Unit 1-Metal Castings

Molding and Core Sands and their Properties

Mold Materials

- A mold material is one, out of which the mold is made
- A mold material should be such that the mold cavity retains its shape till the molten metal solidified.
- Castings can be made in permanent and temporary molds
  a. Permanent molds are made up of ferrous metals and alloys
  b. Temporary molds are made up of refractory sands and resins
- Molds may also be made up of wax, POP, carbon, ceramics etc.
- Permanent molds are generally employed for low melting point materials.
- Permanent molds are very costly. Because of this reason most of the castings produced using refractory mold materials
- The refractory sand molds can cast high melting point materials and bigger objects, where as permanent molds used to produce small castings with better quality.

Types of Refractory Sands

i. Silica Sand

ii. Zircon

iii. Dolomite

iv. Graphite

v. Carbon

Refractory sands

Refractory sands are the best molding materials because:

i. They maintain their shape and other characteristics even at very high temperature while they are in contact with molten metal

ii. Even when packed as the mold cavity they remain sufficiently porous or permeable to give vent to the mold gases

iii. They can be molded into intricate shapes

iv. They are chemically resistant to molten metals

v. They can be used repeatedly for making molds

vi. They are inexpensive

vii. They can be made available without much difficulty

Molding sands:

Sources :

i. Pit Sand
ii. River beds
iii. Sea
iv. Lakes
v. Desert

Types:

i. Natural Sands
ii. Synthetic sands
iii. Loam sands

Ingredients:

i. Refractory sand grains
ii. Binders
iii. Water
iv. additives

Natural Sand : Characteristics

i. A natural sand can be used for making molds as soon as it is received from its source.

ii. A natural sand contains binding materials (5-20% clay).

iii. A natural sand needs only water (5-8%) to mix before making the mold.

iv. Natural sands can maintain moisture content for a long time.

v. Natural sands permit easy patching and finishing of molds.

vi. Natural sands are less refractory as compared to synthetic sands.

vii. Natural sands are employed for casting CI & non-ferrous metals.

viii. Natural sand involves lesser cost as compared to synthetic sand.

ix. Natural sand when mixed with bentonite gets its properties improved and is called ***semisynthetic*** sand.

Synthetic Sand : Characteristics

i. A Synthetic sand consists of:

(a) Natural sand (base) with or without clay.

(b) Binder (say bentonite).

(c) Moisture

ii. A synthetic sand is a formulated sand.

iii. Sand formulation is done in order to acquire certain desired properties not possessed by natural sands.

iv. Synthetic sands are used for casting steel and other ferrous and non-ferrous alloys.

As compared to Natural sand, Synthetic Sand :

i) Contains no organic materials.

ii) Requires less proportion of binders.

iii) Possesses greater refractoriness (above 2500 °C).

iv) More suitable for use in mass production.

v) Possesses low sand maintenance cost.

Loam Sand : Characteristics

i. Loam sand contains much more clay as compared to ordinary molding sand.

ii. The ingredients of loam sand may be **fine sands, finely ground refractories, clays, graphite and fibrous reinforcement.**

iii. Loam dries very hard.

iv. Used for making molds for large castings.

v. Sweep and skeleton patterns may be used for molding.

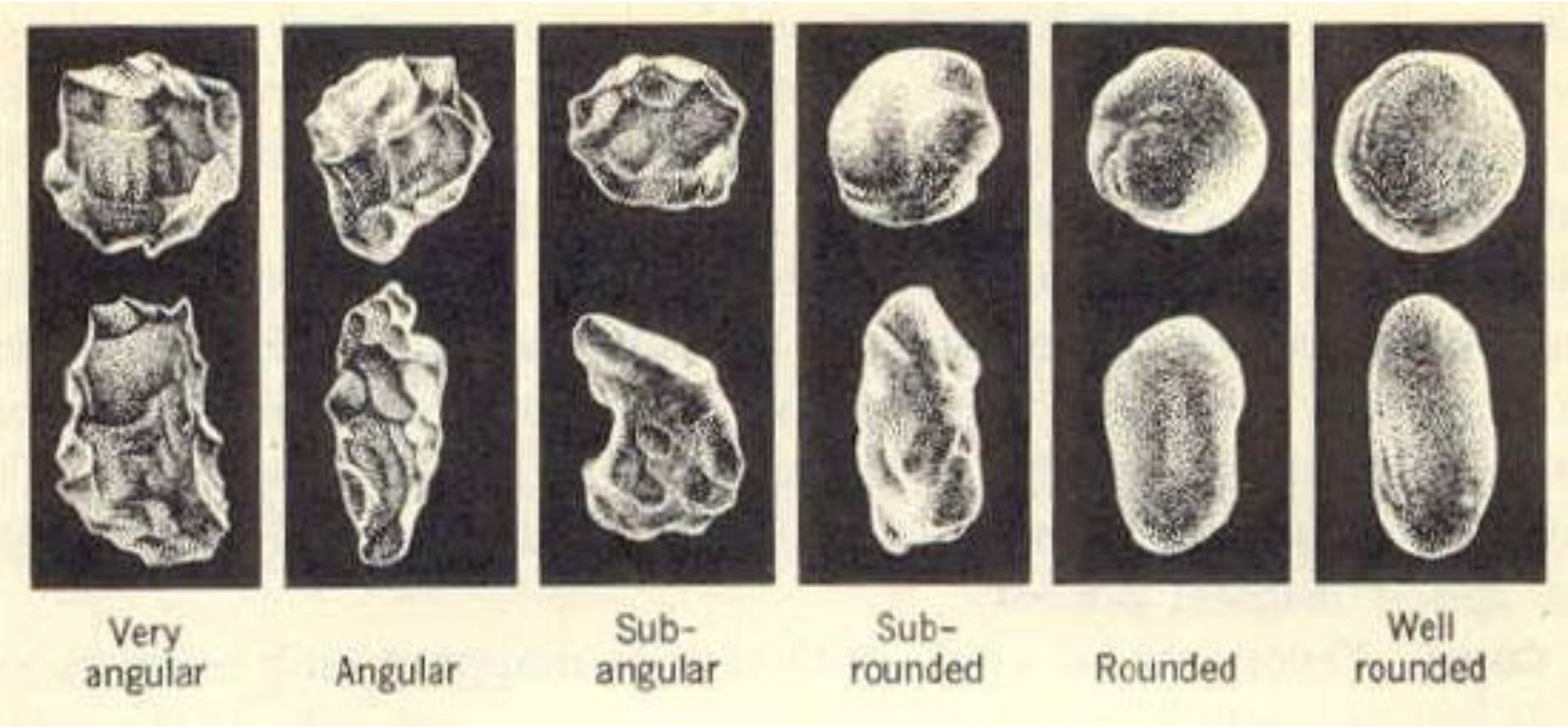
Classification of sands according to Grain size & Grain shape.

i) Rounded sand grains.

ii) Sub-angular sand grains.

iii) Angular sand grains.

iv) Compound sand grains.



Importance of grain size

i) The grain size and distribution influence many sand properties like permeability, refractoriness, surface fineness and strengths.

ii) Fine grind sands give surface fineness, but possess low permeability.

iii) Fine grind sands are used for producing ornamental castings, intricate and small sized castings.

iv) Coarse and uniformly graded sands impart high permeability, high flow-ability, and maximum refractoriness.

v) Coarse grind sands are preferred for producing large castings as they permit easy escape of mold gases.

Rounded sand grains.

i) Round grains impart high permeability as compared to angular grains.

ii) Rounded grain molding sand possess lower strength as compared to sands with angular grains.

iii) Round grain molding sands possess greater flow-ability

iv) Sand grains too smooth and round may result in sand cracks, and sand wash.

Sub-angular Grains

As compared to round grain sands, the sub-angular sands possesses

- ❑ Higher strength and
- ❑ Lower permeability.

Angular Grains

i) Angular grains are stronger and have higher mold strength at low permeability.

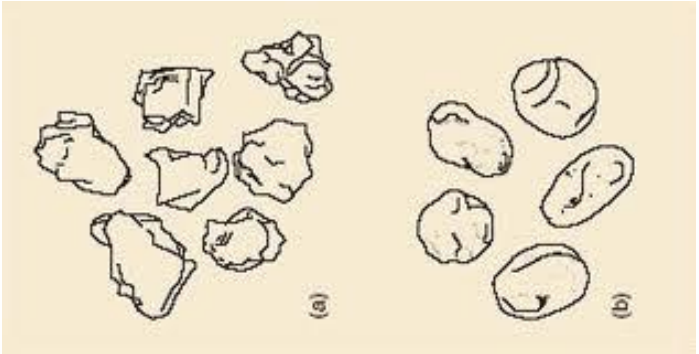
ii) Angular sand grains possesses sharp corners and edges, and flat contacting surfaces.

Compound Grains

i) Compound grains result when two or more grains stick together so tightly that they do not get separated during sieving or washing operation.

ii) Compound grains molding sands are not preferred much.

iii) Compound grains tend to dissociate at higher temperatures.



Molding sand binders

i) Binders produce cohesion between the molding sand grains in the green or dry state.

ii) Binders give strength to the molding sand so that it can retain its shape as mold cavity.

iii) Binders should be added optimally because increase in binder content reduce permeability.

iv) Binders are classified as

a) Fire clay

b) Bentonite

c) Limonite

d) Kaolinite

Core sands

- A core may be defined as any projection into the mold and made of core sand.
- A core form an internal or external surface of a casting, core sand is a suitable mixture employed for making cores
- Cores are made separately, are baked and are suitably placed and positioned in the mold cavity.

Core sand properties

- Adequate green strength to retain its shape before baking
- High dry strength and core hardness after baking
- Adequate permeability for letting go the gases generated
- High collapsibility so that the core gives way easily as the casting cools and shrinks
- High collapsibility avoids the introduction of hot tears and cracks in the cast metal

Core sand properties

- High refractoriness to withstand the effects of high temperature molten metals
- Core sand should impart smooth and good surface finish to cores
- Core sand should generate minimum gases during pouring
- Core sand should be able to retain its properties when stored
- Core sand should be able to resist the effects of molten metal, like erosion, thermal shocks etc.

Core Sand Ingredients

1. Granular refractories
2. Core binders
3. Water
4. Special additives

Granular refractories

a. Clean, pure, and dry silica sand (Most widely used)
b. Zircon (because of high melting points and high density)
c. Olivin
d. Carbon
e. Chamotte

Core Sand Ingredients

Core binders

- A core binder holds sand grains together
- Gives strength to the cores
- Makes cores to resist erosion and breaking
- Imparts adequate collapsibility to cores
- Core binders are of following types
    a. Organic binders
    b. In-organic binders
    c. Other binders

Core Sand Ingredients : Core binders

a. Organic binders

- Core oil (Vegetable oil – linseed oil)
- Water soluble binders (Dextrine or molasses)
- Wood products binders (saw dust or resins)
- Pitch (coal tar)

b. In-organic binders

- Fire clay
- Bentonite
- Silica flour
- Iron oxide

c. Other binders

- Portland cement
- Sodium silicate

Core Material Selection

- Type and size of cores
- Nature of metal / alloy to be poured
- Core properties desired
- Problems associated with core making and baking
- Degree of core surface finish desired
- Cost of binders and other additives used

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Molding and Core Material and Properties

Molding Material Properties

- A large variety of molding materials is used in foundries for manufacturing molds and cores.
- They include molding sand, system sand or backing sand, facing sand, parting sand, and core sand.
- The choice of molding materials is based on their properties.
- The properties that are generally required in molding materials are:
    1. **Refractoriness**
    2. **Green Strength**
    3. **Permeability**
    4. **Dry Strength**
    5. **Hot Strength**
    6. **Collapsibility**

Molding Material and Properties

1. Refractoriness

- It is the ability of the molding material to resist the temperature of the liquid metal so that it does not get fused with the metal.
- The refractoriness of the silica sand is highest.

2. Green Strength

- The molding sand that contains ***moisture*** is termed as ***green sand.***
- The green sand particles must have the ability to cling to each other to impart sufficient strength to the mold.
- The green sand must have enough strength so that the constructed mold retains its shape.

Molding Material and Properties

3. Permeability

- During pouring and subsequent solidification of a casting, a large amount of gases and steam is generated.
- These gases are those that have been absorbed by the metal during melting, air absorbed from the atmosphere and the steam generated by the molding and core sand.
- If these gases are not allowed to escape from the mold, they would be ***entrapped*** inside the casting and cause casting ***defects***.
- To overcome this problem the molding material must be porous.
- Proper venting of the mold also helps in escaping the gases that are generated inside the mold cavity.

Molding Material and Properties

4. Dry Strength

- When the molten metal is poured in the mold, the sand around the mold cavity is quickly converted into dry sand as the moisture in the sand evaporates due to the heat of the molten metal.
- At this stage the molding sand must posses the sufficient strength to retain the exact shape of the mold cavity and at the same time it must be able to withstand the metallostatic pressure of the liquid material.

Molding Material and Properties

5. Hot Strength

- As soon as the moisture is eliminated, the sand would reach at a high temperature when the metal in the mold is still in liquid state.
- The strength of the sand that is required to hold the shape of the cavity is called hot strength.

6. Collapsibility

- The molding sand should also have collapsibility so that during the contraction of the solidified casting it does not provide any resistance, which may result in cracks in the castings.
- Besides these specific properties the molding material should be **cheap, reusable and should have good thermal conductivity**.

Molding Sand Composition

The main ingredients of any molding sand are:

1. Base sand,
2. Binder, and
3. Moisture

1. Base Sand

- Silica sand is most commonly used base sand.
- Other base sands that are also used for making mold are zircon sand, Chromite sand, and olivine sand.
- Silica sand is cheapest among all types of base sand and it is easily available.

Molding Sand Composition

2. Binder

Binders are of many types such as:

i. Clay binders,

ii. Organic binders and

iii. Inorganic binders

i. ***Clay binders*** are most commonly used binding agents mixed with the molding sands to provide the strength.

The most popular clay types are:

- Kaolinite or fire clay (Al_2O_3 2 SiO_2 2 H_2O) and
- Bentonite (Al_2O_3 4 SiO_2 nH_2O)

Of the two the Bentonite can absorb more water which increases its bonding power.

Molding Sand Composition

3. Moisture

- Clay acquires its bonding action only in the presence of the required amount of moisture.
- When water is added to clay, it penetrates the mixture and forms a microfilm, which coats the surface of each flake of the clay.
- The amount of water used should be properly controlled.
- This is because a part of the water, which coats the surface of the clay flakes, helps in bonding, while the remainder helps in improving the plasticity.

Molding Sand Composition

3. Moisture

- A typical composition of molding sand is given in table.

Molding Sand Constituent	Weight Percent
Silica sand	92
Clay (Sodium Bentonite)	8
Water	4

Sand Control Tests

- A molding and core sands are supposed to possess many properties for its efficient functioning.
- The different properties depend upon grain size, shape, distribution, and the content and type of binders used, additives and moisture.
- Sand tests indicate the molding performance and help foundry men in controlling the properties of molding and core sands
- Sand testing controls the molding and core sand properties through the control of composition.
- Production of sound castings largely depends upon uniform and quality of molding and core sands
- Sand control tests are performed on the sand which has been prepared and is ready to be transferred to the molding and core making section

Sand Control Tests: The various sand control tests are:

- **Tests on the Molding sands**

a) Moisture content test

b) Clay content test

c) Grain fineness test

d) Permeability test

e) Strength tests

   i. Green and dry compression test
   ii. Green tensile
   iii. Green and dry shear test
   iv. Bending test

f) Hot strength test

g) Refractoriness test

h) Mold hardness test

Sand Control Tests: The various sand control tests are:

- **Tests on the Core sands**

a) Green Strength test

b) Permeability test

c) Baked Strength test

d) Hot strength test

e) Retained Compression strength test

f) Moisture content test

g) Core hardness test