Cores are used in the casting process to make holes and cavities in the final sand casting.

When molten metal is poured into the mould cavity core should have the following characteristics to manufacture a good sound hollow casting.

Characteristics/properties/requirements of the core in the foundry are as follows:

- Green strength.
- Dry strength.
- Collapsibility.
- Core strength.
- Core stability.
- Permeability.
- Refractory property.
- Friability property.
- Adhesiveness property.
- Core smoothness.
- Core shape.
- Minimum gas formation.
- Dimensional stability.
- Good surface finish.
- Dryness of core.
- Moisture absorption property of core.
- Minimum moisture present in the core.
- Penetration of metal into the core.
- Core size.
- Expansion and contraction of core.
- The shape of the core.
- Hardness of core.
- Storage and handling of the core.

Explained below in detail the properties of the core material in the sand casting process.

- **Green Strength:** The core made of green sand should retain its shape and size until it is baked and cured. The core should have green strength properties.
- **Dry Strength:** The core after baking becomes dry. The dry core should have enough strength to sustain molten metal forces acting on it during the pouring operation. The dry core should have thermal stability during the sand-casting process. The core sand should have dry strength properties. For example, **brass and bronze** should have a dry strength of **4.5** times

the weight of the core as compared to **cast iron** which requires a dry strength of **3.5** times the core. **Steel** requires the highest dry strength of **3.9** times the weight of the casting.

- **Collapsibility of Core:** The core should collapse and disintegrate after the metal solidifies in the mould around the core. The core should have sufficient collapsibility properties during and after the solidification of casting. Core with collapsibility properties will reduce the formation of cracks in the final casting. **Core oil** improves the collapsibility of cores. Cores used in the process should have a higher density to reduce collapsibility when steel as molten metal is used for producing casting. **Brass and bronze** material requires average collapsibility properties and the core should collapse once a thick layer of molten metal solidifies around the core. **Aluminium** used during the casting process is readily able to collapse the sand core during solidification and contraction of molten metal. Collapsibility reduces with high-temperature metal and slow cooling as it weakens the **bond** between sand and binders such as clay.
- **Core Thermal Stability:** The core should have thermal sufficient stability such as the core does not over-expand and contact during and after the solidification process.
- **Permeability of Core:** The core must have permeability property causing gases, heat and water vapour to escape from the core sand. Permeability property widely depends on the amount of clay used, grain size and shape. When **aluminium** is used in sand casting density of the core should be minimal to allow permeability of the gases induced in the casting process. Brass, aluminium and bronze require the least amount of permeability compared to cast iron and steel.
- **Refractory Property of Core:** The core must have high refractory properties. The temperature of molten metal is very high, the core should be strong and should sustain the high temperature of molten metal and resist the heat of the high-temperature liquid metal. Core sand having good refractory properties will be subjected to less cracking and hot tears during the casting process. This can be achieved by using **pure round zircon or silica sand**. When **brass and bronze** are used as casting material sintering temperature of the core sand should be above 1250℃ and for **cast iron** sintering temperature of the core sand should be above 1500℃.
- **Core Strength:** The core should be **strong** to retain its size and shape without getting deformed during the solidification process in sand casting. Core strength property is important from core handling to the solidification of casting in a mould. The strength of the core widely depends on the bond between clay and sand. The strength of the core is important for handling mentalistic forces acting on the core when molten metal is poured into the mould

cavity. For example, **aluminium** requires less core strength as metal is lightweight and produces less pressure in the mould as compared to **cast iron**.

- **Friability properties of Core:** The core should crumble easily after removing it from the mould cavity. The core should have friability property.
- **Adhesiveness of Core:** The core should also have adhesiveness property when molten metal flows in the mould cavity.
- **Good Surface Finish:** The final hollow/cavity produced after the casting is taken out should have a smooth surface finish. This can be achieved by using the core with fine sand material.
- **Core Smoothness:** The core should be smooth to produce a smooth surface of hollow sections.
- **Minimum Gas Formation:** When molten metal comes in contact with the moulding sand, the minimum amount of gases should be generated during this process. This will reduce gas defects in the casting process. The core should be designed keeping in mind the type of material to be cast. For example, when using **brass**, **aluminium**, **steel** and **bronze** for sand casting minimum amount of gases are developed in the mould as compared to **cast iron** which produces a high amount of gases when the molten metal comes in contact with the sand. In **brass** solidification, time slowly allows gases to escape through vents but in **cast iron** metal when comes in contact with the core sand generates a high amount of gases when the metal starts solidifying quickly around the core forming a skin around it.
- **Dimensional Stability of Core:** When molten metal comes in contact with the core in the mould cavity various kinds of forces are generated from the pouring operation to the solidification stage. A core should be able to handle buoyancy force, and compressive force as molten metal solidifies maintaining its dimensional stability and shape to produce the desirable size of cavity/hole.
- **Minimum Moisture:** The core material must absorb the minimum amount of moisture in the sand. Excess moisture content in the core sand will make the core weak.
- **Storage/Handling:** The core must retain its strengthened shape during the process of handling the core in the foundry and during storage.
- **Metal Penetration:** Core material should resist molten metal to penetrate the core improving surface finish and reducing defects in the final casting. When using steel the molten metal density of the core should be higher to reduce the metal penetration of steel into the core.
- **Core Surface Hardness:** When molten metal comes in contact with the core material, the core should be able to resist erosion of the core sand. This is achieved when the core is made

hard and tough having a good binding agent. Cores used for molten metal such as **bronze and brass** should be made with higher density with good binding agents to reduce erosion and cuts of the core. The surface hardness of the core skin depends upon the type of casting material used. For example, when producing **brass, bronze** and **steel casting**, the core should have the highest amount of skin hardness to eliminate erosion and cuts due to turbulence of the molten metal when metal flows around the core as compared to **aluminium casting**.

- **Core Shape:** The core must be able to retain its shape during the baking, curing and drying process.
- **Dry Core:** Core material should have the property to dry during the curing process (This applies to the dry core).
- **Moisture Absorption:** The core should be able to absorb a sufficient amount of moisture to keep the sand binding together.
- **Expansion and Contraction:** The core must be able to expand and contract to a desirable tolerance during the solidification of molten metal when the core is surrounded by the metal.
- **Core Size:** Small cores require a high amount of strength, refractory properties, high density and collapsibility as compared to the larger core which can sustain stress, stain and shearing.