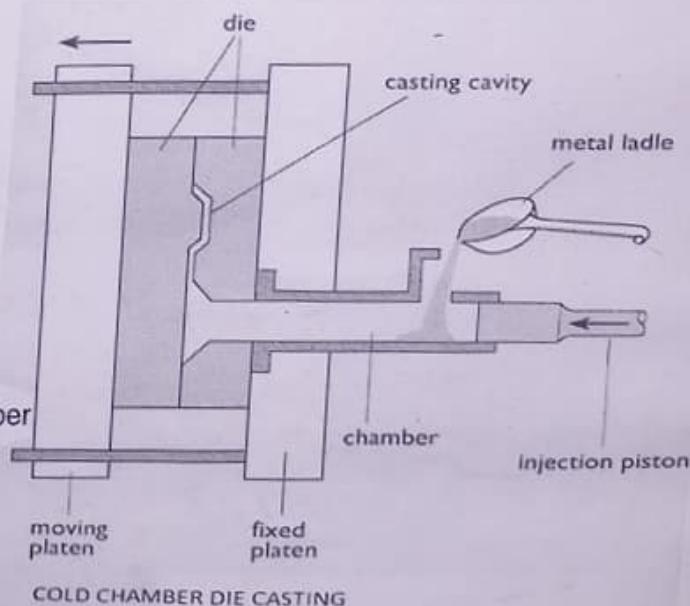
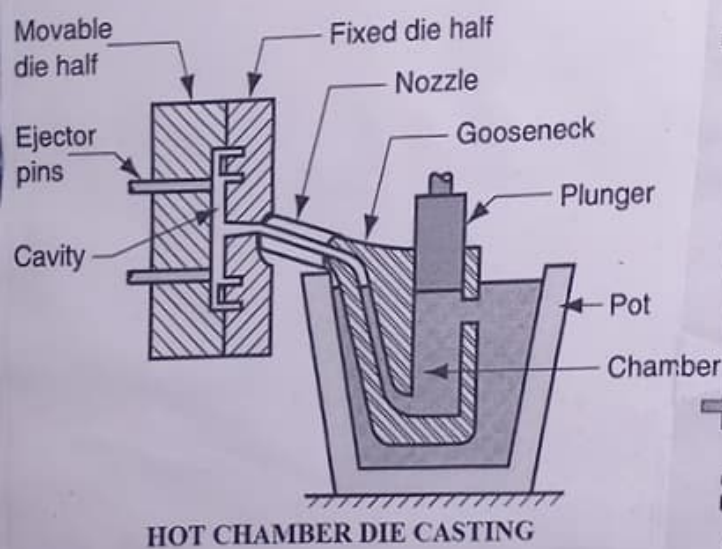
- \* Liquid metal will be forced into die cavity under external pressure. Furnace is integrated with die.
- \* Low melting point materials used
- \* Liquid metal is getting solidified under external pressure.
- \* Used for complex shape of object with thin section.
- Due to fast rate of cooling fine grain structure can be produced.
- High dense structure with better mechanical properties can be produced.
- Accuracy & Surface finish is very high.

Note Due to sticking tendency of Al, life of goose neck will be reduced. It is not used in hot chamber die casting.

\* Low Melting point: Zn, Pb, Tin, Non-alloying etc.  
High Melting point: Cu, Al, Brass etc.

### COLD CHAMBER CASTING:

- Used Non-ferrous metals & alloy. [Al, Cu, Brass]
- Plunger pushes molten metal into die casting.





## SLUSH CASTING

- Hollow casting are produced without the use of core.
- Molten metal is poured into the metallic mould and allowed to solidify upto the required thickness.
- Normally small thickness casting of lead, Zinc & low melting alloys are obtained.
- Moulds are made up of two halves.

### Application -

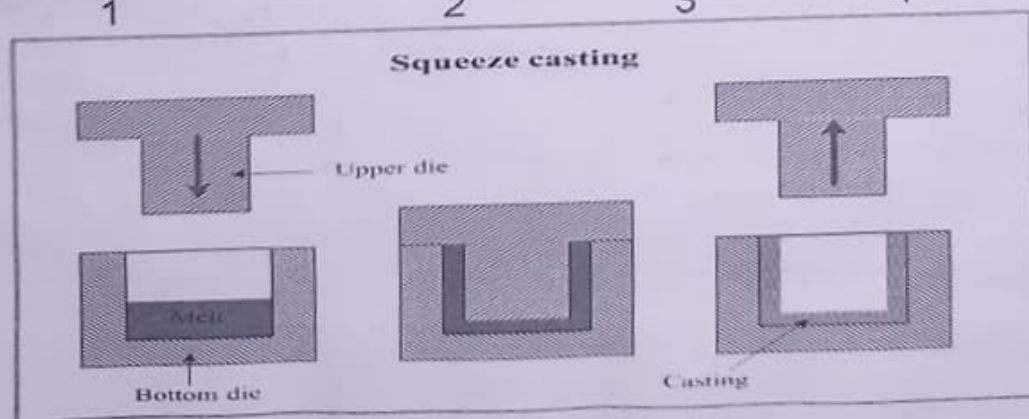
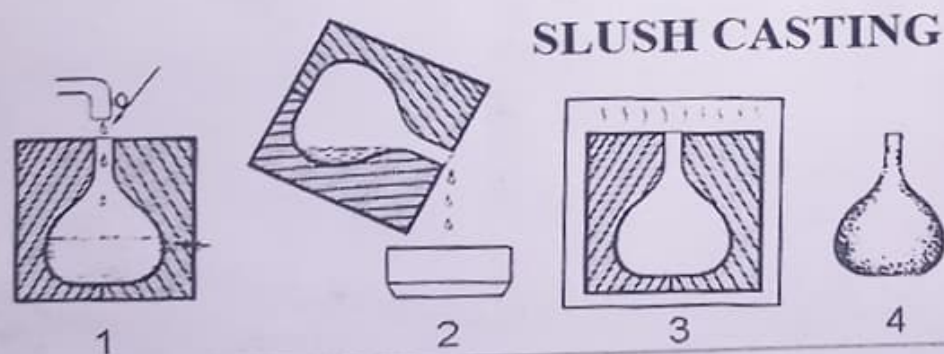
Ornaments, Statues, toys etc.

## SQUEEZE CASTING :

- Liquid metal will be filled into the die.
- External pressure is applied on the liquid metal using the plunger such that liquid metal is solidified b/w plunger and die under external pressure from the plunger.
- ~~Combi~~ Pressure of the plunger decides the shape & size of the casting.
- High dense structure with better mechanical prop<sup>r</sup> can be produced.

### Application

- Brake shoe made up of Aluminium.
- Bushes made up of brass & bronze.





- Molten metal is fed by gravity into the mould and withdrawn by the rolls below.
- Die is water cooled and self lubricating.
- Upper end of die is in molten metal and thus serves the function of riser.
- A saw is provided below the rolls to cut the product to desired length or oxy-acetylene cutting is done.
- Argon is added with molten metal to avoid atmosphere contamination.

## Application

Production of blooms, billets, slabs, sheets, bars etc. Rectangular, Square, hexagonal etc shape can be produced.

