UNIT: 1
Engineering Materials

STRUCTURE

Introduction.

Classification of Engineering Materials.

Mechanical Properties of Metals.

Ferrous Metal.

Non – Ferrous Metal.

Non –Metals.

Importance of Safety Precautions in Workshop

INTRODUCTION:

Metals are used for various engineering purpose and requirements, such as structural members, pipes, tanks and building up of engineering machines. Out of all metals, Iron is the most popular metal in the field of engineering. All the metals have a crystalline structure.

CLASSIFICATION OF ENGINEERING MATERIALS:

Engineering materials are basically classified into two groups namely metals and non-metals, and their sub classification is given below.

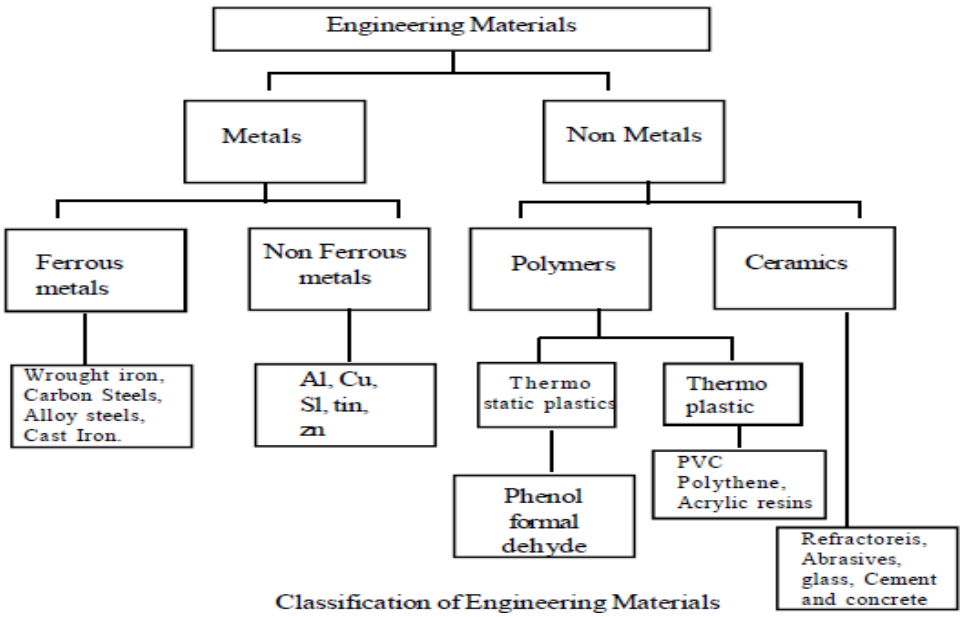

Fig 1.1 Classification of Engineering Materials

MECHANICAL PROPERTIES OF METALS:

The mechanical properties that determine the behavior of metals under applied forces. These properties are most important for the designing point of view.

1. **Strength:** Ability of a material to resist loads without failure.
2. **Tensile Strength:** Ability of a material in tension to withstand stress without failure.
3. **Shear Strength:** Ability of a material to withstand transverse loads without fracture.
4. **Elasticity:** Property of material which enables it to regain its original shape after deformation within the elastic limit.
5. **Stiffness:** Property of material which enables it to resist deformation.
6. **Plasticity:** Ability of material to be deformed permanently without fracture even after removal of force.
7. **Ductility:** Ability of a material to deform plastically without rupture under tensile load.
8. **Malleability:** Property which enables the metal to withstand deformation by a compressive load without fracture.
9. **Brittleness:** Property of the material of sudden fracture without any appreciable deformation.
10. **Hardness:** Property of the material which enables it to resist abrasion, indentation, machining and scratching.
11. **Toughness:** Ability of material to absorb maximum energy up to fracture takes place.
12. **Fatigue:** Failure of material under repeated loads or fluctuating loads.
13. **Weldability:** Ability of a material to be joined by welding
14. **Castability:** Property of a metal which indicates the ease with which it can be cast into different shapes and sizes from its liquid state.

FERROUS METALS:

The metals which contain iron as base metal are called ferrous metals.
eg. Cast Iron, Alloy steels etc.

These are classified as

1) Pig iron	**2) Cast iron**	**3) Wrought iron**
4) Carbon Steel	**5) Alloy steel**	**6) Stainless steel**

Cast iron:

Pig iron re-melted and there by refined together with definite amount of lime stone, Steel Scrap and spoiled castings in cupola. It contains 2-4% Carbon, a small percentage of Silicon, Sulphur, Phosphorus and Manganese.

Properties of Cast Iron:

1. It has good fluidity.
2. It can be easily machined.
3. It is brittle in nature.
4. It is resistance to deformation.
5. It is wear resistant.

Uses of Cast Iron:

1. It is used in making pipes.
2. It is used for making machine bodies.
3. It is used in making automotive industry parts.

Wrought iron:

It is a almost pure iron. Its carbon content is 0.15%.

Properties of Wrought iron:

1. It is soft at white stage of heat. It can be easily forged and welded.
2. It is ductile, malleable and tough.
3. Its melting point is15000c.
4. It is resistant to corrosion.
5. Its specific gravity is7.8

Uses of Wrought iron:

Used for making rivets, railway couplings, chains bolts and nuts etc.

Carbon steels:

Steel is made as the iron alloy with carbon content up to 2%.Carbon steels are divided into two types. They are

1) Mild steel (or) Low carbon steel **2) High carbon steel**

1.3.3.a. Mild steel (or) Low carbon steel:

These are also called low carbon steels having carbon content of 0.15 – 0.3%.

Properties of mild steel:

1. It has low fluidity.
2. It has good tensile strength.
3. It is ductile.

4. It can be cold worked easily.

Uses of mild steel:

1. It is used for making structures.
2. It is used for making nuts and bolts.
3. It is used for making machine components.
4. It is used for making boiler plates.

High carbon steel:

High carbon steels have more than 0.60% carbon i.e.0.6–0.9% carbon. It is generally used for making parts requiring strength, hardness and wear resistance.

Properties of high carbon steels:

1. It has good strength.
2. It has high toughness.
3. It has increased wear resistance.

Uses of high carbon steels:

1. It is used for making Drop hammers.
2. It is used for making Screwdrivers.
3. It is used for making laminated springs.
4. It is used for making gears.
5. It is used for making piston rings.

Alloy Steel:

Steel is a metal alloy consisting mostly of iron, in addition to small amount of carbon, depending upon the grade and quality of the steel. Alloy steel is any type of steel to which one or more elements besides carbon have been added to produce desired physical properties. The most common alloying elements added to steel are Chromium, Nickel, manganese, silicon, Vanadium etc...

Properties of alloy steel:

1. High Strength.
2. High corrosion resistance.
3. High wear resistance.
4. Good toughness.

Uses of alloy steel:

1. It is used for making aero plane parts.
2. It is used for making auto mobile parts.
3. It is used for railway track work.
4. It is used for making locomotive parts.

Stainless steel:

It contains 18% chromium, 8%nickel, 0.06% to 0.12% carbon. They are called stainless because in the presence of oxygen, they develop a thin adherent film of chromium oxide that protects the metal from corrosion.

Properties of stainless steel:

1. It has high corrosion resistance.
2. It has high strength.
3. Good toughness.
4. It posses nonmagnetic properties.
5. It can be rolled.

Uses of stainless steel:

1. It is used for making surgical instruments.
2. It is used for making utensils.
3. It is used for making containers for pharmaceutical industries.
4. It is used for making springs.

NON – FERROUS METALS:

The metal which do not contain iron as base metal Eg: Al, cu, Lead, Zn and gold etc. All the nonferrous metals have common set of properties. The melting points of these metals are generally lower than ferrous metals.

Copper:

Copper is easily identified from all other metals due to reddish in colour and is extracted from copper pyrites.

Properties of copper:

1. It is relatively soft.
2. It is very malleable and ductile.
3. It is very good conductor of heat and electricity.
4. It is very flexible.

Uses of copper:

1. It is used for making electrical cables.
2. It is used for making kitchen vessels.
3. It is used for making pipes which are used in refrigerators.
4. It is used making for ornaments.

Brass:

It is basically refers to a yellowish alloy of copper and zinc and it comprises of 65% copper and 35% zinc. There are various classes of brass, depending on the proportion of copper and zinc are available for various uses. The melting point of brass ranges from 8000C-10000C.

Properties of Brass:

1. It is noncorrosive.
2. Air, water and some acids do not affect it.
3. It is poor conductor of electricity.

Uses of Brass:

1. It is used for making utensils.
2. It is used for manufacturing ornaments.
3. It is used in hydraulic fittings, pump lining, in making bearing and bushes.
4. It is used in making locks.

Bronze:

It is alloy of copper and tin. The composition range is 5-25% tin and 75 to 95% copper. The corrosion resistances of bronzes are superior than brasses.

Properties of Bronze:

1. It is comparatively hard.
2. It is resistance to surface wear.
3. It can be casted into wires and sheets.
4. It has high strength.

Uses of Bronze:

1. It is used in hydraulic fittings, pump linings.
2. It is used in making utensils, bearings, bushes, sheets, rods, wire etc.

Tin:

Although it is used in small amounts, tin is an important metal. Tin is used as protective layer on the sheet metal. It is obtained from tin stone.

Properties of Tin:

1. It is white soft metal.
2. Good resistance to acid corrosion.
3. Low strength.
4. It is malleable and ductile.
5. It does not corrode at both dry and wet climates.

Uses of Tin:

1. It is used as a coating on steel containers for preservation of food products
2. It is used in making thin foil sand as an alloying element in the manufacture of bearings.

Zinc:

It is fourth most utilized industrially after iron, Aluminium and copper. It is used for galvanizing the steel sheet or wire as it serves as an ode to protect from corrosion attack.

Properties of Zinc:

1. It is soluble in copper.
2. Low melting point and high fluidity.
3. High corrosion resistance.
4. It is ductile and malleable.

Uses of Zinc:

1. It is used for die casting.
2. It is used for production of brass.
3. It is used in battery cells for making dry batteries.
4. It is used as protective coating in iron and steel against rusting.

Gun Metal:

Gun metal contains10% tin, 88% copper and 2% zinc. Zinc is added to clean the metal and increase fluidity. It is not suitable for being worked in the cold state.

Properties of Gun Metal:

1. It is highly anti corrosive.
2. It has good mach inability.
3. It has good harden ability.

Uses of Gun Metal:

1. It is used for casting guns and cannons.
2. It is used for boiler fitting.
3. It is used for making bearings.
4. It is used for making glands in centrifugal pumps.

White Metal:

White metal contains copper-tin-antinomy and it contains 88% tin, 8% antimony and 4% copper.

Properties:

5. It is a soft metal with low coefficient of friction.
6. It has little strength.

Uses:

It is the most common bearing metal used into cast iron boxes when the bearings are subjected to high pressure and load.

Aluminium:

Aluminium is most abundant metal in the earth crust. It is silvery white in colour. It makes up about 8% by weight of the earth's solid surface Aluminium is remarkable for its low density and ability to resist corrosion

Properties of Aluminium:

1. It is a good conductor of heat and electricity.
2. It is very light in weight.
3. In pure state is very weak and soft.

Uses of Aluminium:

1. It is used for making automobile parts.
2. It is used for ornamental purpose.
3. It is used for making aircraft parts.
4. It is used for making bars, tubes &rivets.

NON –METALS:

1. **Wood**:

Another name given to wood is timber. It is obtained from trees after full growth and made suitable for engineering building process.

2. **Plastics**:

The word plastic is common term that is used for many materials of a synthetic or semi synthetic nature. Now plastic materials are most widely used for domestic as well as industrial purpose due to its low cost, light weight and it looks decorative.

3. **Rubber**:

Rubber is a polymer which is a word that is derived from the Greek meaning "many parts". Natural rubber is formed in the latex which comes from the rubber trees. It is collected in a cup mounted on each tree. Rubber is used for making tyres, tubes, shock absorbers, rubber cushions, weather stripping around car's wind shield and gaskets

IMPORTANCE OF SAFETY PRECAUTIONS IN WORKSHOP:

1. Never wear loose clothing, ties and shirts with long sleeves.
2. Keep the shop floor clean and free from oil and grease.
3. Don't use blunt or dull tool, it slips and causes injury.
4. While using chisels, see that cutting is performed in the direction away from the body.
5. Keep hands away from moving parts.
6. There must be sufficient light and ventilation at work place.
7. Exhaust fans should be provided to remove smokes and fumes.
8. Use proper tools according to the nature of the job.
9. Use of shoes and apron is essential.
10. Never carry tools in pocket.
11. Observe all the safety codes while working in the workshop.

SHORT ANSWER QUESTIONS

1. Write the classification of Engineering Materials.
2. Write the properties of Wrought Iron.
3. Write the uses of Aluminum.
4. Explain the non-metal plastics.

LONG ANSWER QUESTIONS

1. Explain the mechanical properties of metals.
2. Explain the properties and uses of
   a) cast iron b) carbon steel c) stainless steel
3. Explain the properties and uses of non-ferrous metals
   a) copper b) Tin c) zinc