University of Technology
Materials Engineering Department
General Materials Branch

Fourth Class

Casting Technology I

Lecture No.5 : Patterns and Cores

Patterns

- casting requires a pattern—a full-sized model of the part, enlarged to account for shrinkage and machining allowances in the final casting.
- Materials used to make patterns include wood, plastics, and metals. Wood is a common pattern material because it is easily shaped.
- Its disadvantages are that it tends to warp, and it is abraded by the sand being impacted around it, thus limiting the number of time sit can be reused .
- Metal patterns are more expensive to make, but they last much longer. Plastics represent a compromise Between wood and metal. Selection of the appropriate pattern material depends to a large extent on the total quantity of castings to be made

Pattern Materials

Material	Pattern Life	Relative Machining cost
Wood	5 Mold Impressions	1X
Plastic	1,000 Mold Impressions	2X
Metal	100,000 Mold Impressions	3X

Shrinkage Allowance in Metals

Metal	Shrinkage Allowances
Cast iron	0.8–1.0%
Steel	1.5–2.0%
Magnesium	1.0–1.3%
Brass	1.5%
Aluminum	1.0–1.3%

Type of Patterns

1. Solid Pattern
2. Split Pattern
3. Match Plate Pattern
4. Cope & drag Patterns

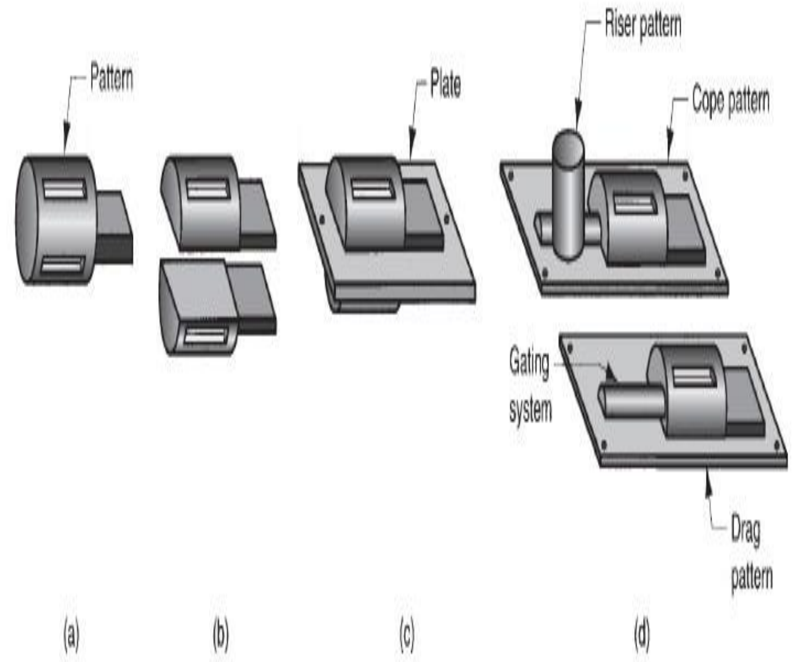
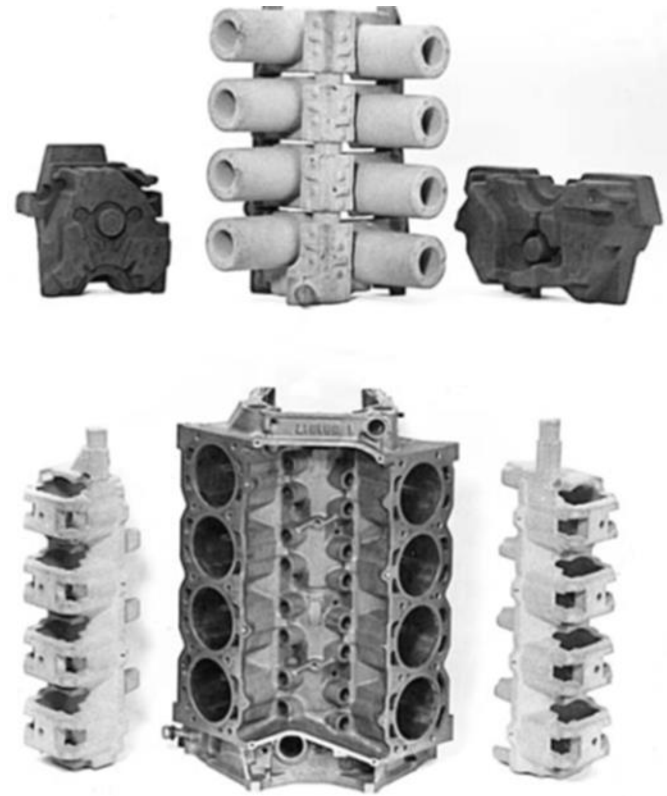


FIGURE 11.3 Types of patterns used in sand casting: (a) solid pattern, (b) split pattern, (c) match-plate pattern, and (d) cope-and-drag pattern.

Core

- A **core is a device used in casting and molding processes** to produce internal cavities and reentrant angles. The core is normally a disposable item that is destroyed to get it out of the piece. They are most commonly used in sand casting, but are also used in injection molding



Core Manufacturing Machine

- Various machines have been developed to mechanize the packing procedure. , These machines operate by any of several mechanisms, including

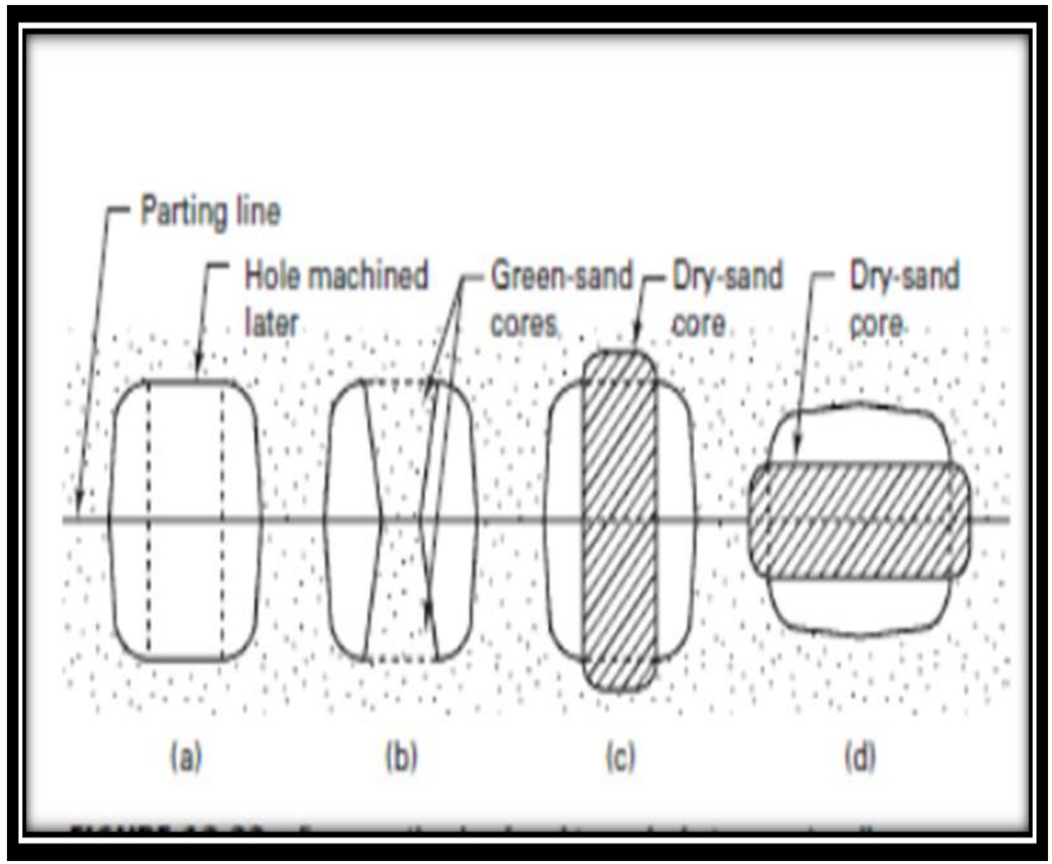
1. Squeezing the sand around the pattern by pneumatic pressure;
2. A jolting action in which the sand, contained in the flask with the pattern, is dropped repeatedly in order to pack it into place; and
3. A slinging action, in which the sand grains are impacted against the pattern at high speed.

Core Requirements

1. Green Strength: In the green condition there must be adequate strength for handling.
2. In the hardened state it must be strong enough to handle the forces of casting; therefore the compression strength should be 100 to 300 psi (0.69 to 2.07MPa).
3. Permeability must be very high to allow for the escape of gases.
4. Friability: As the casting or molding cools the core must be weak enough to break down as the material shrinks. Moreover, they must be easy to remove during shakeout.
5. Good refractoriness is required as the core is usually surrounded by hot metal during casting or molding.
6. A smooth surface finish.
7. Minimum generation of gases during metal pouring

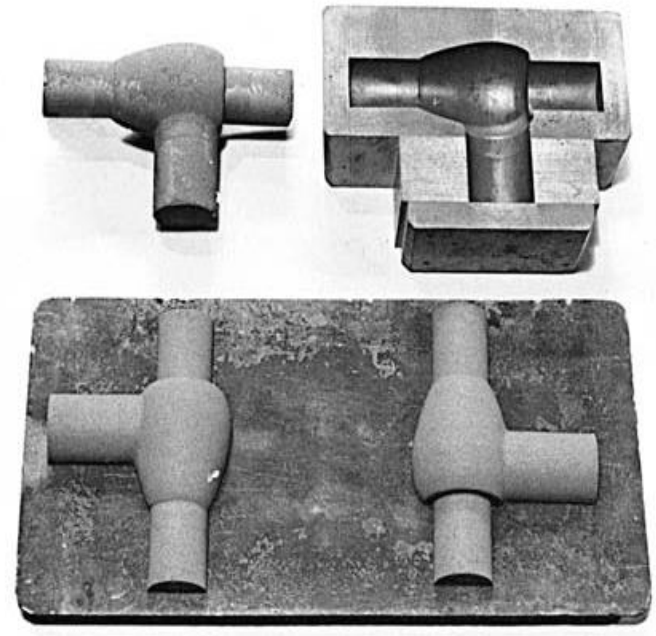
Type of Core

1. Green Sand Cores
2. Dry Sand Cores
3. Lost Cores

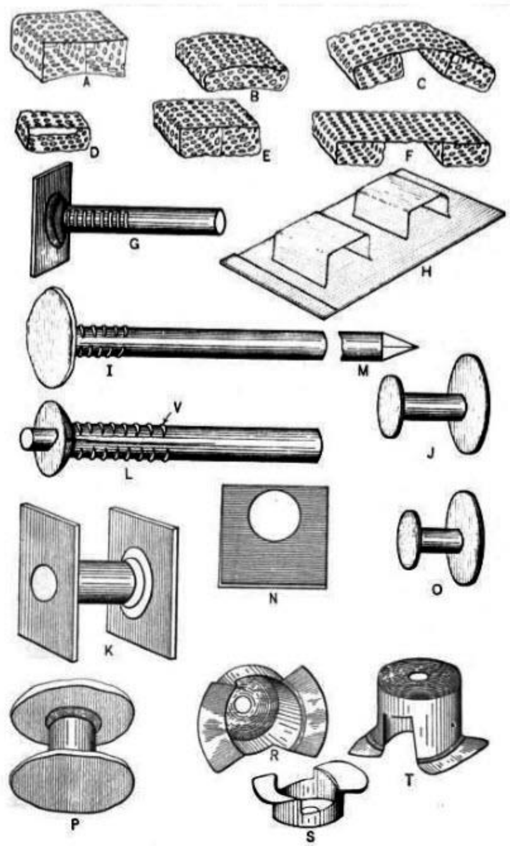


Types of Core box

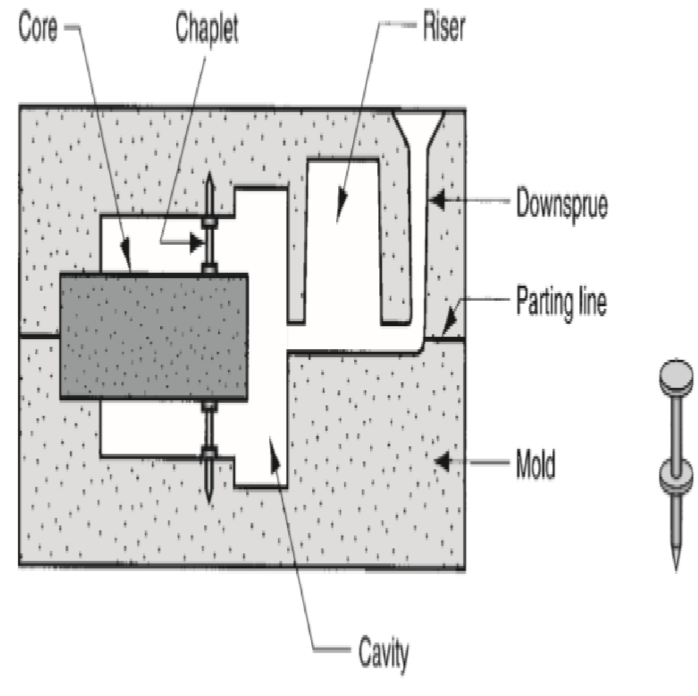
1. Half core box
2. Dump core box
3. Split core box
4. Left and right core box
5. Gang core box
6. Strickle core box
7. Loose piece core box
8. Ghayoor



Chaplets



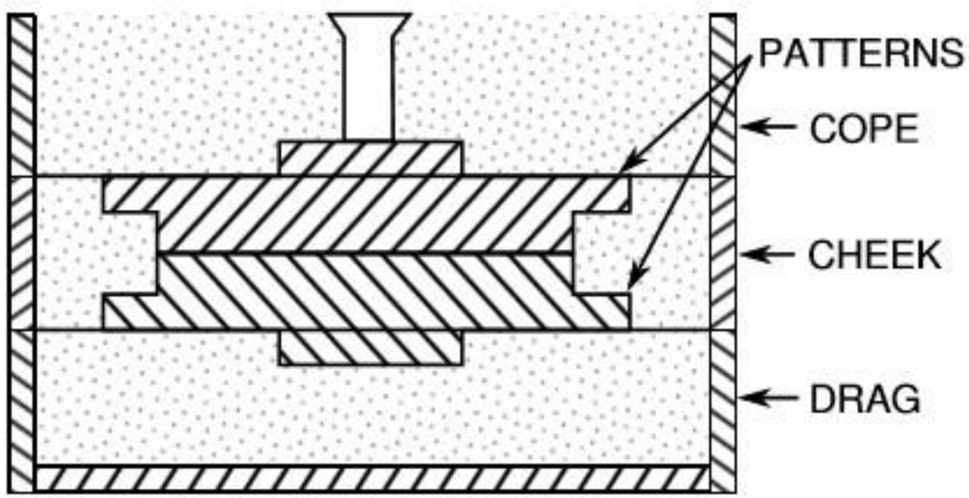
Various types of chaplets.



(a)

(b)

Cheeks



A cheek used to create a pulley

The buoyancy force

- $F_b = W_m - W_c$

- Where
- F_b= buoyancy force, N(lb)
- W_m=weight of molten metal displaced, N(lb);
- W_c = weight of the core, N (lb).
- Weights are determined as the volume of the core multiplied by the respective densities of the core material (typically sand) and the metal Being cast.
- The density of a sand core is approximately=1.6g/cm^3(0.058lb/in^3).Densities of several common casting alloys are given

TABLE 11.1 Densities of selected casting alloys.

Metal	Density g/cm^3	Density lb/in^3	Metal	Density g/cm^3	Density lb/in^3
Aluminum (99% = pure)	2.70	0.098	Cast iron, gray[a]	7.16	0.260
Aluminum-silicon alloy	2.65	0.096	Copper (99% = pure)	8.73	0.317
Aluminum-copper (92% Al)	2.81	0.102	Lead (pure)	11.30	0.410
Brass[a]	8.62	0.313	Steel	7.82	0.284

Source: [7].
[a]Density depends on composition of alloy; value given is typical.

Example (1) Buoyancy in Sand Casting

- A sand core has a volume= $1875 cm^3$ and is located inside as and mold cavity . Determine the buoyancy force tending to lift the core during pouring of molten lead into the mold.

Solution:

- Density of the sand core=1.6g/cm^3.
- Weight of the core is 1875(1.6)=3000gm =3 Kg
- Density of lead, based onTable11.1, is11.3g/cm^3.
- The weight of lead displaced by the core is1875 (11.3)=21,188g=21.19 kg.
- The difference=21.193.0-18.19 kg. Given that 1kg=9.81 N
- the buoyancy force is therefore Fb=9.81(18.19)=178.4 N.

Problem 1

- An 92% aluminum-8% copper alloy casting is made in a sand mold using a sand core that weighs 20 kg. Determine the buoyancy force in Newtons tending to lift the core during pouring. ?

Solution

- Sand density = 1.6 g/cm^3 = 0.0016 kg/cm^3
- Core volume V = 20/0.0016 = 12,500 cm^3
- Density of aluminum-copper alloy
- ρ = 2.81 g/cm^3 = 0.00281 kg/cm^3 (Table 11.1).
- Weight of displaced Al-Cu
- W = 12,500(0.00281) = 35.125 kg
- $Fb = Wm - Wc$
- Difference = (35.125 - 20) x 9.815 = **148.5 N**

Problem 2

- A sand core located inside a mold cavity has a volume of 2.45 cm^3. It is used in the casting of a cast iron pump housing. Determine the buoyancy force that will tend to lift the core during pouring.

Solution

- Sand density = 1.6 g/cm^3
- Wc = 2.45 (1.6) = 3.925 g
- From Table 13.1, density of cast iron ρ = 7.16 g/cm^3
- Wm = 2.45 (7.16) = 17.16 g
- $Fb = Wm - Wc$
- Fb = 17.16 – 3.925 = **13.235 g**

Problem 3

- Caplets are used to support a sand core inside a sand mold cavity. The design of the caplets and the manner in which they are placed in the mold cavity surface allows each caplet to sustain a force of 5 Kg. Several caplets are located beneath the core to support it before pouring and several other caplets are placed above the core to resist the buoyancy force during pouring. If the volume of the core = 5078 cm^3, and the metal poured is brass, determine the minimum number of caplets that should be placed

A. Beneath the core .

B. Above the core.

Solution

- Sand density = 1.6 gm/cm^3. From Table 11.1, density of brass ρ = 8.62 gm/cm^3
- *Wc* = 5(1.6)= **8.124 Kg**
- At least **2 caplets** are required beneath to support the weight of the core. Probably 3 or 4 caplets would be better to achieve stability.
- (b) *Wm* = 5(8.62) = **43.1**Kg
- *Fb* = 43.1- 8.124 = **34.976 Kg**
- A total of **9 caplets** are required above the core to resist the buoyancy force

Problem 4

- A sand core used to form the internal surfaces of a steel casting experiences a buoyancy force of 23 kg. The volume of the mold cavity forming the outside surface of the casting $=5000\ cm^3$. What is the weight of the final casting? (*Hint:- Ignore considerations of shrinkage*) .

Solution

- Sand density = 1.6 g/cm^3, steel casting density ρ = 7.82 g/cm^3
- $Fb = Wm - Wc = 7.82V - 1.6V = 6.22V$ = 23 kg = 23,000 g V = 3698 cm^3.
- Cavity volume V = 5000 cm^3
- Volume of casting V = 5000 - 3698 = 1302 cm^3.
- Weight of the final casting W = 1302(7.82) = 10,184 g = **10.184 kg**