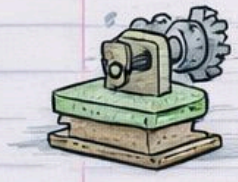


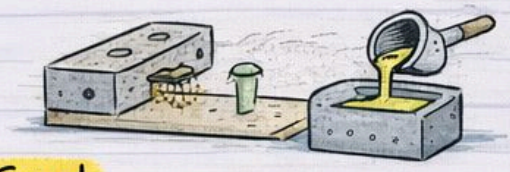
Manufacturing Practices

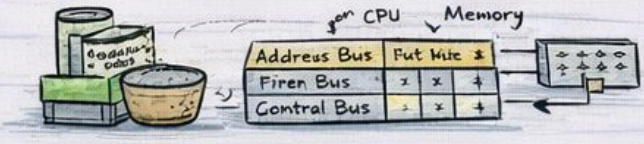
Module-1 Notes

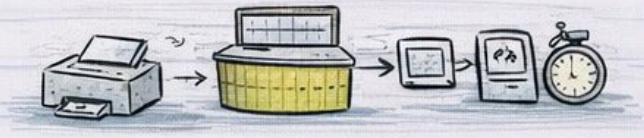
by pyqfort.com

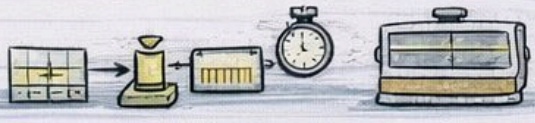
Contents Covered:

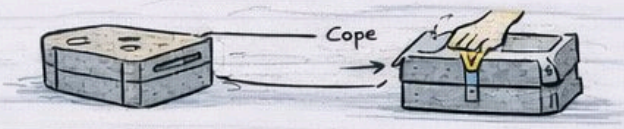
- Mould Making Intro
- Constituents of Moulding Sand
- Sand Preparation
- Properties and Types
- Testing of Moulding Sand
- Types of Moulds
- Moulding Boxes
- Moulding Processes
- Moulding Boxes
- Moulding Processes

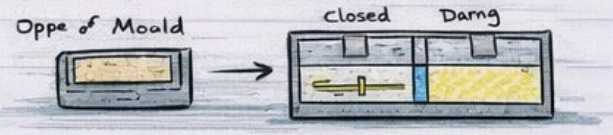


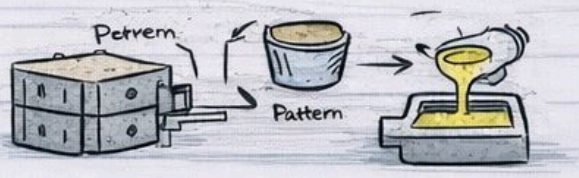








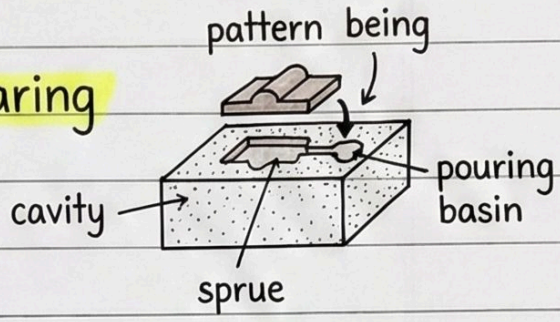




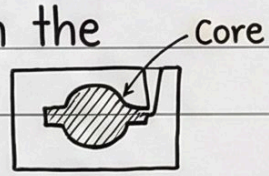
MOULD MAKING PRACTICE: INTRODUCTION & MOULDING SANDS

1. Introduction (Foundry):

- Foundry is the practice of preparing moulds for metal casting.

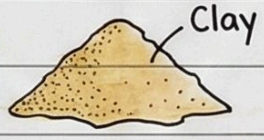


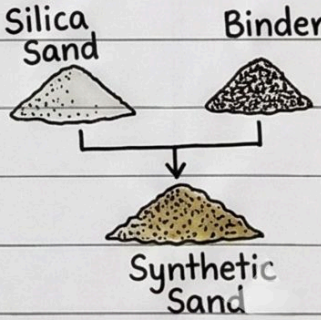
- Moulds are cavities made by the use of patterns.
- Moulds can be made of sand, plaster, or metals, but sand moulds are most popular.
- Additional elements in the mould: gating system, pouring basin, sprue, runner, etc.
- Cores are placed to get holes and recesses in the casting.



2. Moulding Sands:

- Common sources: rivers, lakes, sea, and deserts.
- Mainly grouped as:
  (a) Natural Sand: Contains sufficient amount of binding clay. No more binder is required.
  (b) Silica Sand: Does not possess the clay content. Needs addition of a suitable binder.

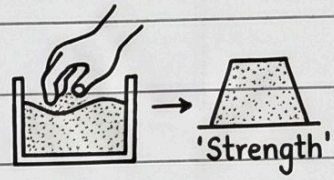




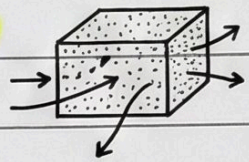
- When mixed with binders and additives, it is known as synthetic sands.

CONSTITUENTS OF MOULDING SAND: BINDERS

Purpose of Binders:

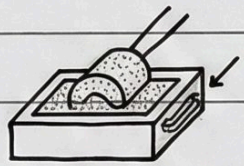


- Added to impart it sufficient strength and cohesiveness to the sand.
- Enables sand to retain its shape after mould is rammed and pattern withdrawn.
- Produces an adverse effect on the permeability of the sand mould.



Classification of Binders:

- Grouped as: 1. Organic binders
  2. Inorganic binders.



1. Organic Binders:

- Used specifically in coremaking.
- Common types: Dextrin, Molasses, Linseed oil, Cereal binders, Pitch (up to 2% max), Resins (phenol and urea formaldehydes).

2. Inorganic Binders:

- Common types: Clay, Sodium silicate, Portland cement.

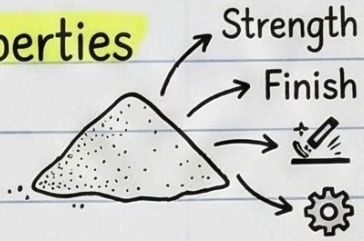
- Clay binders are most commonly used.
- Types of clay: (i) Bentonite, (ii) Kaolinite, (iii) Limonite, (iv) Ball clay, (v) Fire clay, (vi) Fuller's earth.

- Bentonite is most widely used.
- Deposits found in Bihar, Rajasthan and Kashmir.

CONSTITUENTS OF MOULDING SAND: ADDITIVES

Purpose of Additives:

- Materials added to improve existing properties or impart new properties to the sand.

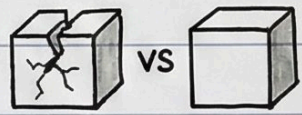


Commonly Used Additives:

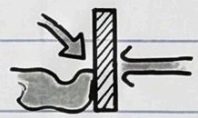
1. Coal dust: Used for grey & malleable iron. Creates reducing atmosphere, prevents oxidation. Reduces cohesiveness & strength.

2. Seal coal: Finely ground soft coal. Improves surface finish, restricts mould wall movement.

3. Cereals or cornflour: Promotes mould wall movement, reduces expansion defects. Improves collapsibility.



4. Silica flour: Increases hot strength, decreases metal penetration & expansion defects.



5. Wood flour: Promotes mould wall movement, improves collapsibility & thermal stability.

6. Pitch: Improves hot strength & surface finish for ferrous castings.

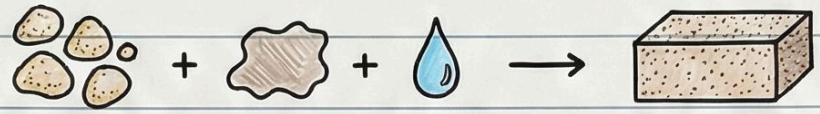
7. Dextrin and molasses: Increases dry strength.

8. Fuel oil: Reduces the requirement of free water.

CONSTITUENTS OF MOULDING SAND: WATER

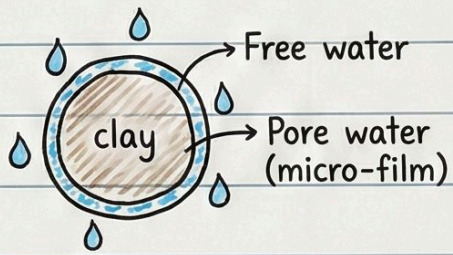
1. Purpose & Quantity:

- Water is added to **activate the clay binder** and develop the required **strength and bond.**



- Quantity varies from **2 to 8 percent** depending on requirements.

2. Types of Water in Sand:

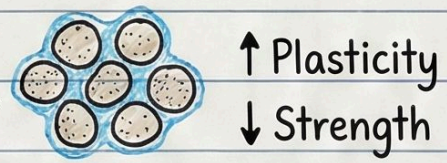


- Present in two forms:
  - (a) **Free water**: In the free state.
  - (b) **Pore water**: In mixed form, filling the pores of the clay.

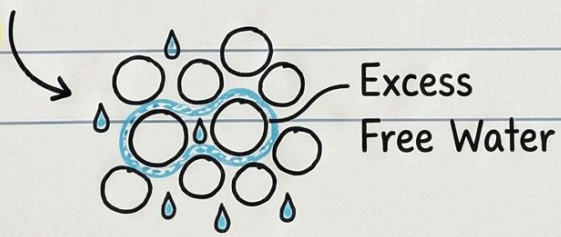
3. Role of Pore Water:

- Forms a **rigid micro-film** held by the clay.
- Mainly responsible for **imparting strength** to the sand.
- Bond quality depends on the **thickness of this water film.**

4. Role of Excess Free Water:

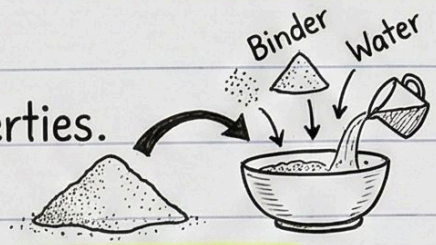


- **Excess amount** acts as a **lubricant** between clay particles.
- **Improves mouldability and plasticity.**
- However, it **reduces the strength** and **weakens the mould.**



SAND PREPARATION AND CONDITIONING

1. Why is it needed?



- Natural sand often lacks required properties.
- Sand mixing adds missing materials.
- Proper conditioning is crucial to avoid casting defects.

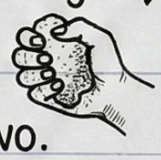
2. Goals of Conditioning:

- Uniform distribution of clay bond over sand grains.
- Even distribution and control of moisture content.
- Removing foreign materials (nails, gaggers) by riddling.

- Thorough mixing of the entire mass.

3. Manual Conditioning (Small Foundries):

- Relies on moulder's practical experience (no testing equipment).
- Handful Test for judging condition:
  - Grip and release a handful, break into two.

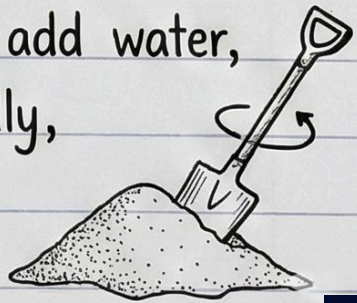


  - No deformation at edges → Properly conditioned.

  - Surface settling/compressed → High moisture.

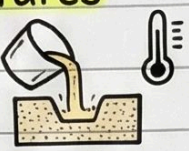
  - Sprinkled grains/separation → Weak bond, low moisture.

- Mixing Process: pile sand & constituents, add water, turn upside down with a shovel repeatedly, then riddle.

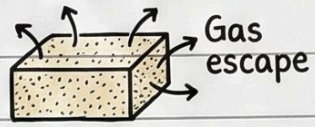


PROPERTIES OF MOULDING SAND AND THEIR CONTROL

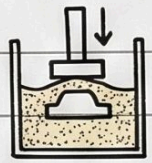
1. **Refractoriness**: Ability to **withstand high temperatures** of molten metal without fusing.
   - Depends on metal poured (e.g., steel > iron > brass), quartz content, grain shape & size (rough, larger grains → higher refractoriness).
   - Reduced by impurities (iron oxides, calcium, etc.).



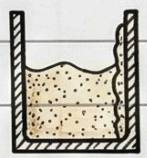
2. **Permeability** (Porosity): Ability to allow gases and steam to **escape** from the mould.
   - Crucial for sound castings.
   - Depends on grain size, shape, moisture, and clay content.



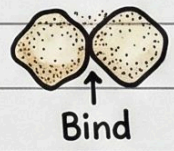
3. **Flowability (Plasticity)**: Ability to flow under ramming pressure to **pack around the pattern.**
   - Increases with clay and water addition.



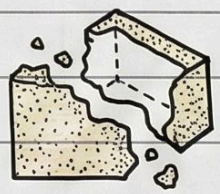
4. **Adhesiveness**: Ability to **adhere** to surfaces of other materials (flask, gaggers).



5. **Cohesiveness**: Ability of sand particles to **bind together** firmly.
   - Provides **green strength** and **dry strength**.
   - Depends on grain size, clay, and moisture.



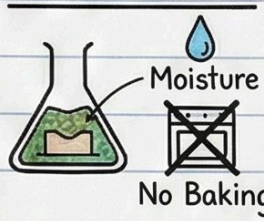
6. **Collapsibility**: Ability to **collapse automatically** after solidification to allow metal contraction.



7. Other Requirements: **Cheap & available**, **low coefficient of expansion**, **reusable**, **chemically inert**, **non-sticking** to casting surface.

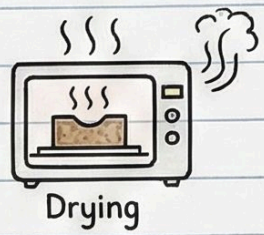
TYPES OF MOULDING SAND

1. **Green Sand** : Also known as tempered sand.

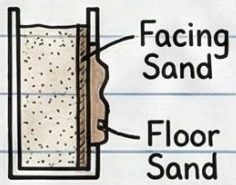


- Contains just enough moisture for sufficient bond.
- Used for green sand moulds, no baking required before pouring.

2. **Dry Sand** : Originally has excess moisture, which is then evaporated by drying the mould in a suitable oven.



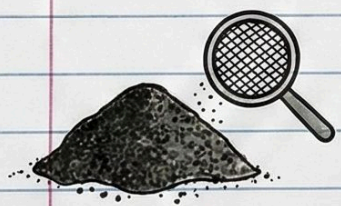
3. **Facing Sand** : Also known as 'fat' sand.



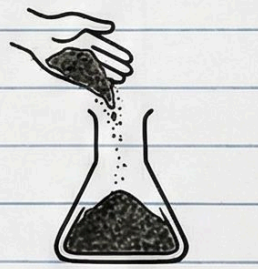
- Forms the face of the mould, rammed against the pattern surface. It is fresh and well tempered.

4. **Parting Sand** : Sprinkled on parting surfaces to prevent sticking of sand or pattern.
   - Burnt sand and dry silica sand are used.

5. **Floor, Black or Baking Sand** : Used sand left on the floor after casting. Riddled to remove foreign material, then re-used to fill the bulk of the flask (backing sand).

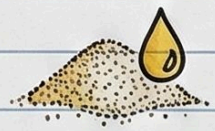


   - Reconditioned floor sand in mechanised foundries is unit sand.

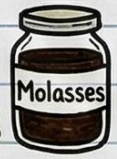


6. **Core Sand** : Has high silica content, used for making cores.

7. **Oil Sand** : Silica sand using oil binders.



8. **Molasses Sand** : Uses molasses as binder. For small castings with intricate shapes and thin sections.



TESTING OF MOULDING SAND

Carried out to control properties.
Chemical tests for impurities, Mechanical tests for physical properties.

1. **Grain Fineness Test**: Indicates average grain size and percentage distribution.
Uses a set of standard sieves graded by mesh.

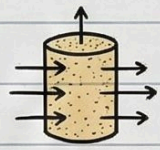
2. **Moisture Content Test**: 50g of moist sand heated in an oven at 105°C to 110°C to dry.

Formula: $\%\ \text{Moisture} = \frac{(\text{Weight of wet sand} - \text{Weight of dry sand})}{50} \times 100.$

Instruments used: Moisture teller, Moistmeter.

3. **Clay-content Test**: Sand is washed with caustic soda solution and distilled water to remove clay.
After settlement, clay-water mixture is siphoned off.
Process repeated until water is clear. Dried sand is weighed.

4. **Permeability Test**: Quantity of air that passes through a standard specimen under given pressure and time.



$$\text{Permeability No.} = \frac{v \times h}{p \times a \times t}$$

where v = vol of air, h = height, p = pressure, a = area, t = time.

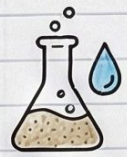
5. **Compression Strength Test**: Finds maximum compressive strength of a standard rammed specimen (5 cm dia × 5 cm height).
Load is applied until breakage. Green strength is for moist sand.

6. **Hardness Test**: Uses a Mould-hardness tester (pocket instrument).

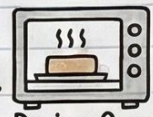
Principle is similar to Brinell, proportional to penetration depth.

TYPES OF MOULDS

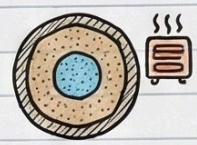
1. **Green-Sand Moulds**: Made from moist sand, used for ferrous & non-ferrous alloys.
   - Least expensive, time-consuming. No drying or baking.
   - Not very strong, can be damaged during handling/pouring.
   - Potential for blow holes/pinholes due to poor permeability.
   - Cannot be stored for long.


moist sand

2. **Dry-Sand Moulds**: Made from sands with binders, no moisture required.
   - Surfaces sprayed with molasses, dried in ovens at 200°C – 300°C.
   - Stronger, less damage. Moisture defects eliminated. Used for steel casting.
   - Expensive, labour oriented, time consuming.


Drying Oven

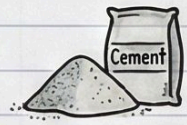
3. **Skin-dry Moulds**: Green sand moulds with moisture from surface (≥ 25 mm depth) dried using heaters.
   - Combined advantage of green & dry sand moulds.
   - Not as strong as dry sand moulds. Water can seep through dry layer.



4. **Loam Moulding**: Constructed of porous bricks cemented with loam mortar.
   - Loam mortar: Equal amount of sand grains & clay mixed with water.
   - Brick structure faced with loam layer (6–12 mm) for shape.
   - Used for large castings.
   - Disadvantages: Requires large space/floor area, less accurate, time consuming. Not for repeated casting.


Brick & Loam

5. **Cement-Bonded Moulds**: Made by bonding silica sand with portland cement, dried in air. No backing.
   - Advantages of dry-sand moulding, used for large ferrous castings.
   - Mould materials cannot be reused, requires large space for air drying.



Cement Bond

6. **Oil-Sand Moulding**: Sand, dextrin, bentonite mixture binded by linseed oil, vegetable oils, etc.
   - Basic materials are very expensive.

7. **Synthetic Sand Moulds**: Mixed ingredients with sand and clay (Bentonite & water added).
   - Advantages over natural sand: More uniform grain size, easier control of properties, less binder, high refractoriness, less moisture.


Synthetic Mix

8. **Metallic Moulds**: Permanent moulds used for die casting.
   - Metal introduced under air pressure.
   - Presses operated pneumatically or hydraulically.
   - Advantages: Less floor space, high production rate, quality casting, thin casting, good surface finish, precision.
   - Disadvantages: High cost of moulds/equipment, special skills needed, limited range/size (non-ferrous alloys).


Die Casting

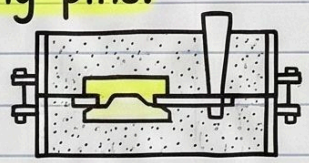
MOULD MAKING WITH THE USE OF A CORE

1. Select a moulding box of suitable size.

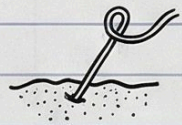
2. Place the drag part upside down on the bench.
3. Position the lower pattern in the drag.

4. Fill with prepared green sand and ram properly.
5. Remove excess sand with a strike-off bar.

6. Sprinkle parting sand, then turn the drag upside down.
7. Place the cope over the drag, align with locking pins.

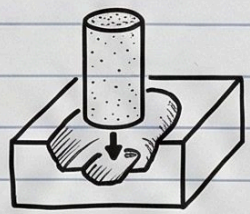


8. Place the top pattern, runner, and riser.
9. Sprinkle parting sand, fill the cope with green sand and ram.
10. Remove excess sand, form a pouring basin.

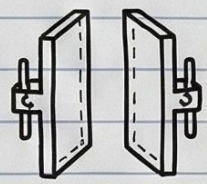


11. Use venting wire to create escape passages for gases.
12. Remove runner/riser, then separate cope from drag.

13. Remove the patterns to form the mould cavity.
14. Repair any damage, blow off loose sand.
15. Backwash the cavity with graphite/clay water mixture for finish.
16. Bake the mould if required.



17. Place the core in the core prints.



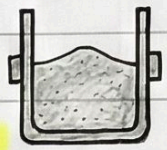
18. Lock the cope and drag together with locking pins.

19. The mould is ready for pouring.

MOULDING BOXES (FLASKS)

1. Purpose & Types:

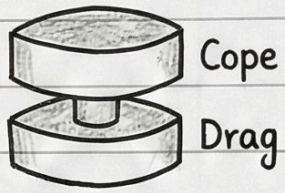
- Moulding boxes or flasks contain the sand mould.
- Used in sand moulding, can be made of wood, cast iron or steel.



- Two main types: (a) Closed moulding boxes,
  (b) Open type of snap flasks.

2. Parts of a Flask:

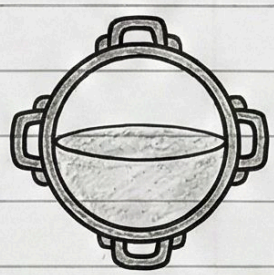
- Consists of two or more parts.
- Lower part is called drag.
- Upper part is called cope.



- Intermediate parts (if used) are called cheeks.
- Equipped with clamping means for pouring.

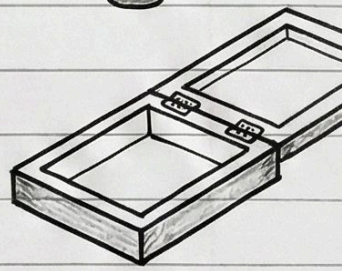
3. Materials & Use:

- Wooden flasks: Generally for green sand moulding.
- Metallic boxes (Cast iron/Steel): Required for dry sand moulds (heated for drying).
- Large, heavy boxes are metallic, handled by cranes.



4. Snap Flask:

- Hinged in one corner, rectangular, made of wood.
- Used for bench moulding.
- Allows making multiple moulds from the same set of flask.

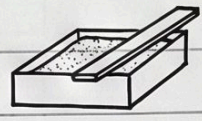


HAND TOOLS FOR MOULDING

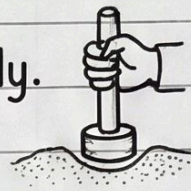
1. **Sand Preparation & Handling:**
   - **Shovel:** For transferring sand from one place to another.

   - **Hand Riddle:** To remove the lumps and foreign particles from the sand.

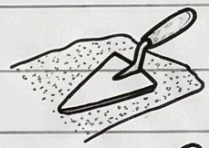
   - **Strike off Bar:** To strike off the excess sand from the top of the moulding box.



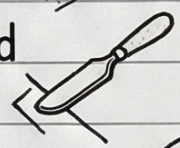
2. **Ramming Tools:**
   - **Rammer:** For packing sand in the moulding box uniformly.
   - Two types: (i) **Pin rammer** (for narrow spaces) and (ii) **Flat rammer** (for flat surfaces).



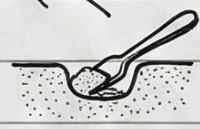
3. **Finishing & Repairing Tools:**
   - **Trowels:** Used for finishing flat surfaces and joints in the mould.



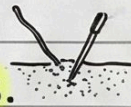
   - **Slicks:** For repairing and finishing the mould surfaces and edges. Double ended.



   - **Lifters:** For removing loose sand from inside the mould cavity.

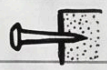


   - **Plane Smoother:** For smoothening the sand surface after striking off.
4. **Venting & Withdrawal Tools:**
   - **Vent Wire:** Used to make small holes to allow the exit of gases.



   - **Swab:** To apply a small amount of water around the pattern edge before removing.

   - **Draw Spike or Screw:** To withdraw the pattern from the mould.



   - **Bellow:** To blow out the loose or unwanted sand from the cavity.

5. **Gating & Reinforcement Tools:**
   - **Sprue Pin:** Embedded to produce a runner for molten metal.

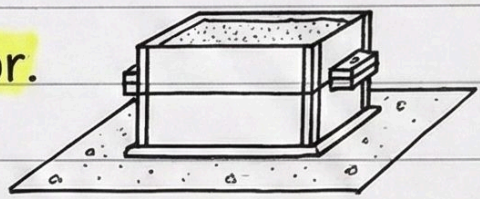
   - **Gate Cutter:** To cut gates for easy flow of molten metal.

   - **Gaggers:** Steel wire to reinforce the sand and support hanging portions.

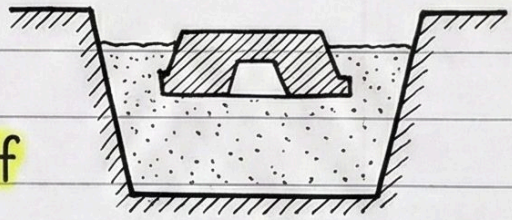
MOULDING PROCESSES

1. **Bench moulding:**
   - For small moulds made on a convenient bench.
   - Used in laboratories and workshops of polytechnics & colleges.
   - Process is very slow and laborious.
   - Uses hand ramming and loose patterns.

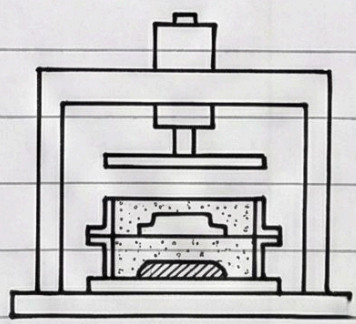
2. **Floor moulding:**
   - Carried out on the foundry floor.
   - For medium and large moulds.



3. **Pit moulding:**
   - For very large castings.
   - Very big moulds are made in a pit or cavity cut in the floor of the foundry.

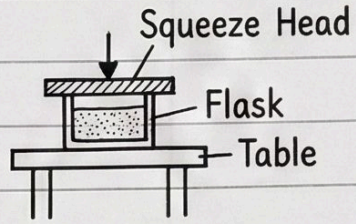


4. **Machine moulding:**
   - Uses various types of machines.
   - Makes small, medium and large moulds.
   - Process is very fast and produces uniform moulds.
   - Best suited for production work.
   - Requires mounted patterns.



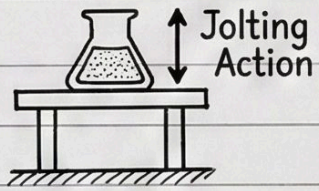
MOULDING MACHINES

1. **Squeeze Machine:**



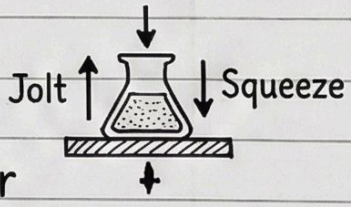
- Moulding sand is **squeezed** between the machine table and overhead **squeeze** head to attain desired density.
- Operated **pneumatically** or **hydraulically**.
- Two types:
  - **Top Squeezer**: Table is raised to compact sand against the stationary squeeze head.
  - **Bottom Squeezer**: Squeeze head is used to compact the sand. **Density is not uniform.**

2. **Jolt Machine:**



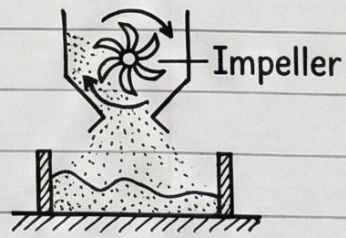
- Flask is **raised and dropped** in succession (jolting). Sand is packed by **sudden change in inertia.**
- Sand packs **evenly around the pattern**, but is **less dense at the top.**

3. **Jolt Squeeze Machine:**



- A **combination** of **jolt** and **squeeze** actions for **even ramming.**
- Has both **squeeze** and **jolt actions** one after the other.

4. **Sand Slinger:**



- **Consolidation** and **ramming** obtained by the impact of sand falling with **high velocity.**
- Sand is thrown by an **impeller** at a rate of **500 kg/min** to **2000 kg/min.**
- Used for **medium to large sized moulds**; produces **strong** moulds.