



WELCOME  
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*"There is  
nothing  
impossible to  
they who will  
try."*



# GATE 2024



**प्रचण्ड** Batch

## PRODUCTION

# CASTING

PART-3

## Mechanical Engineering





**GATE 2024**



**प्रत्न** Batch

**MECHANICAL ENGINEERING**



**MON/ TUE/ WED- 9PM**

**THEORY OF MACHINE (TOM)**



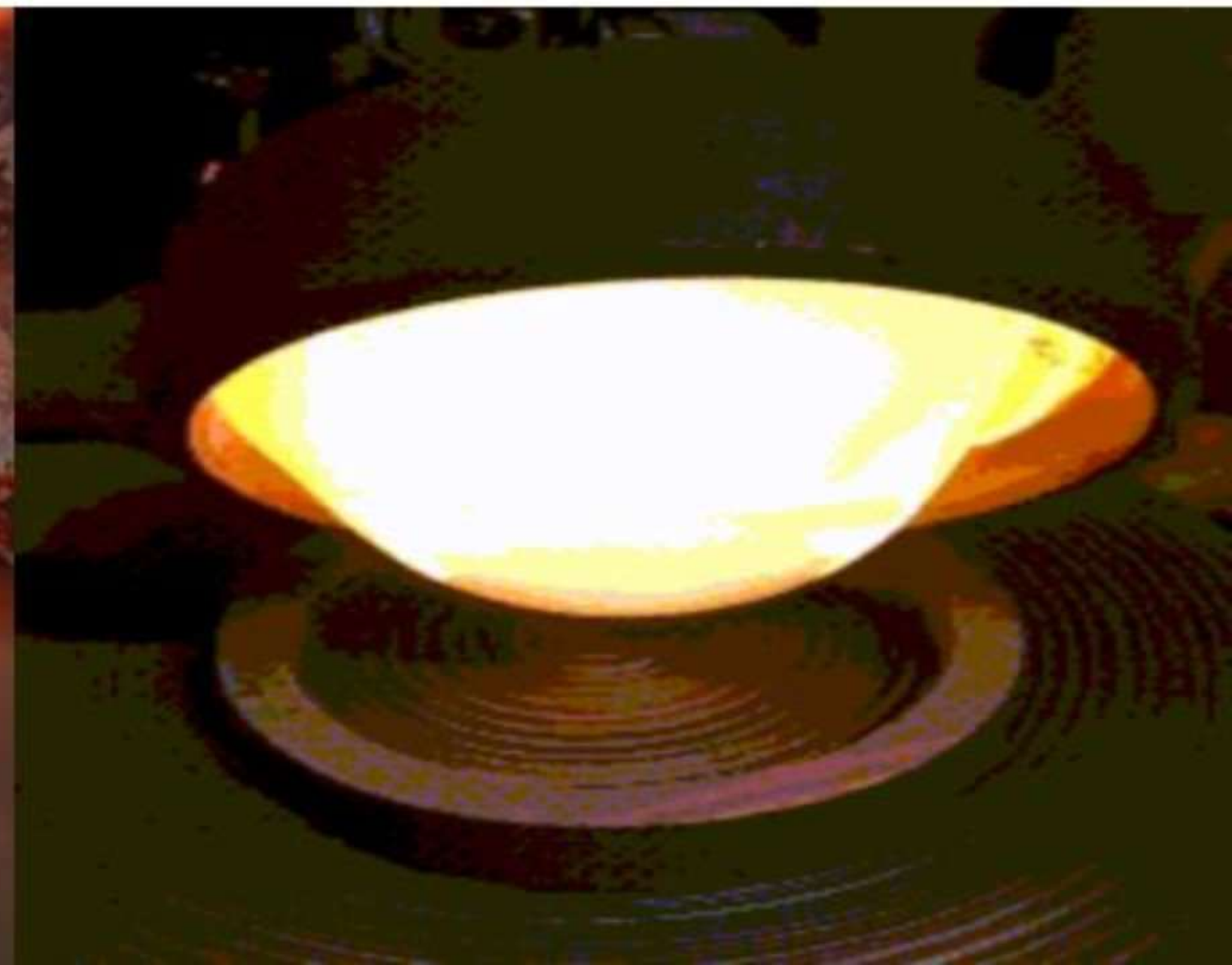
**THUR/ FRI/ SAT- 6PM**

**PRODUCTION ENGINEERING**



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# CASTING





**Casting, Forming and Joining Processes:** Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

**Machining and Machine Tool Operations:** Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming.

**Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly; concepts of coordinate-measuring machine (CMM).



**Computer Integrated Manufacturing:** Basic concepts of CAD/CAM and their integration tools; additive manufacturing.

**Engineering Materials:** Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.



## INDEX

Introduction of Casting

Broad Steps in Sand Casting

Cooling Curve for Sand Casting

Types of allowances

Types of pattern

Moulding sand and its properties



## Types of Allowances

✓ Shrinkage or contraction

✓ Draft or Taper

✓ Machining or Finish

✓ Shake or Rapping

✓ Distortion or camber

A grey cast iron block of dimensions 200, 100 and 10 mm is produced by sand casting moulding process, Pattern making allowances is 1%. What is the ratio of volume of the pattern to the volume of the casting.

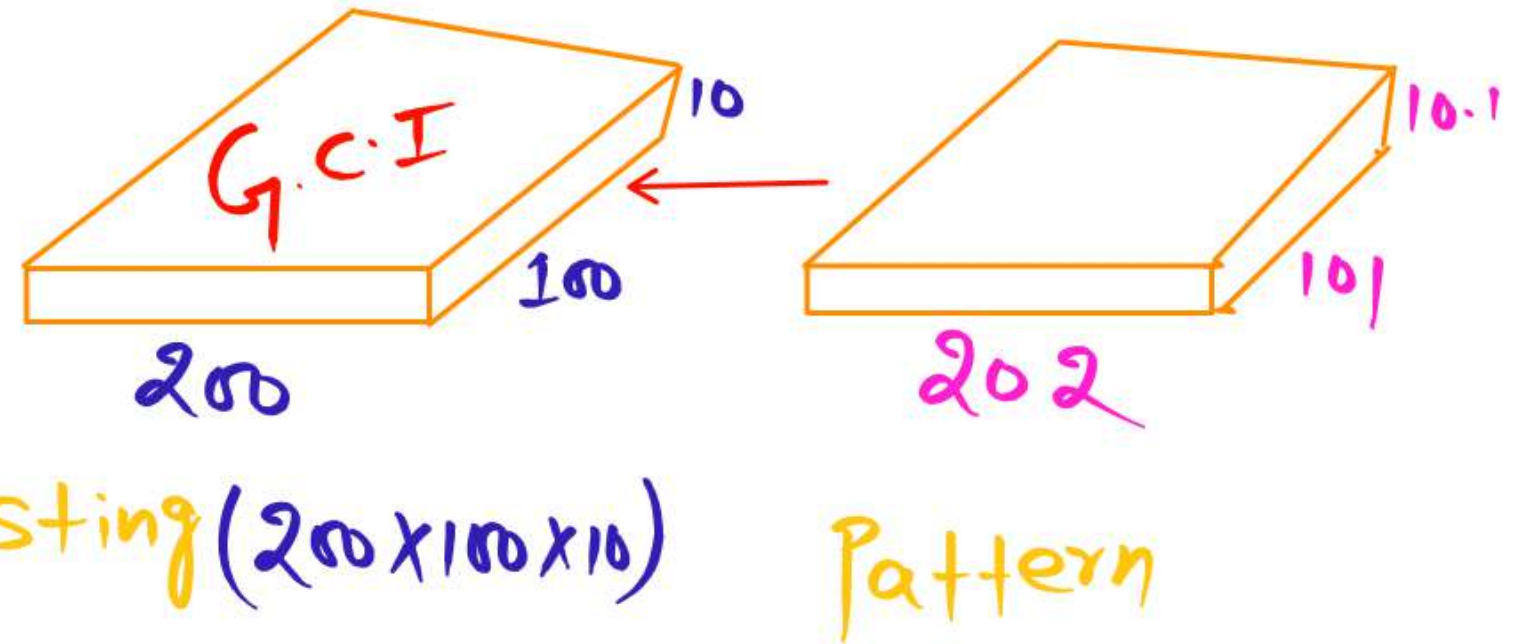
☺ \* G.C.I → -ve All  
(Phase-change)

☺ \* G.C.I →  $200 \times 100 \times 10 \text{ mm}^3$   
\* Allowances → 1%

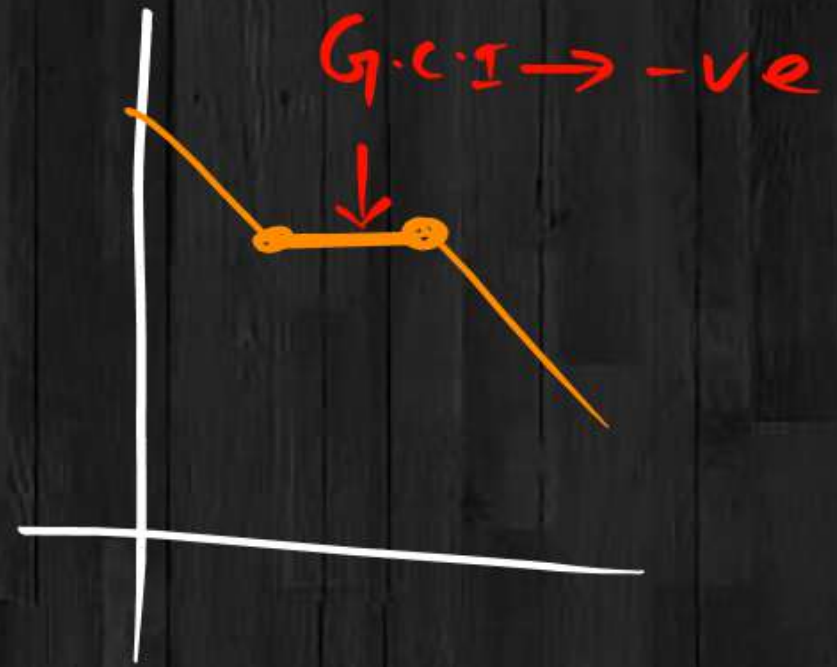
Solution: →

$$* \frac{V_p}{V_c} = \frac{202 \times 101 \times 10.1}{200 \times 100 \times 10} = 1.03 \text{ Casting } (200 \times 100 \times 10)$$

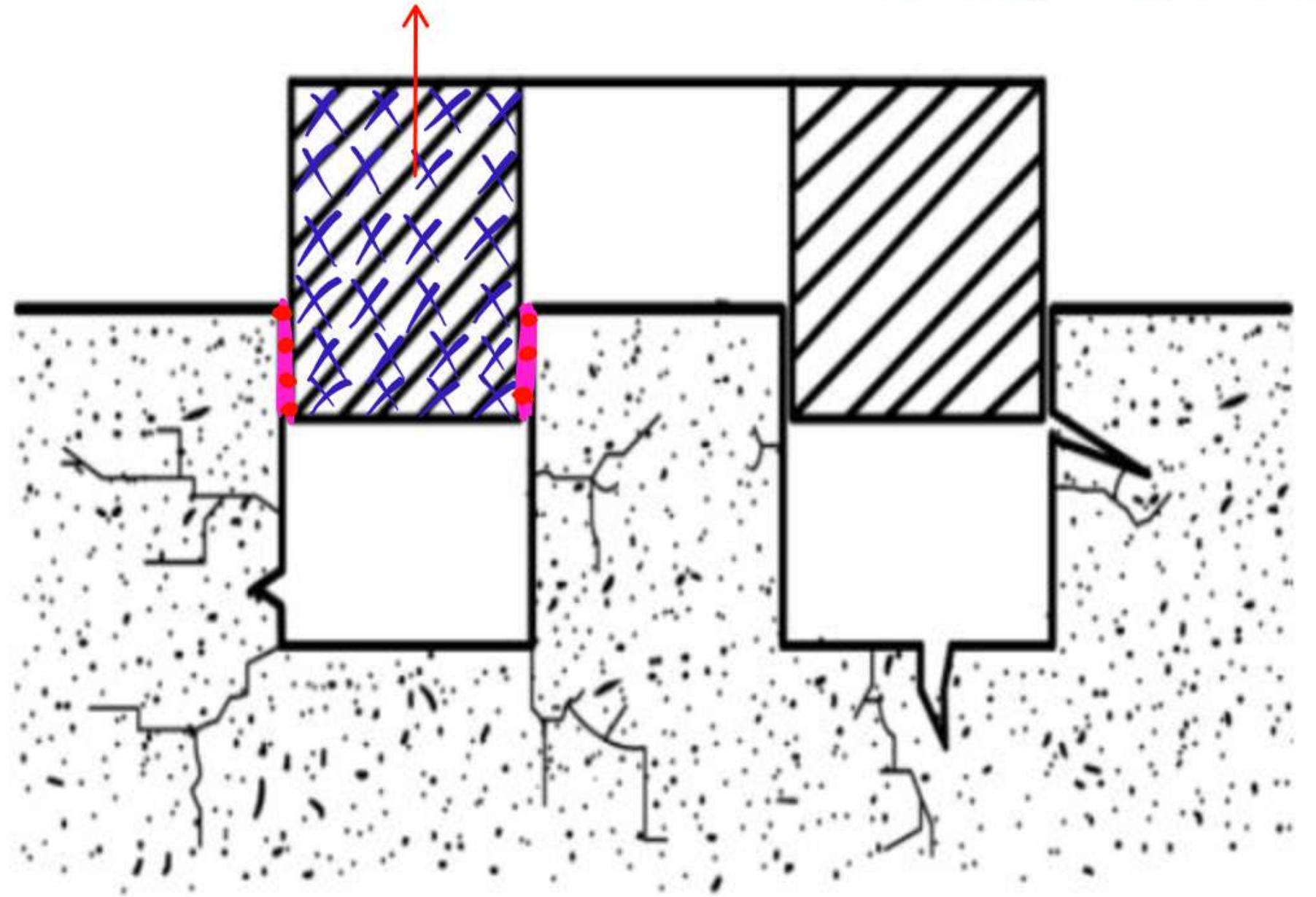
$$* \frac{V_p}{V_c} = 1.03$$





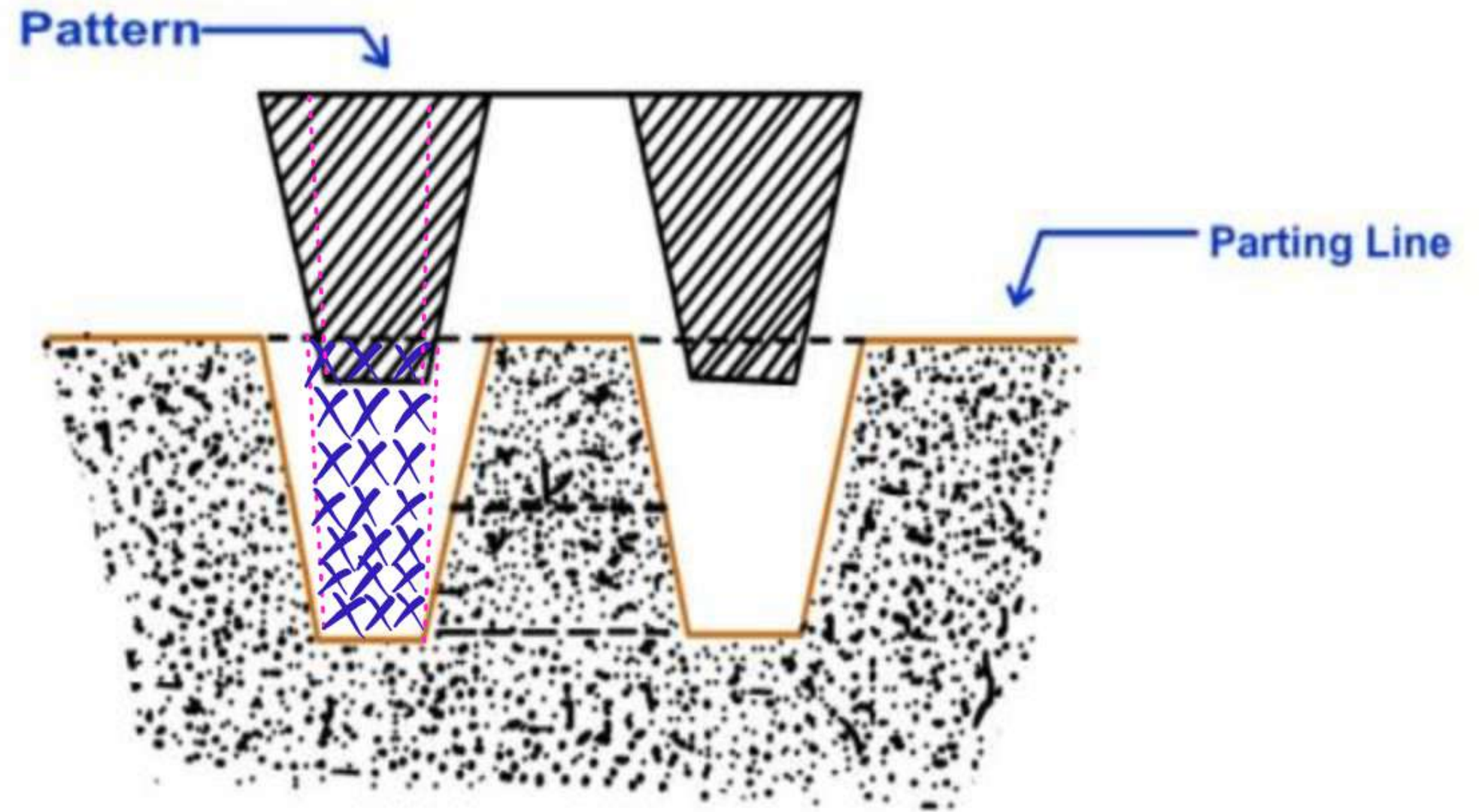


Draft or Taper Allowances



Ad



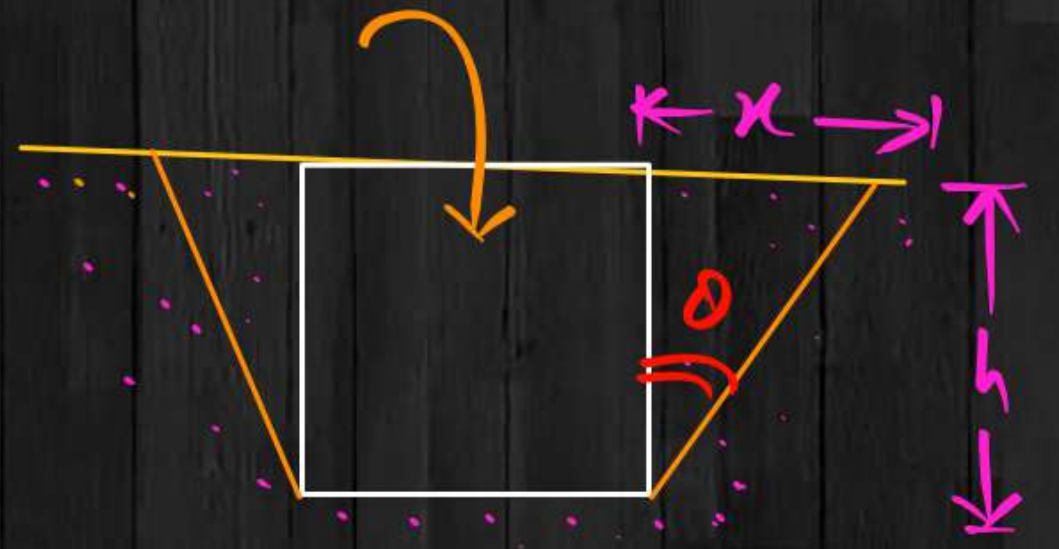
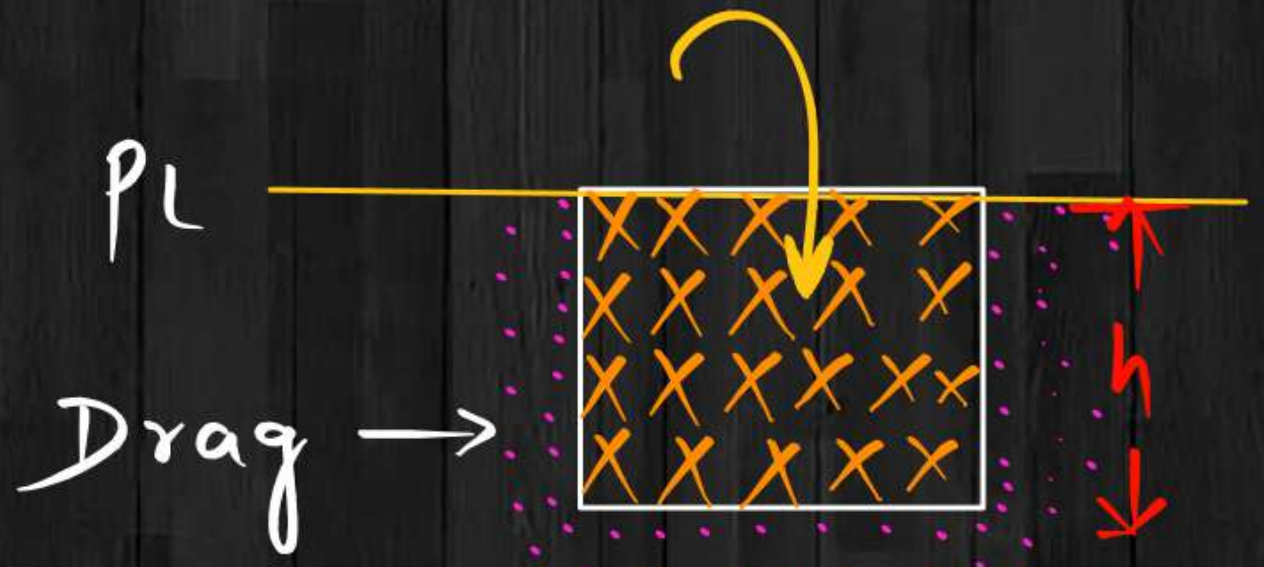




$\theta \rightarrow \frac{1^\circ}{2} \text{ to } 2^\circ$

\*  $\tan \theta = \frac{\kappa}{h}$

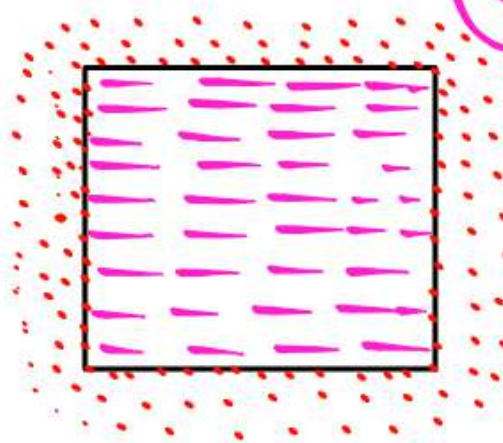
\*  $\kappa = h \cdot \tan \theta$





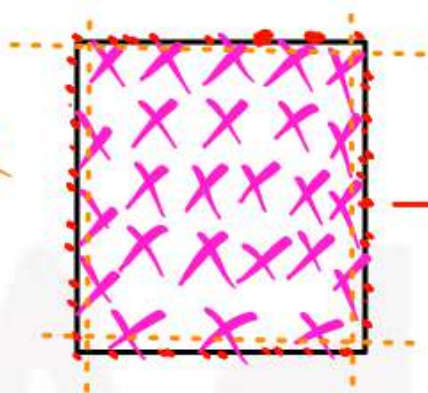
Machining or Finish Allowance  $\rightarrow$  (mm/surface)

😊 +ve Allowances

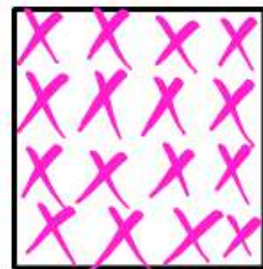


20/22  
Pattern (20x10)

10/12

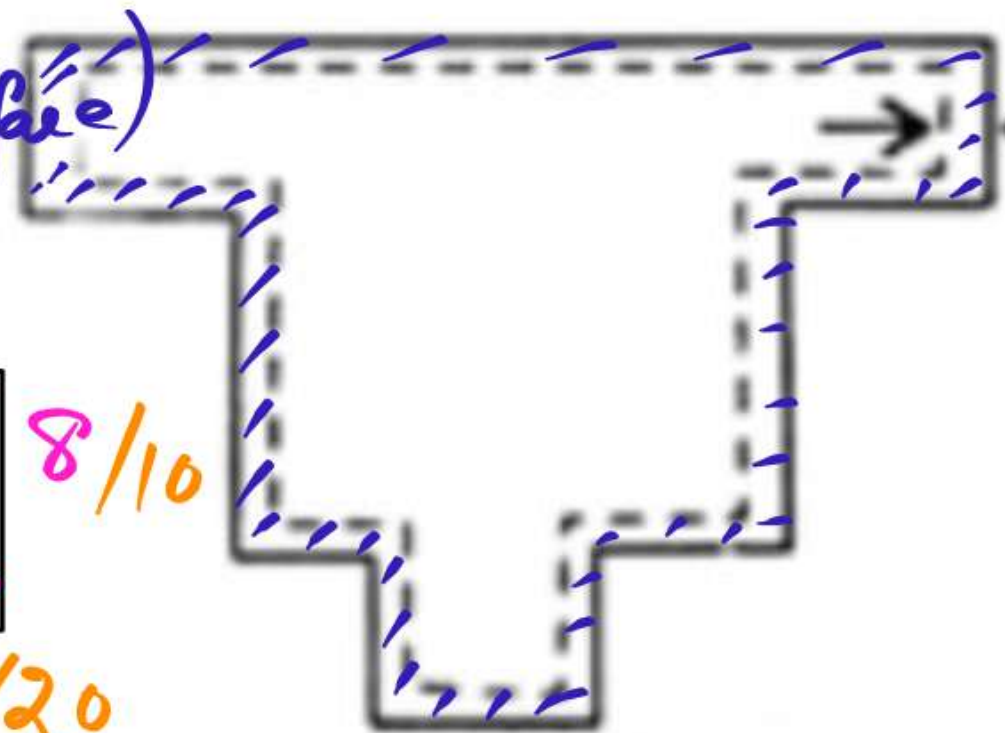


Casting (18x8)



18/20

8/10



Machining allowance

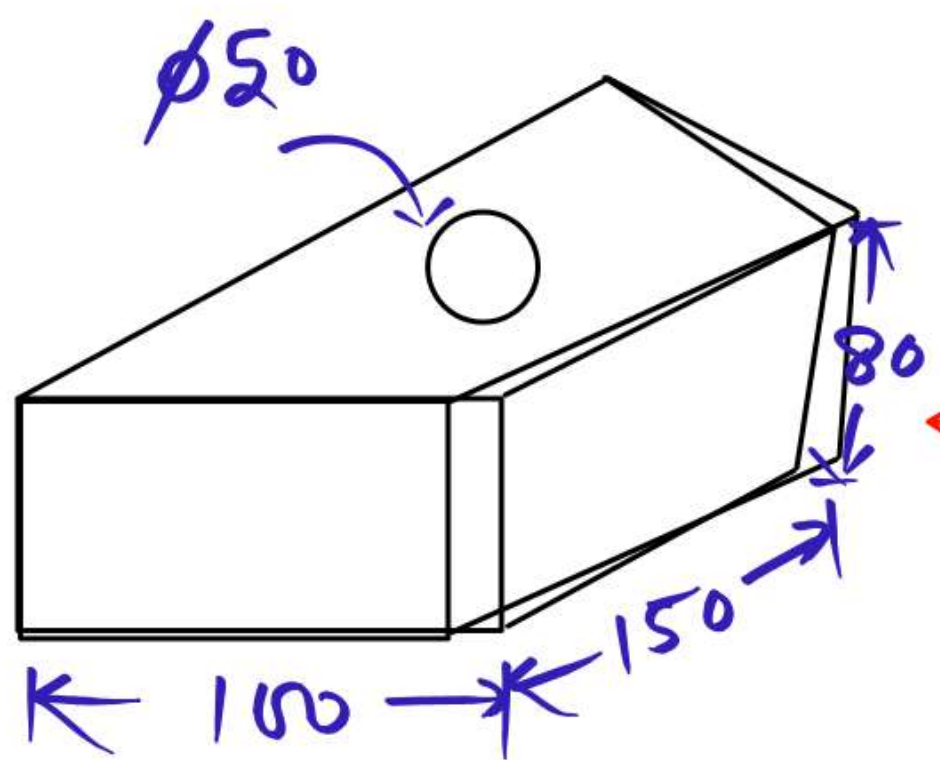
Exp:  $\rightarrow$   
\* M.A  $\rightarrow$  1 mm/surface

110



\* 100 x 150 x 80 mm

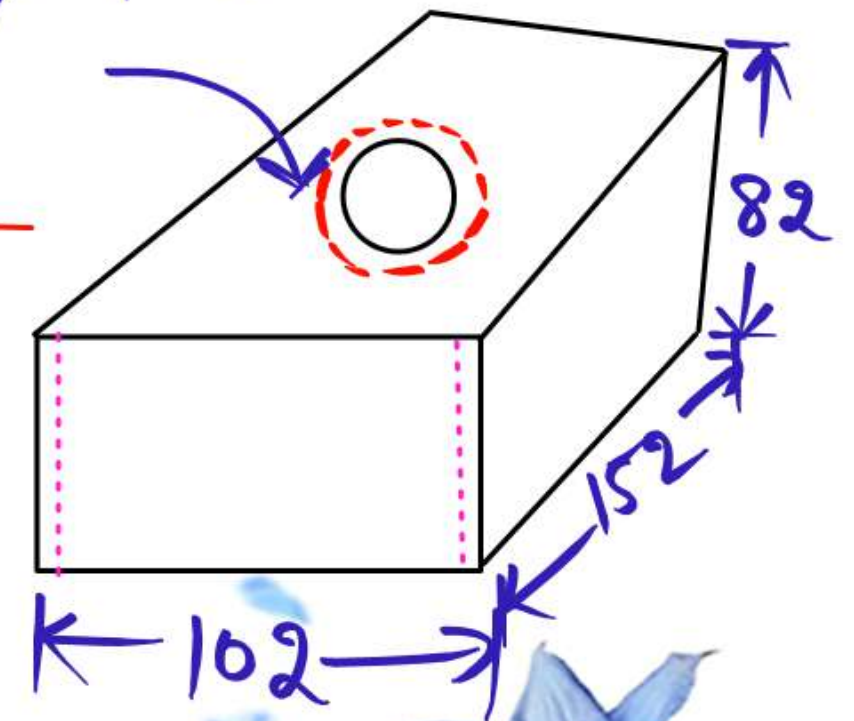
\* M.A → 1 mm/surface



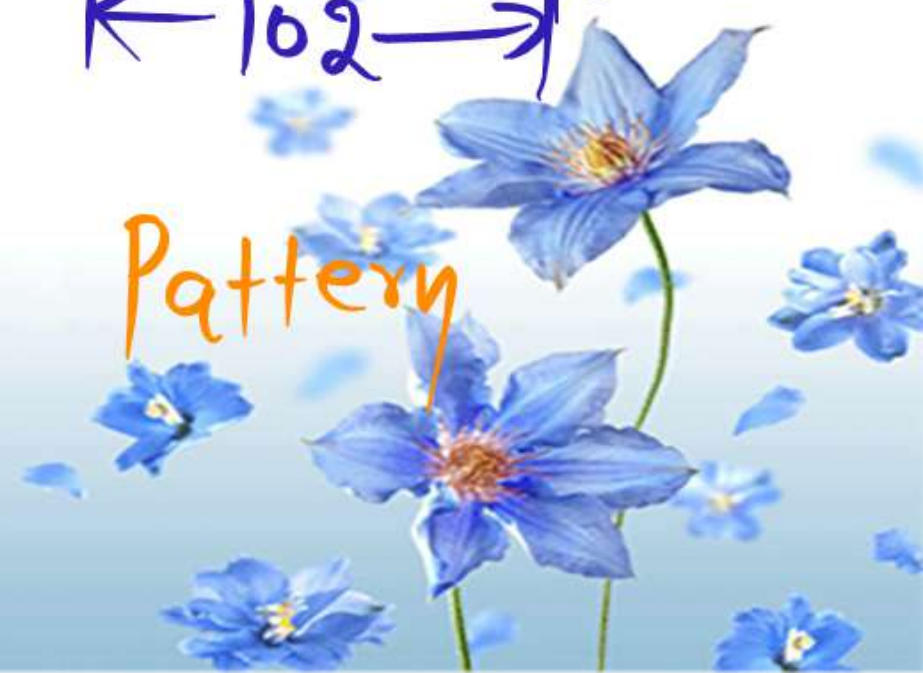
Casting



φ 48



Pattern



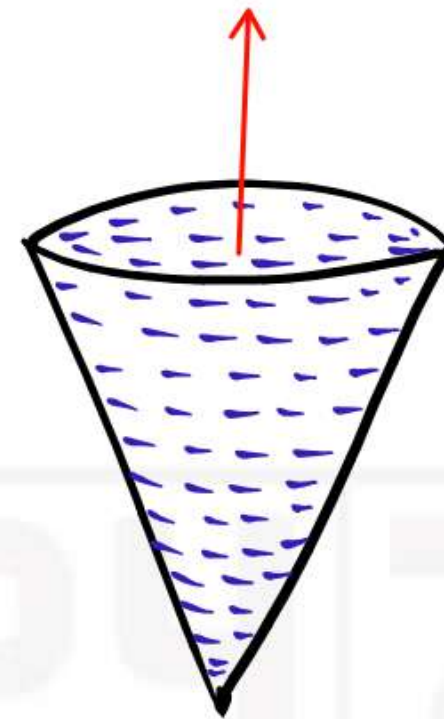




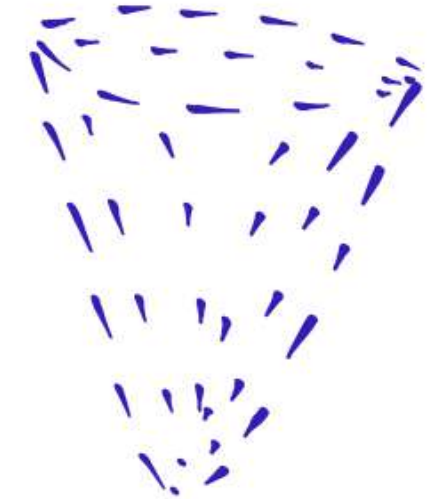
### Shake or Rapping Allowances



-ve Allowances



Pattern



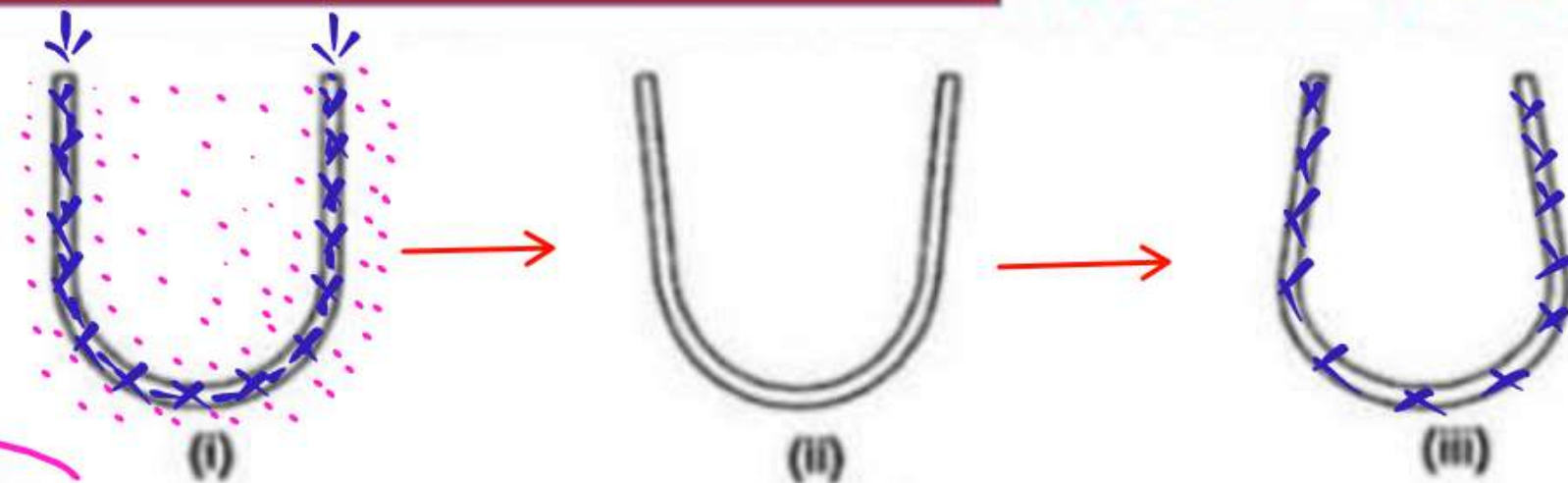
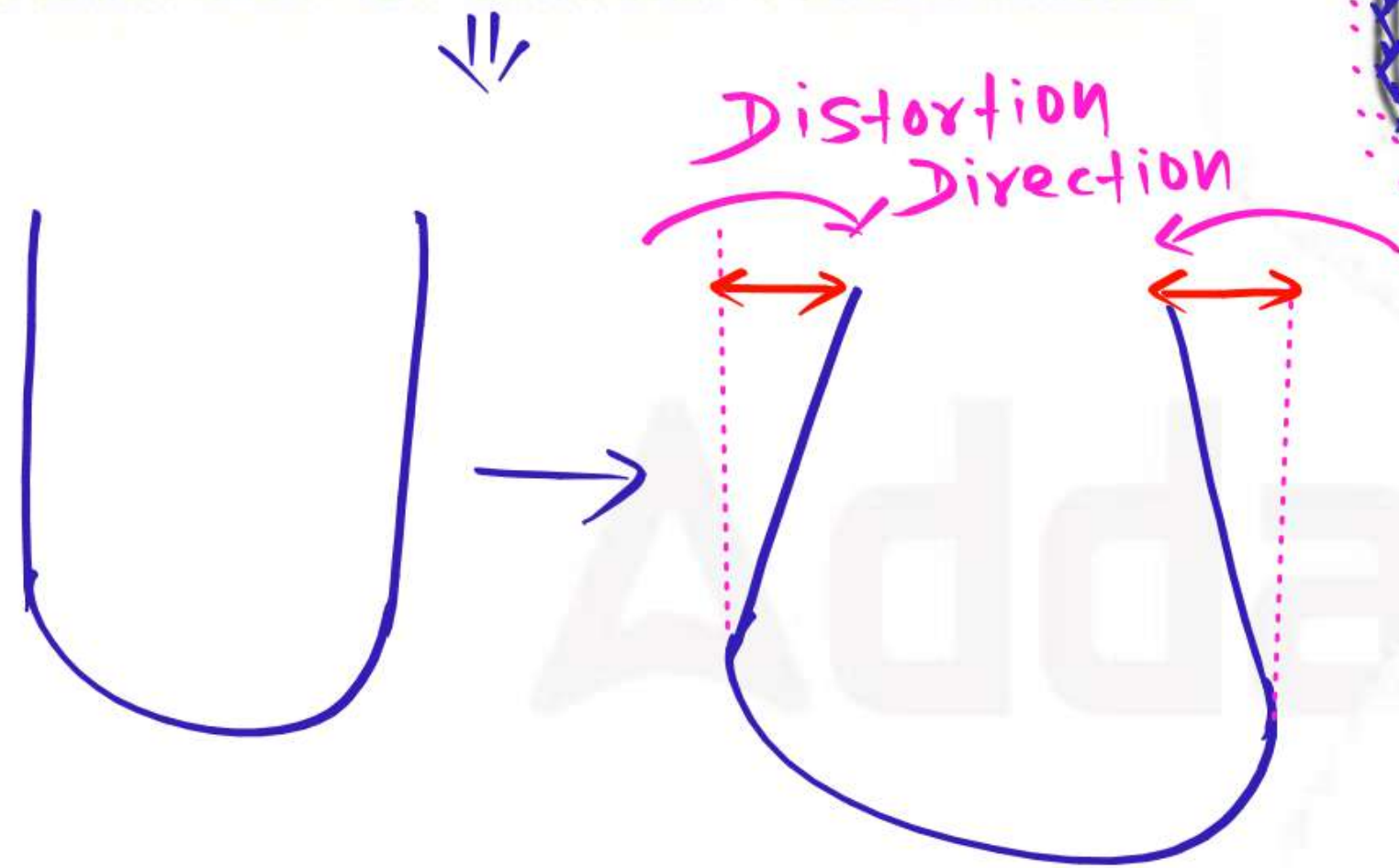
Casting



-ve Allowances

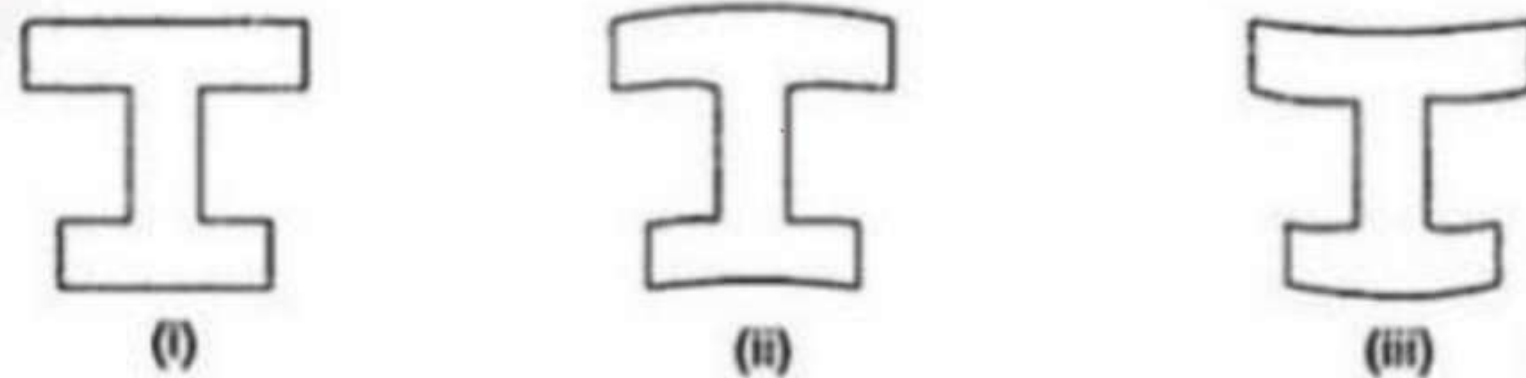


### Distortion or camber Allowances



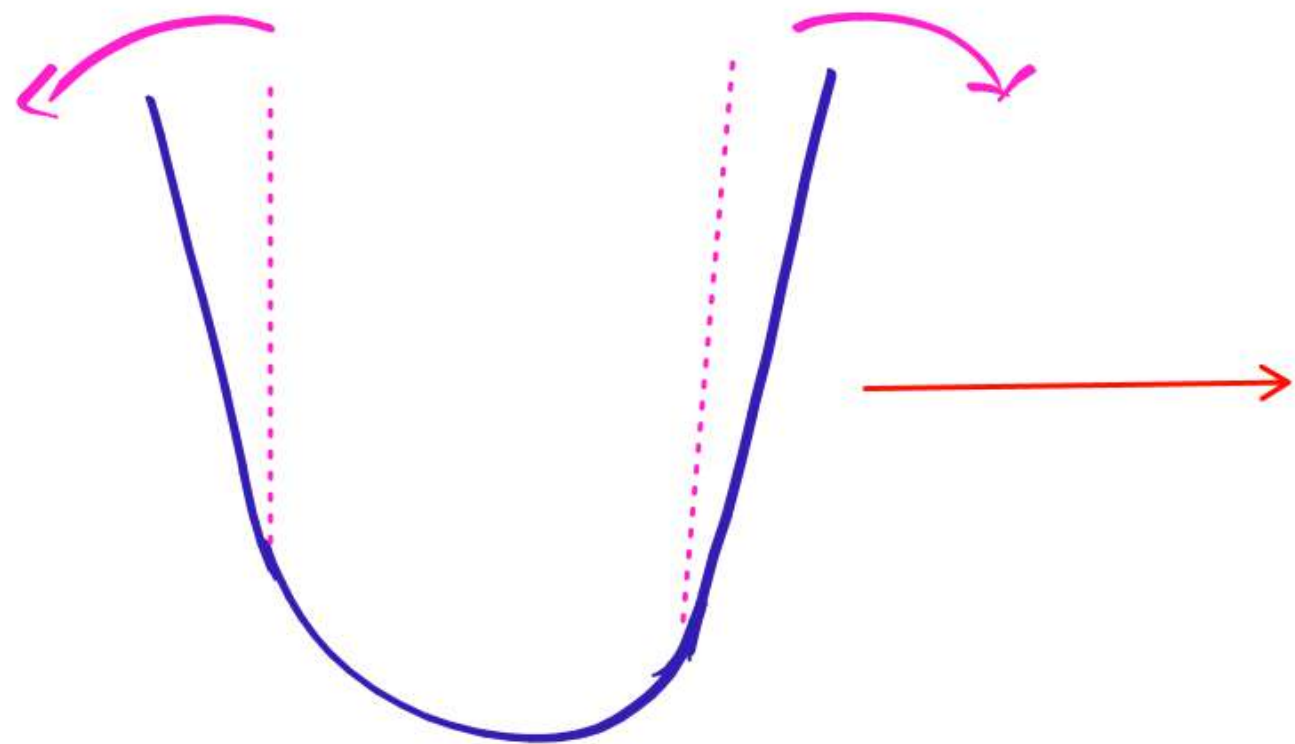
(a) U-shaped Casting

- (i) Required shape of casting
- (ii) Casting produced with distortion
- (iii) Pattern provided with Camber allowance

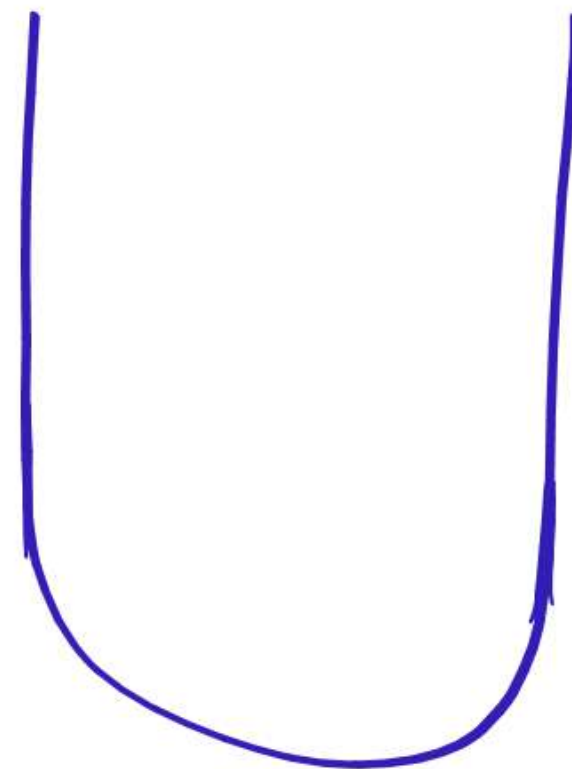


(b) I-section Casting

Distortion Allowances



Pattern



Casting



Distortion Allowances will be provided by the pattern opposite to the Distortion direction.



\* U, V Shape  $\rightarrow$  Distortion Allowances





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## Types of pattern

Solid or single piece pattern

Split piece pattern

Loose piece pattern

Gated pattern

Match plate pattern

Sweep pattern

Follow board pattern





## Solid or single piece pattern

\* If the object is having simple in shape and size.

One of the surface of the pattern is flat. Solid or single

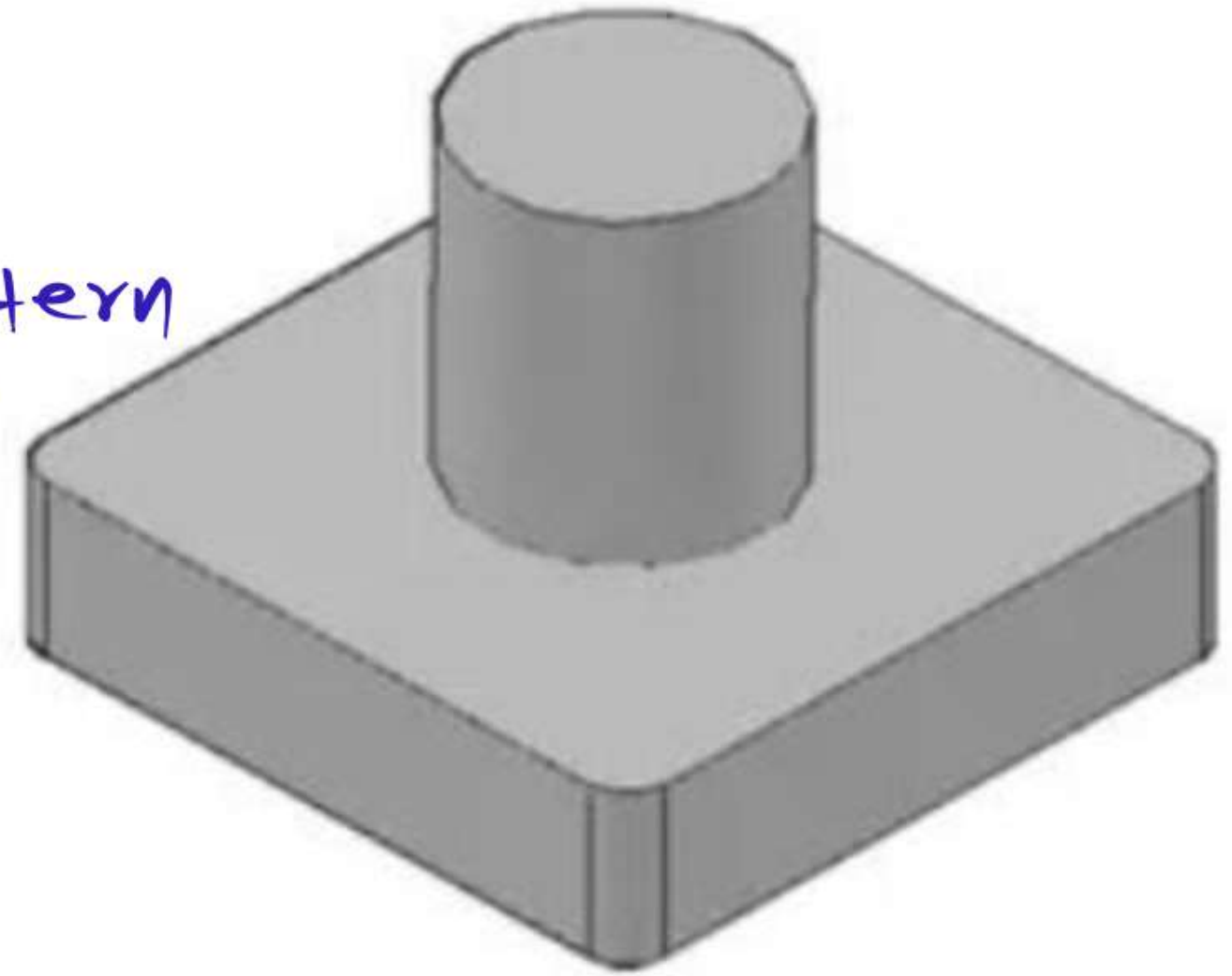
Piece pattern can be used.

\* It is a simplest type of pattern.



**Solid or Single Piece Pattern**

Single Piece Pattern  
→

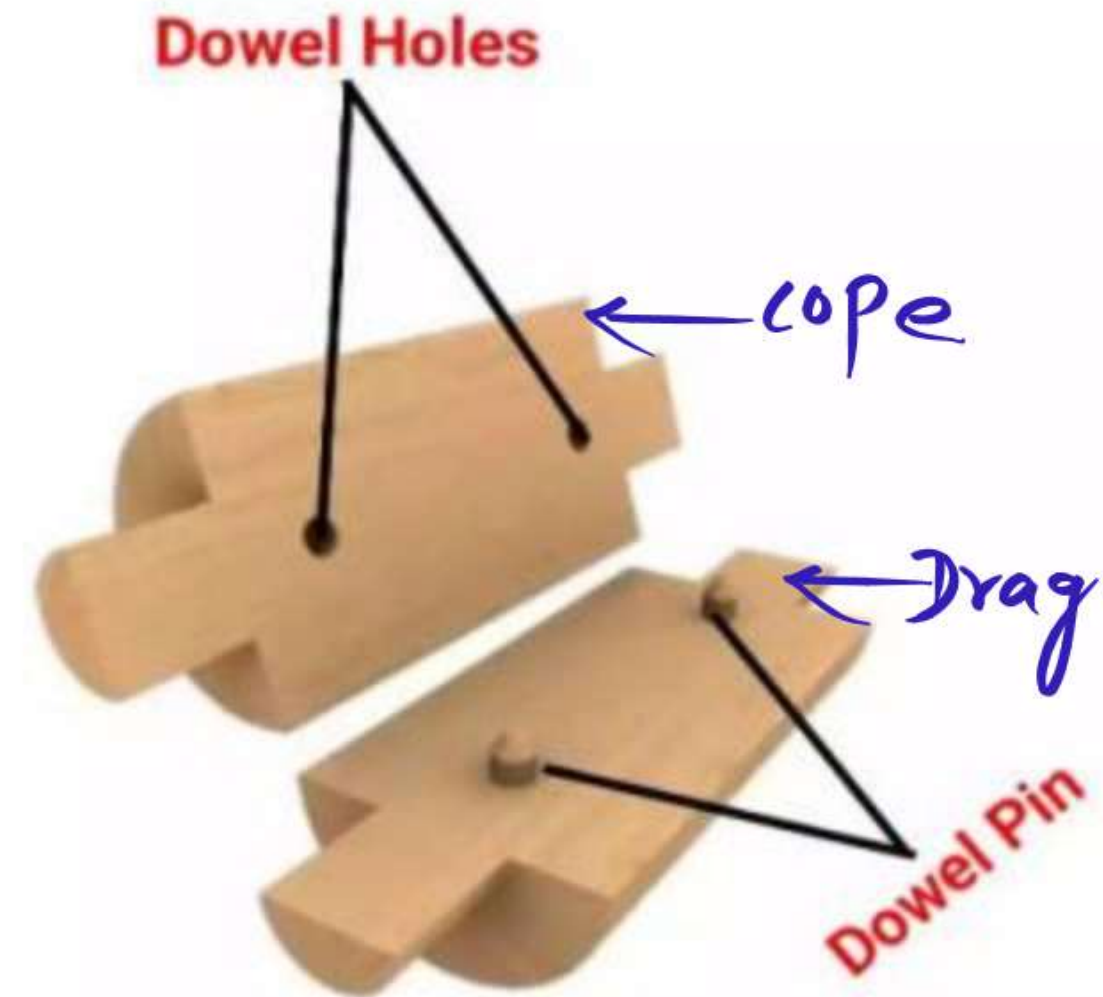
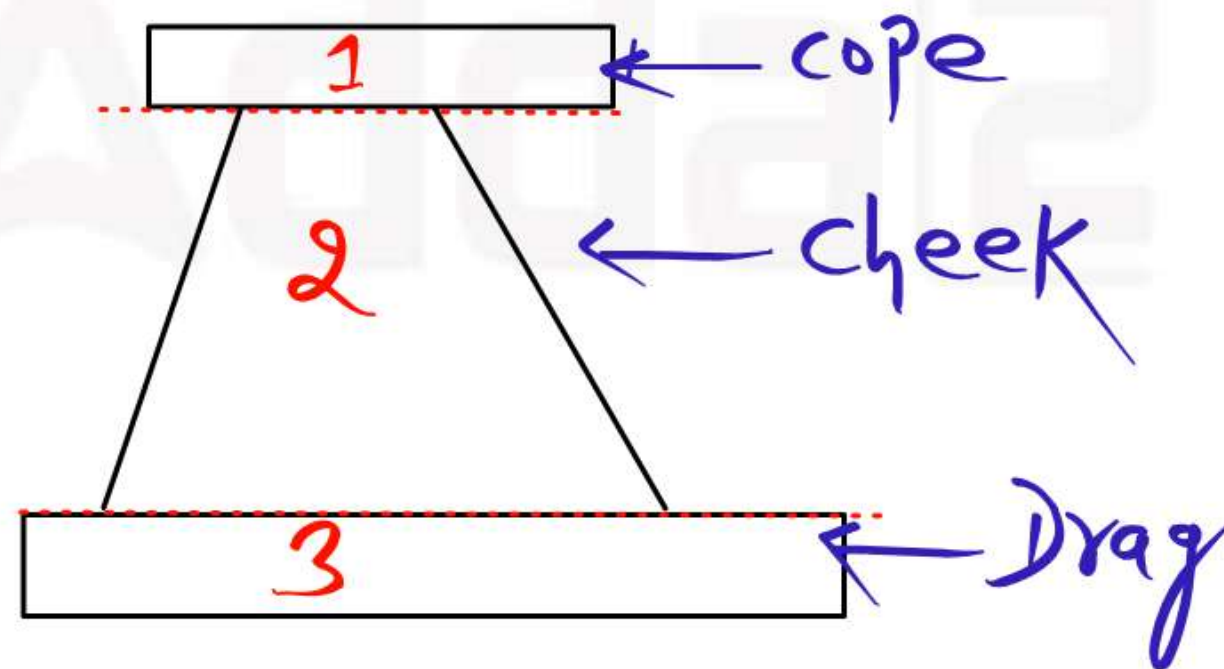


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## Split piece pattern

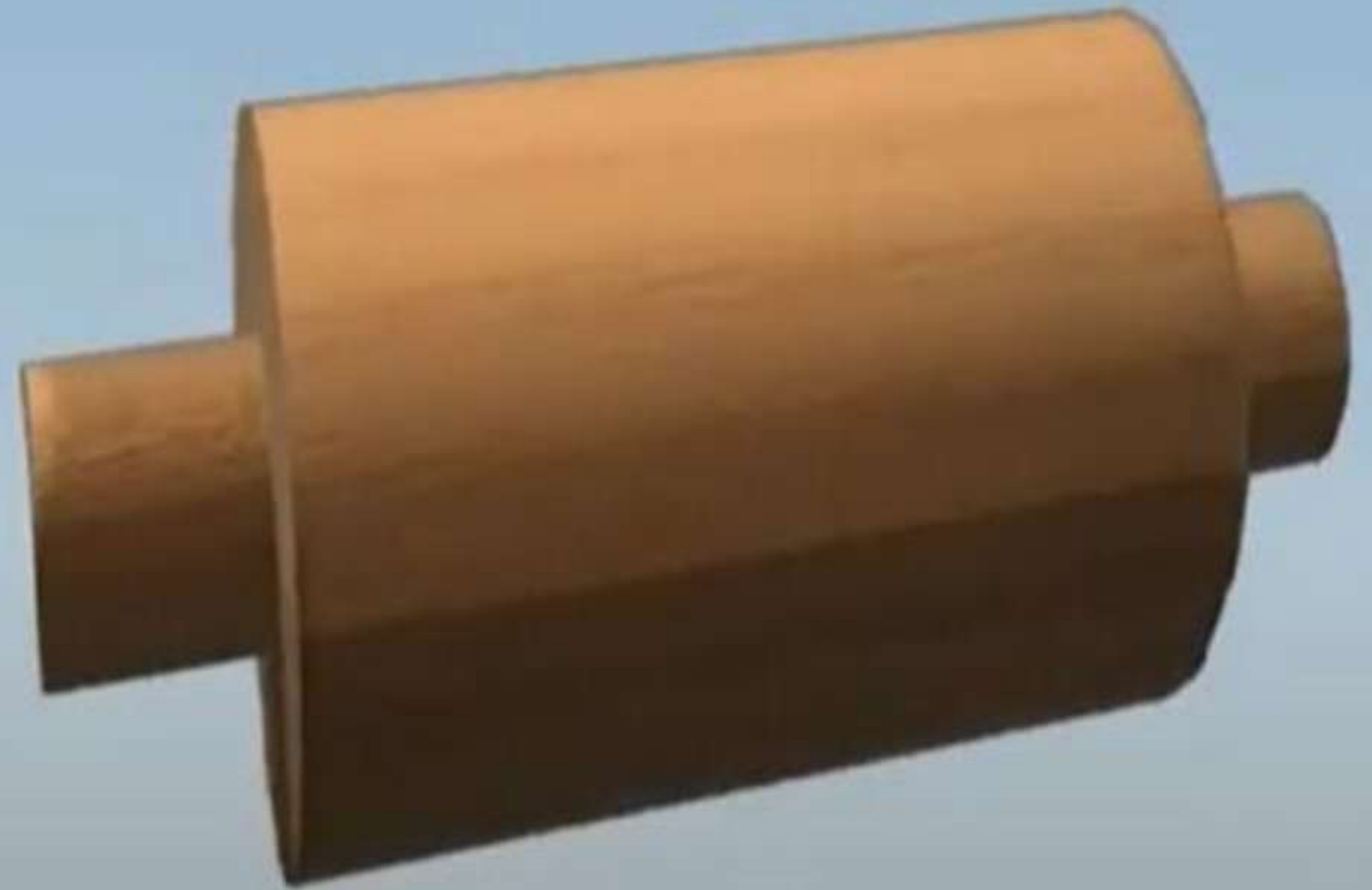
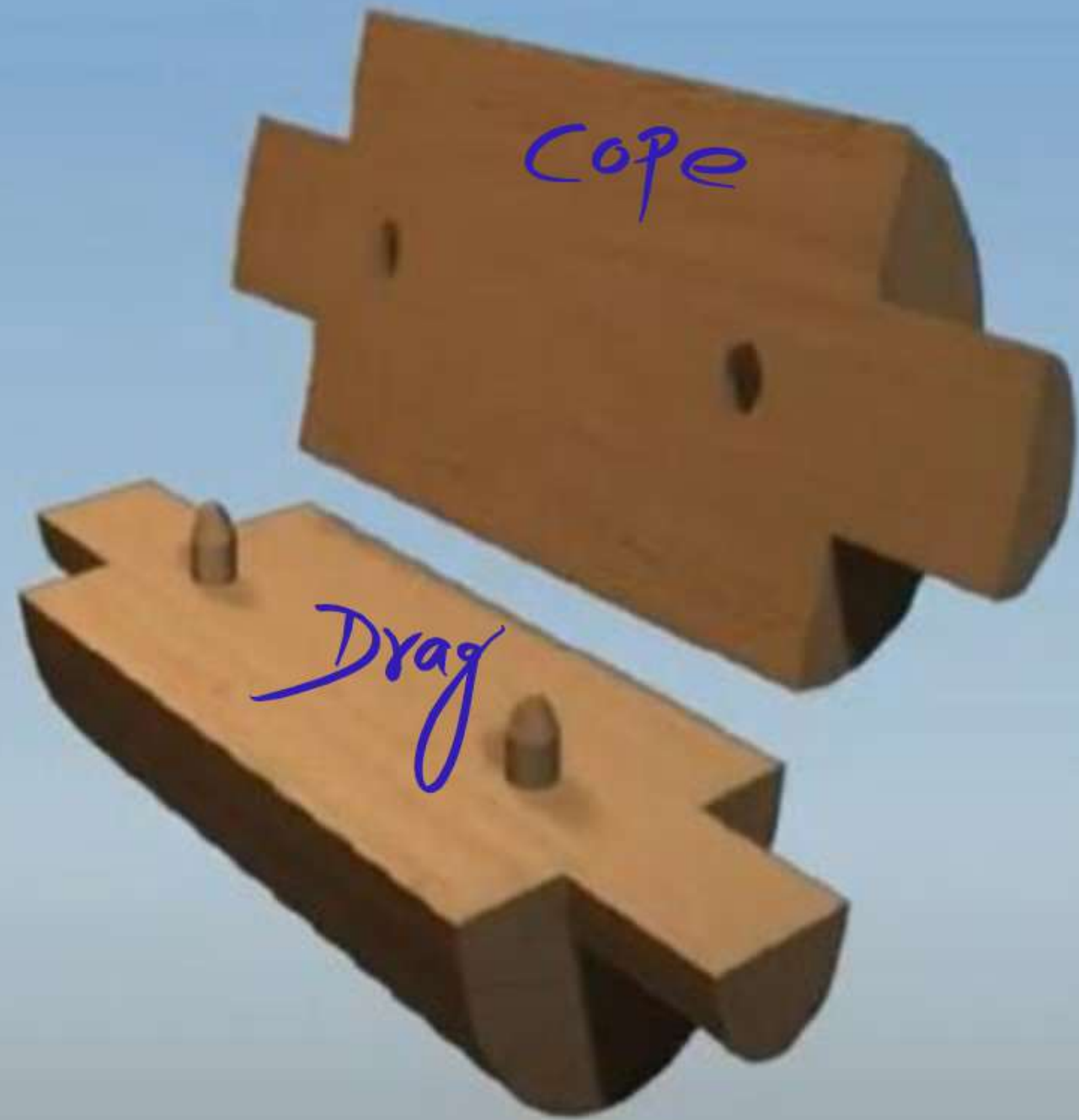
If the objects are having complex in shape and size pattern can be split along the parting line and they can be removed from cope and drag boxes separately



Split Pattern or Two Piece Pattern

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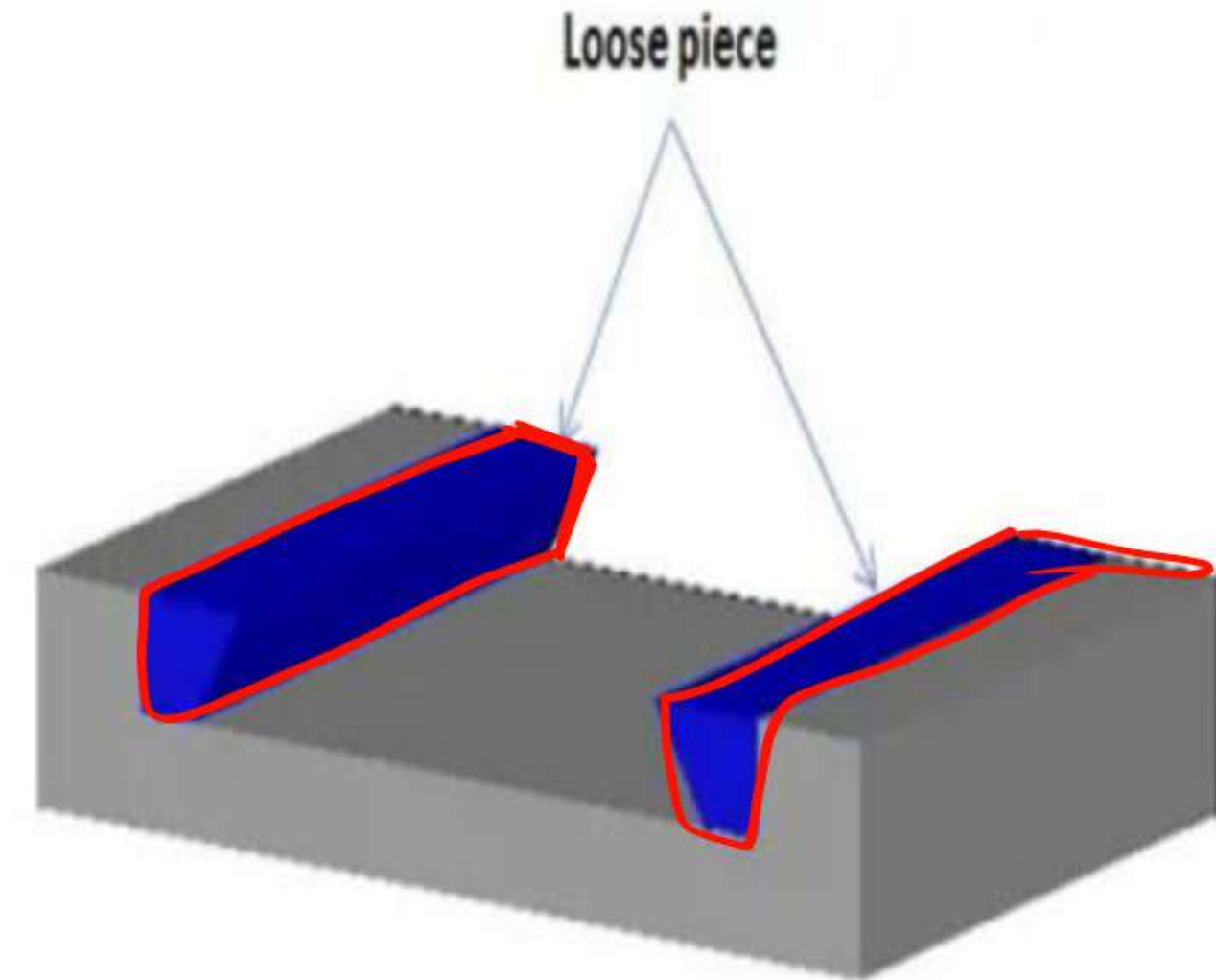
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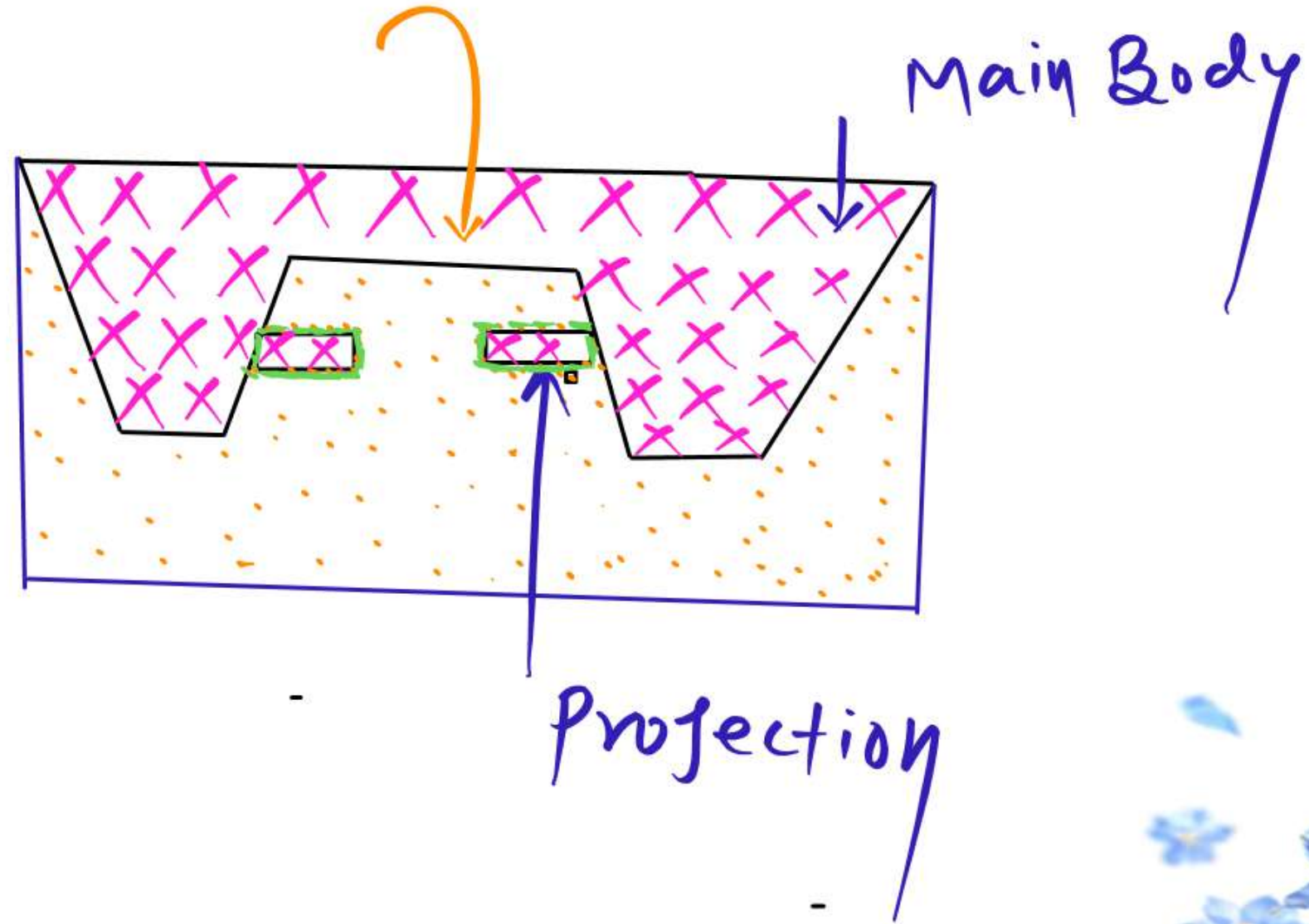
## Loose piece pattern

Loose piece pattern is used when pattern is difficult for withdrawal from the mould. Loose pieces are provided on the pattern and they are the part of pattern. The main pattern is removed first leaving the loose piece portion of the pattern in the mould. Finally the loose piece is withdrawal separately leaving the intricate mould.





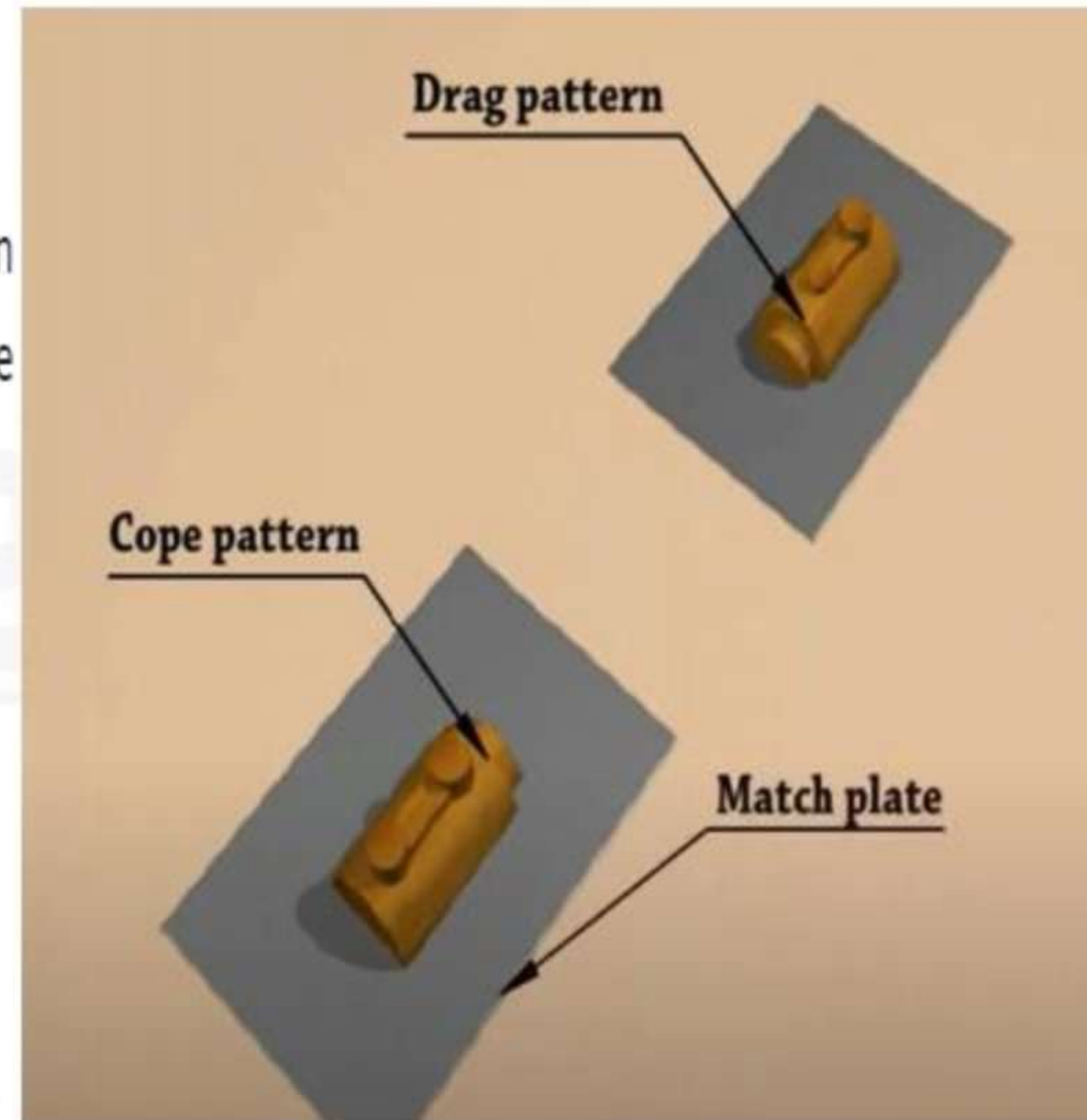
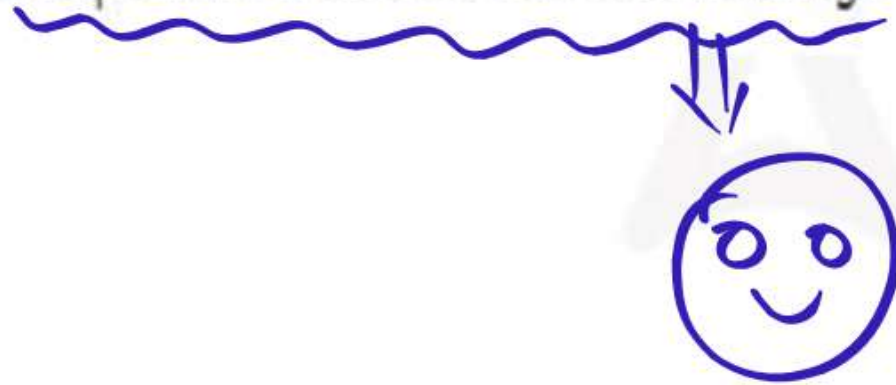
\* Projection  
\* Undercuts





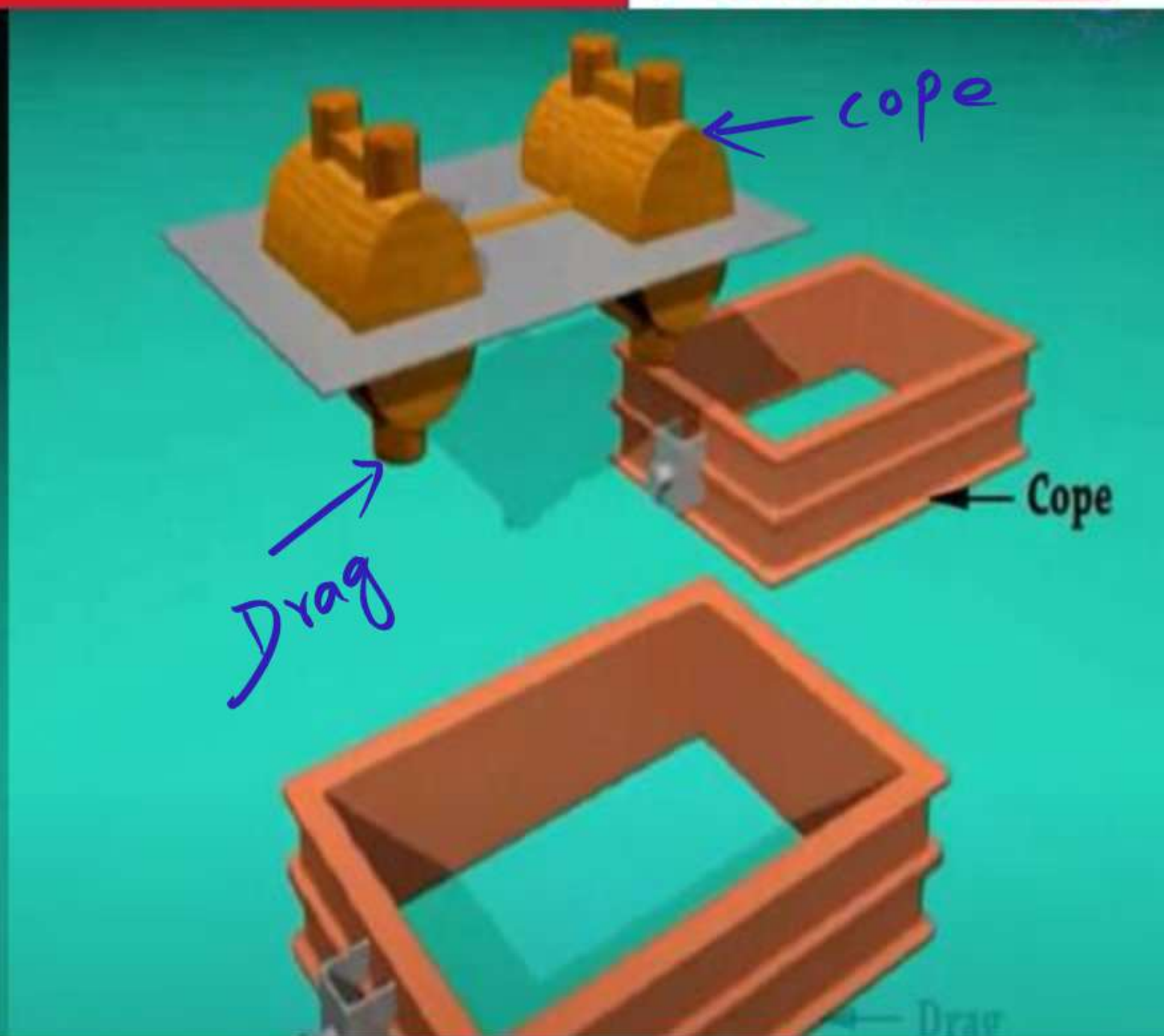
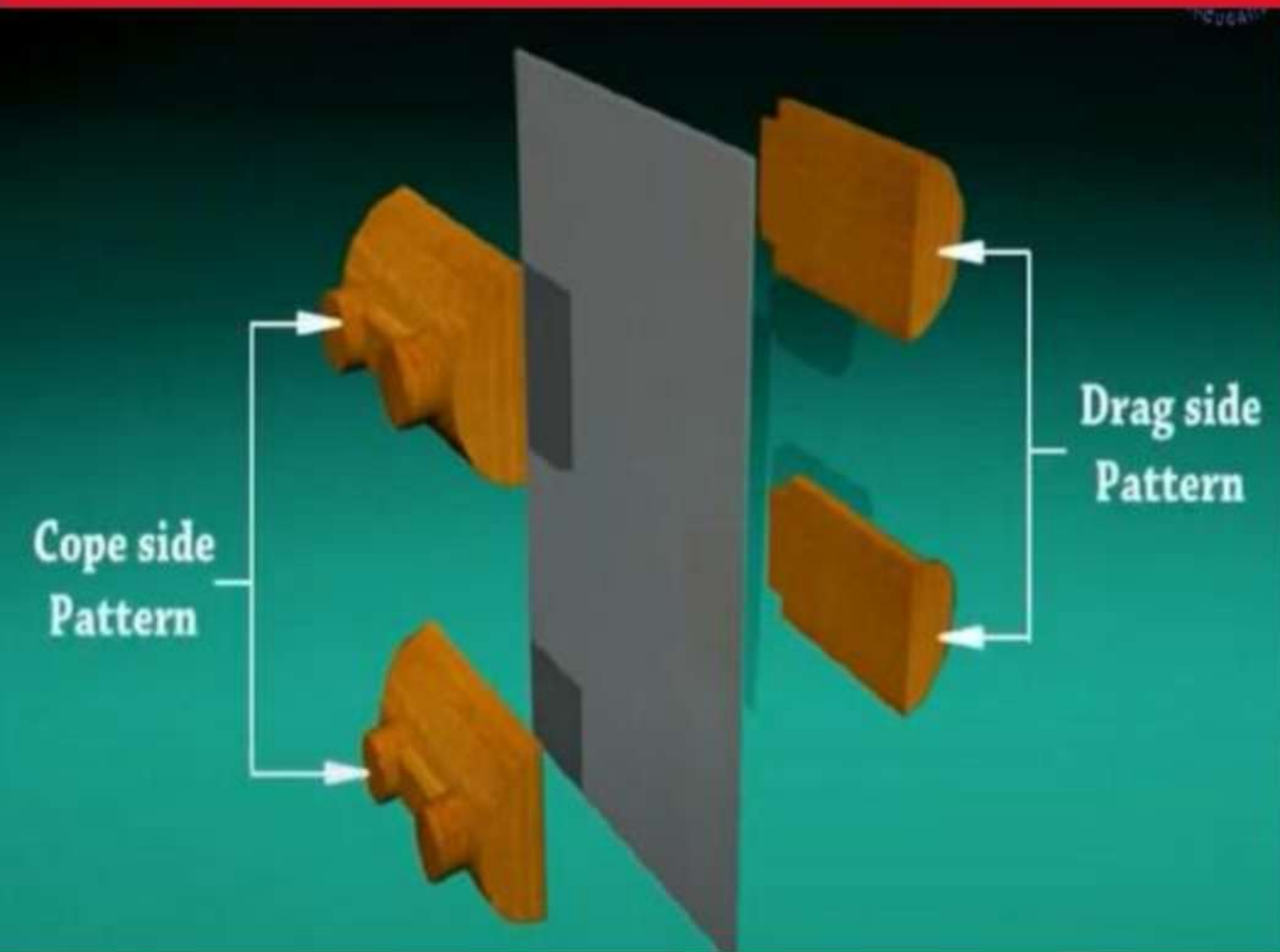
## Match plate pattern

This pattern is made in two halves and is mounted on the opposite sides of a wooden or metallic plate, known as match plate. The gates and runners are also attached to the plate. This pattern is used in machine molding.



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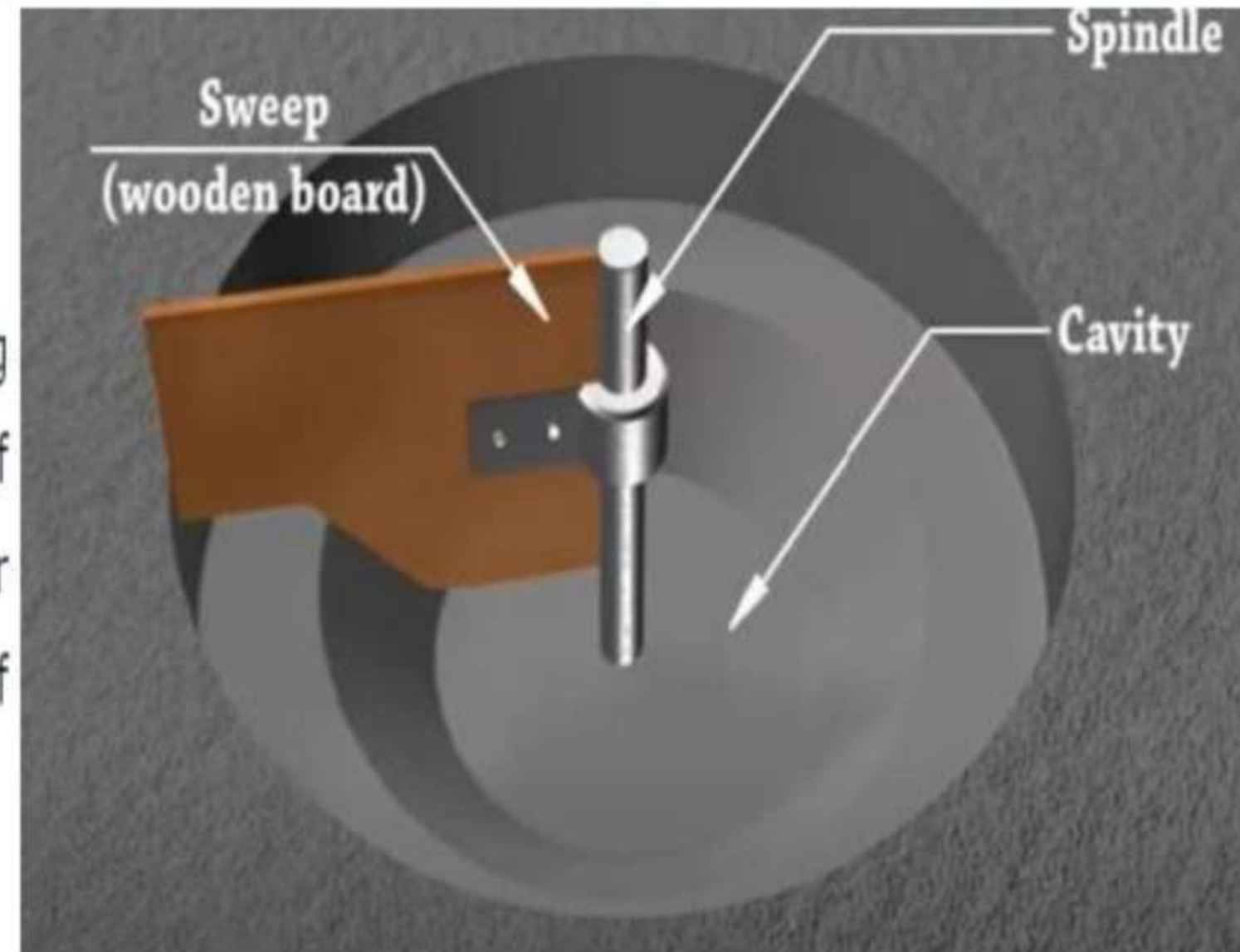
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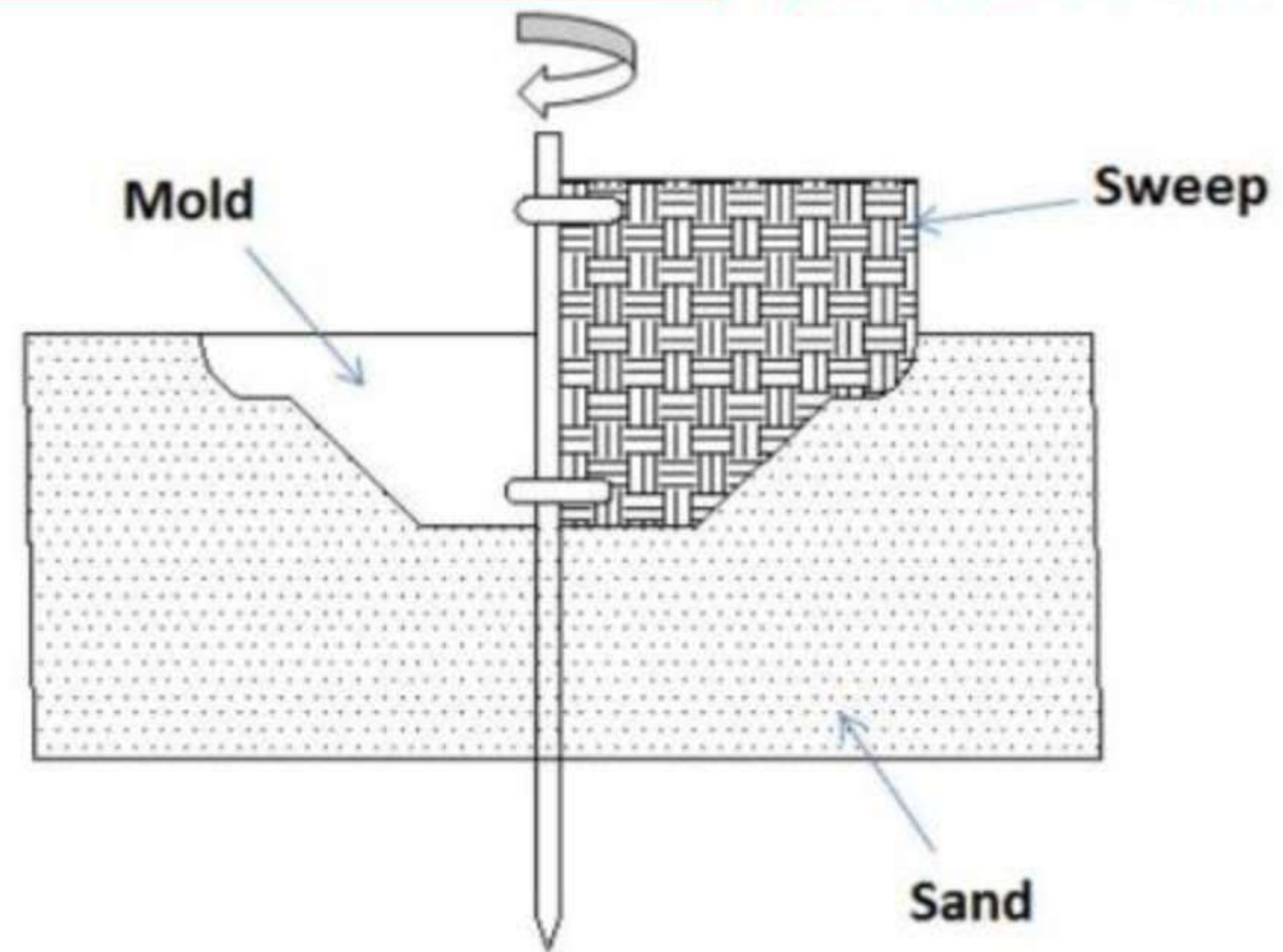
## Sweep pattern

Sweep patterns are used for forming large circular moulds of symmetric kind by revolving a sweep attached to a spindle as shown in Fig. Actually a sweep is a template of wood or metal and is attached to the spindle at one edge and the other edge has a contour depending upon the desired shape of the mould. The pivot end is attached to a stake of metal in the center of the mould.

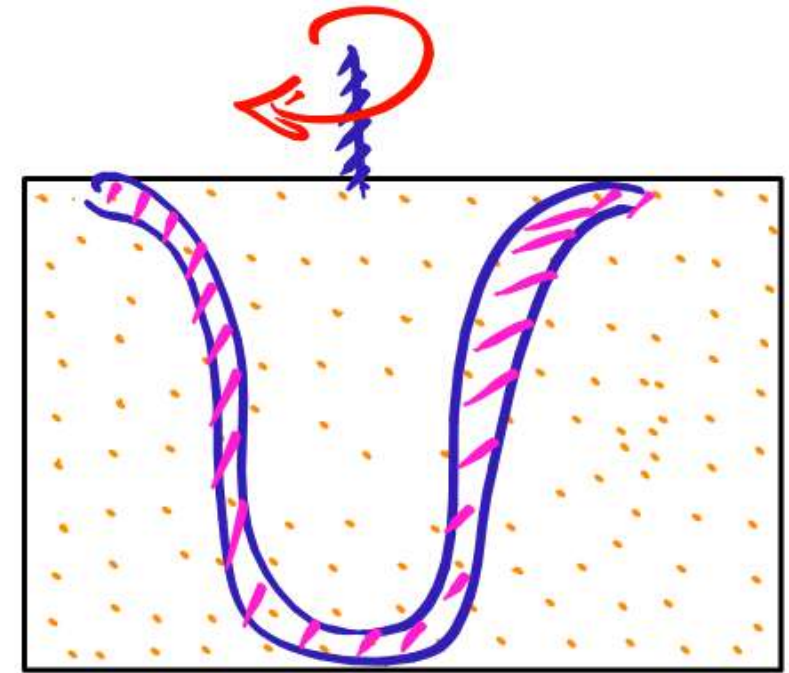
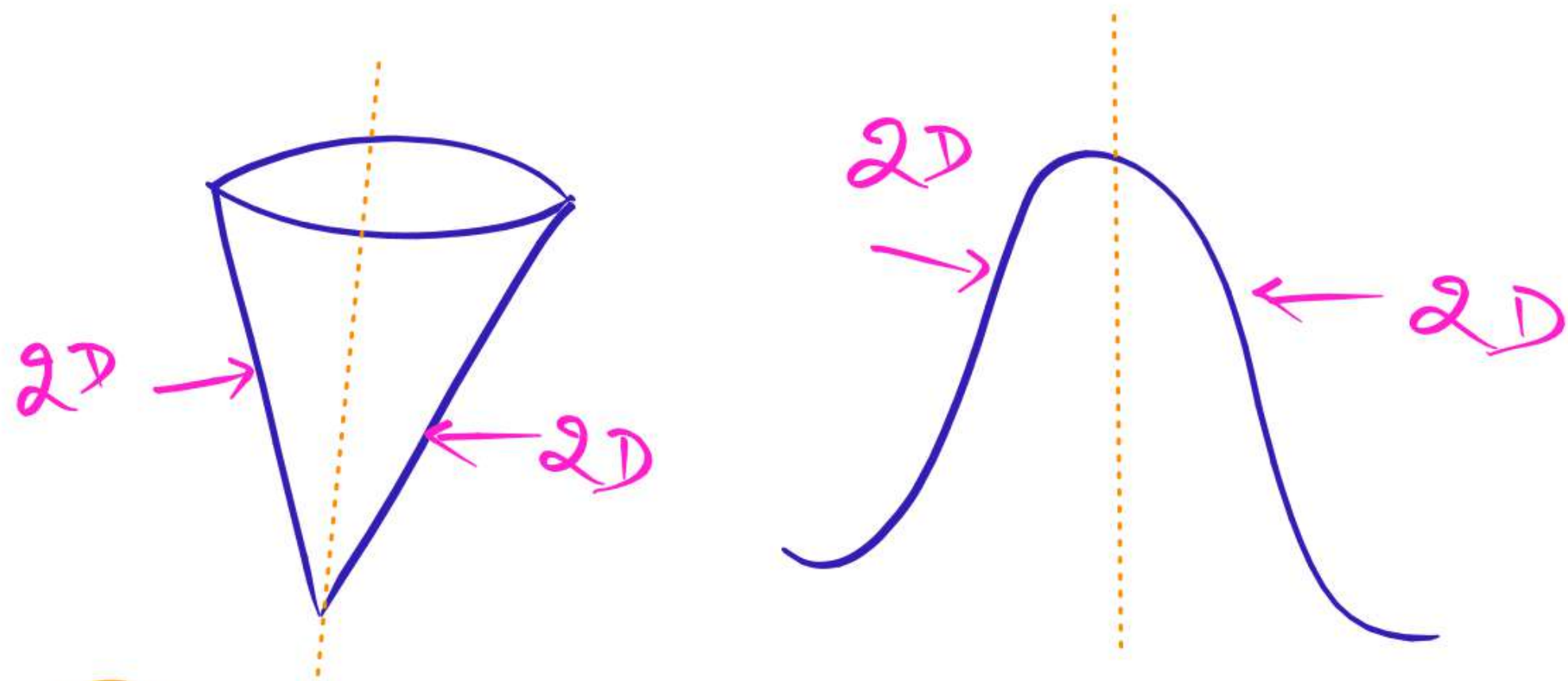


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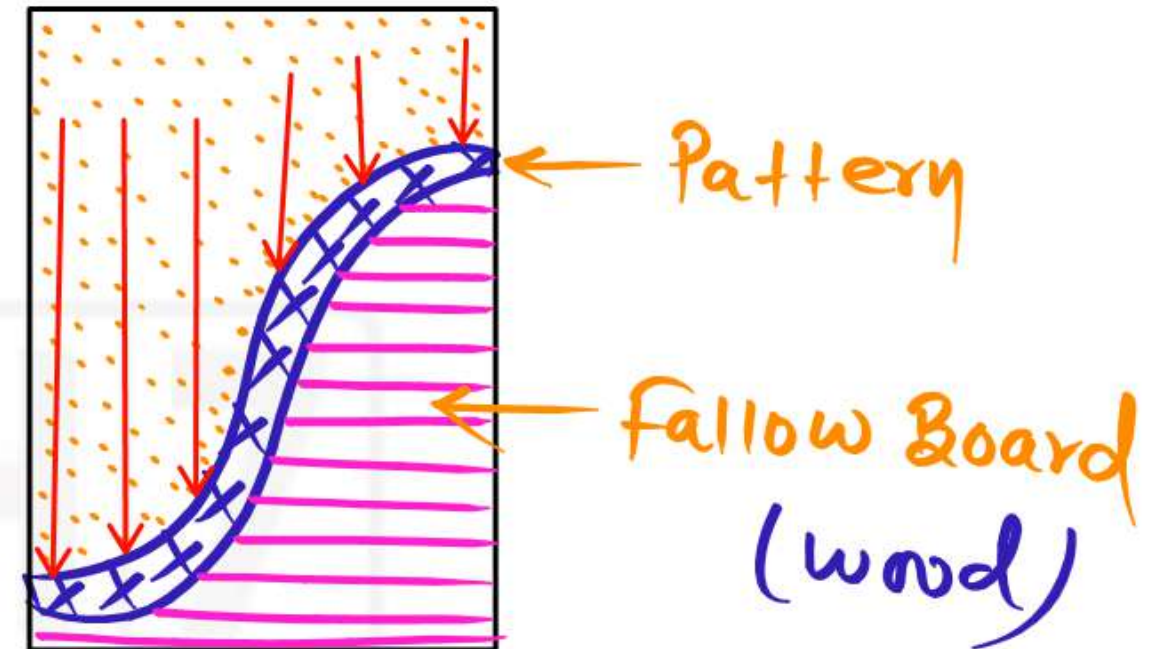
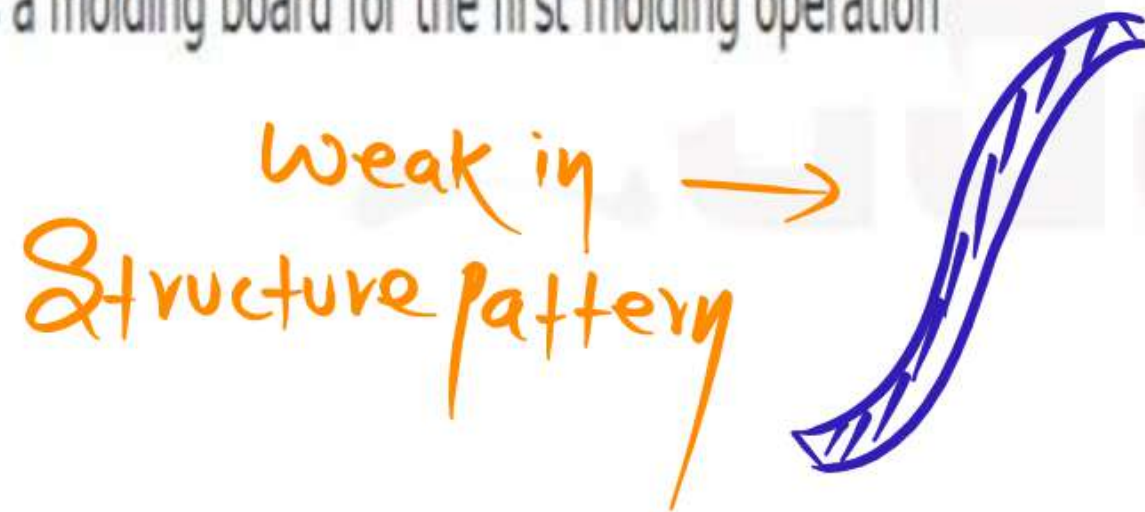
😊 To obtain Symmetrical 3-D Product Pattern, Rotate the 2-D Pattern to obtain 3-D Pattern.

Ex: → Cone, Large Size Bell, cylinder.



## Follow Board Pattern

When the use of solid or split patterns becomes difficult, a contour corresponding to the exact shape of one half of the pattern is made in a wooden board, which is called a follow board and it acts as a molding board for the first molding operation





## Moulding sand

- Molding sand are the most commonly used for making all types of molds irrespective of whether they are used for producing casting of ferrous or non-ferrous metal
- Most sand casting operations are used silica sand.
- Sand used to manufacture a mould for casting process is held by mixture of water and clay.
- A typical mixture by volume could be 89% sand, 4% water and 7% clay.





\* Silica  $\rightarrow$  70 to 85 %

\* Clay  $\rightarrow$  10 to 20 %

\* Water  $\rightarrow$  2 to 8 %

\* Additives  $\rightarrow$  1 to 4 %





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## Types of moulding sand

- Green Sand
- Dry Sand
- Loam Sand
- Facing Sand
- Backing Sand
- Parting 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.



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### 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.

### Backing sand

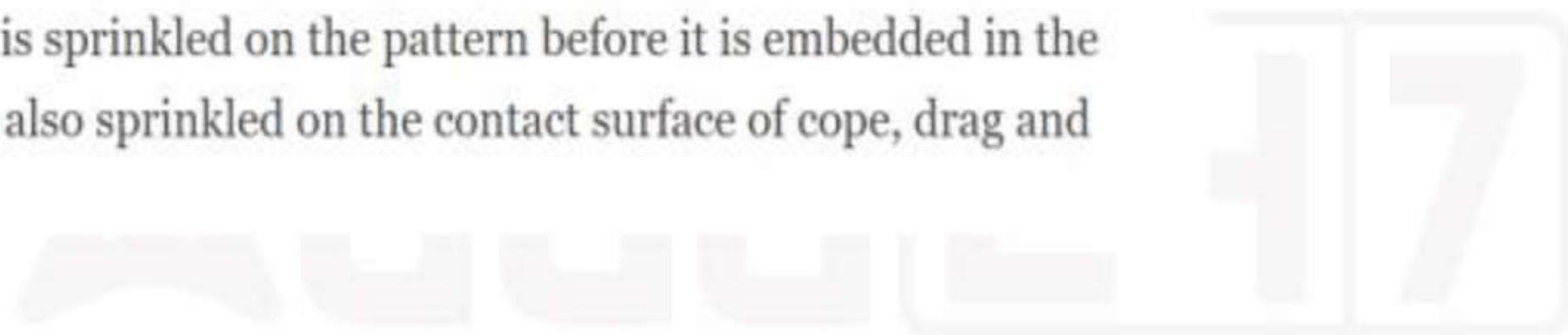


The backing sand is old and repeatedly used sand of black colour. It is used to back up the facing sand and to fill the whole volume of the box. This sand is accumulated on the floor after casting and hence also known as floor sand.

### 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.





## Properties of moulding sand

### 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.



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Permeability

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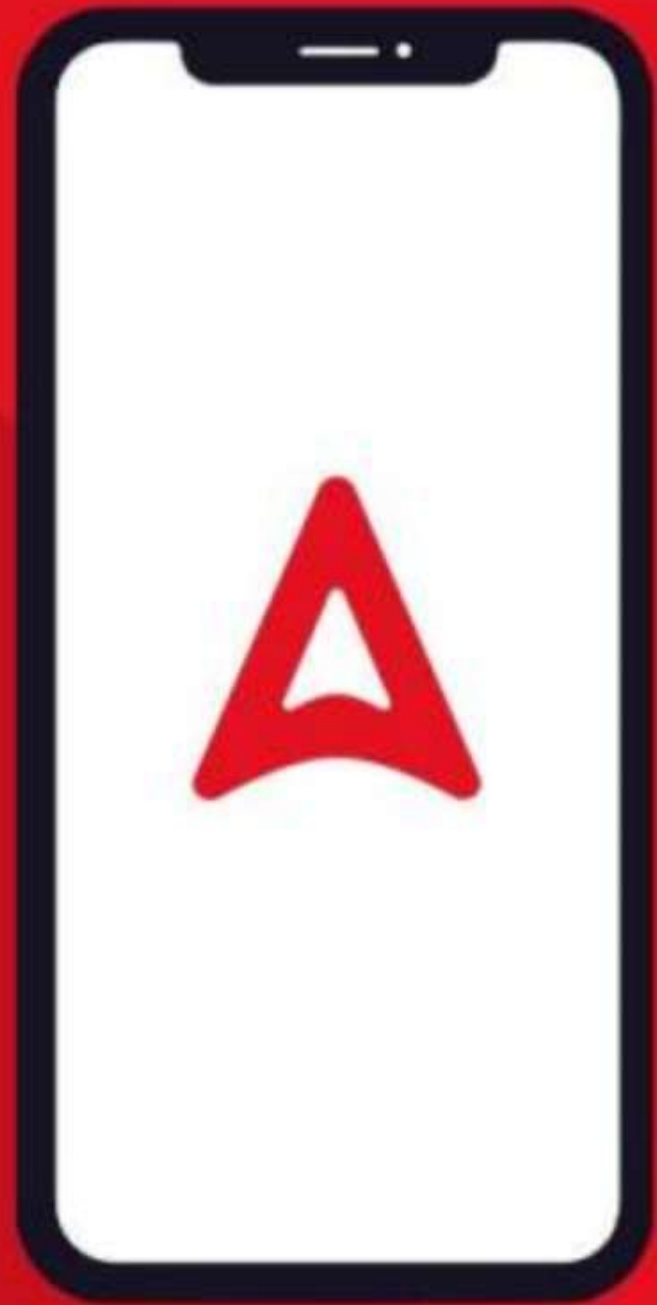


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