- It is called chilled CI if cooling rates is very high.
- It is extremely hard and brittle and almost impossible to machine.
- It has a very limited application where wear resistance is required without ductility. *E.g., Rollers of rolling mills and in extrusion nozzles*.

Malleable Cast Iron

- When white CI is heated to a temperature of 800 - 900° C for a prolonged time period and in neutral atmosphere (to prevent oxidation), it causes decomposition of cementite to graphite in the form of clusters or rossets surrounded by a ferrite or pearlite matrix.
- Strength and ductility increases.

  Composition : (2.3 - 2.7% C) + (1 - 1.5% Si) + (<0.55% Mn)

  Properties

  (i) It possesses high yield strength

  (ii) It can be hammered and rolled to different shapes

  (iii) It has high Young's modulus and low coefficient of thermal expansion

  (iv) It possesses good wear resistance and vibration damping capacity

  (v) It has shrinkage of 1.5mm/100mm

  (vi) It is soft, tough and easily machined

  Uses : Connecting rods, transmission gears, differential cases, flanges marine and heavy duty services, brake pedals, tractor springs, hangers, washing machine parts, agriculture implements, universal joint yoke, automotive crankshafts, rail road, etc.

Wrought Iron

- Extremely low carbon content (0.02%). It has a fibrous structure. It is ductile and has good forming qualities and has very high resistance to corrosion.
- It is produced in less quantity because of high cost.

  Applications : Pipes, engine bolts and rivets, chains and crane hooks, forging applications etc.

5.4 COPPER

- It is malleable and ductile metal and can be easily rolled, drawn or forged.
- The tensile strength and hardness of copper can be improved by cold working although the ductility is reduced.
- Conversely, the annealing can improve the ductility at the expense of the tensile strength and hardness.
- It has high electrical conductivity, good thermal conductivity and corrosion resistance.
- The impurities present in copper can have serious effects upon the properties of the metal. The electrical conductivity is reduced by 25% due to the presence of 0.04% phosphorus.
- Addition of 0.5% lead or tellurium imparts free-cutting properties to copper.
- Hydrogen is soluble in solid copper.
- Addition of 1% Cd improves the strength when used in telephone wires, but has minimal effect on the electrical conductivity.
- Copper is rapidly attacked by sulphuric acid, hydrochloric acid, nitric acid, ammonia, sodium hydroxide, potassium hydroxide and amines. Copper can be safely used with sulphurous acid (in paper industry), neutral salts, e.g., sodium chloride, hydrocarbons, alcohol, acetic acid aldehydes, ketones, ethers, lactic and tannic acid.
- Upto 0.5% arsenic added to copper to used in locomotive.

Alloys of Copper

Brass

Alloy of Cu and Zn having high corrosion resistance and good machinability.

- It acts, as good bearing material.
- Brass may joined by soft soldering using tin based solders with an antimony content below 5%. With decrease in Zn content, risk of cracking during soldering reduced.