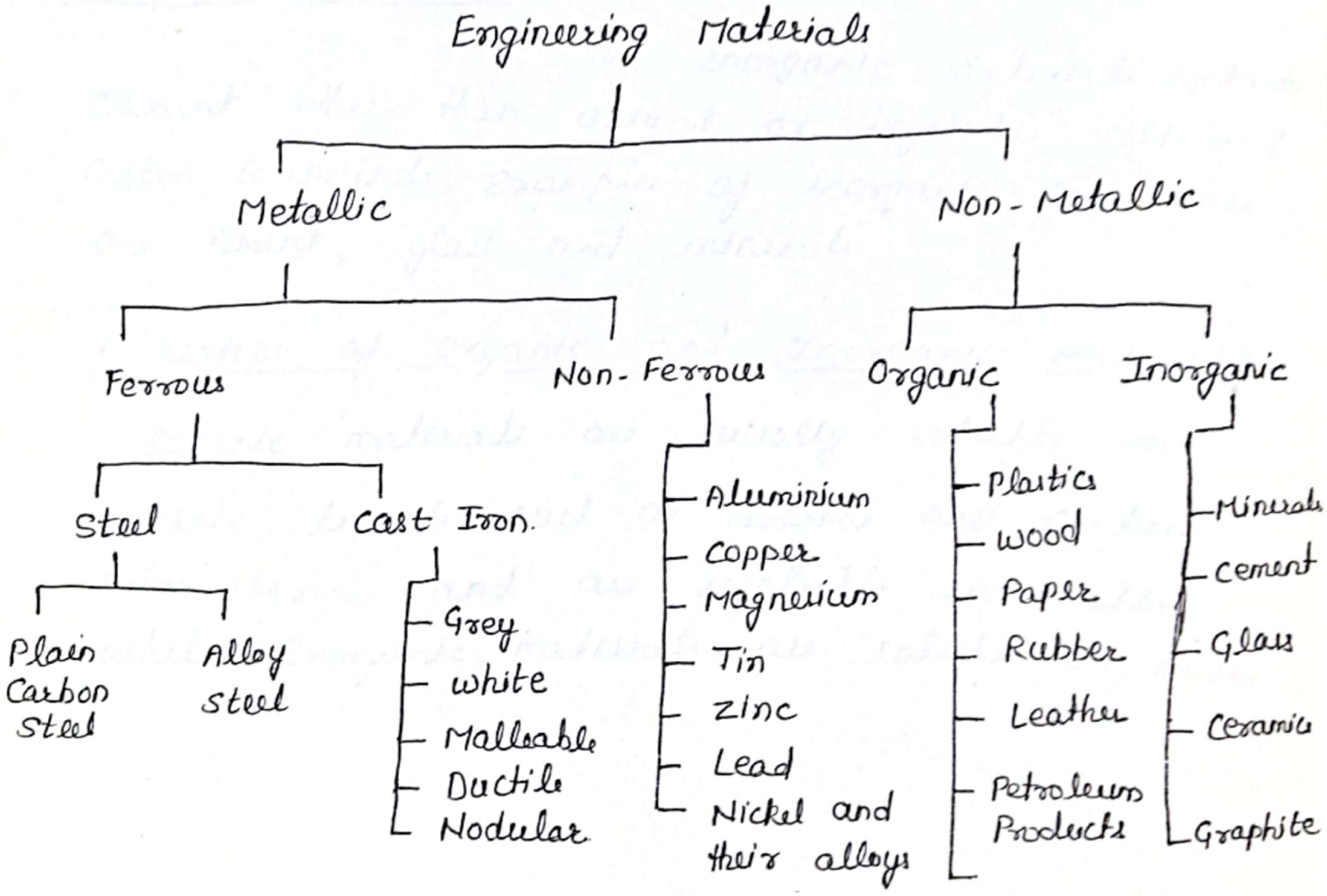
INTRODUCTION OF MATERIALS:-

Engineering Materials :-

The solid materials useful to human beings are referred to as Engineering Materials.

Classification of Engineering Materials :-



Ferrous Materials :-

The ferrous materials contains iron as their main constituent. Example of ferrous metal are Iron, Cast Iron, Steel.

Non-Ferrous Materials :-

Non ferrous materials contains substances other than iron as their main constituent Examples of Non ferrous materials are Aluminium, zinc and lead.

ORGANIC MATERIALS:-

The organic material are made from animals and vegetable cells or organic compounds Examples of organic materials are plastic, leather, wood and paper.

Inorganic Materials:-

The inorganic materials contain Element other than animal or vegetable cells and carbon compounds. Examples of inorganic compounds are cement, glass and minerals.

Properties of organic and Inorganic Materials:-

Organic materials are usually soluble in organic liquids such as alcohol and carbon tetrachloride and are insoluble in water. while Inorganic materials are soluble in water.

COMPARISION OF PROPERTIES OF METALS & NON-METALS

S.No.	Property	Metals	Non-Metals.
1	Structure	All solid Metals have crystalline structure.	They exist in amorphic form.
2.	state.	Generally solids at room temperature.	Gases and solids at ordinary temperature.
3.	Lustre	Possess Metallic Lustre	Do not possess metallic luster.
4.	conductivity	Good conductor of heat and electricity.	Bad conductors of heat and electricity.
5.	Mallability	Malleable	Not Malleable.
6.	Ductility	Ductile	Not Ductile.
7.	Hardness	Generally Hard	Hardness Varies.
8.	Density	High Density	Low Density.

IRON :—

The basic source of iron and steel is iron ore, which is an oxide of iron mixed with alumina, silica, phosphorus, magnesium, sulphur and other materials.

Major iron ores are "Haematite & Magnetite" which contain about 55% iron. other iron ores are "Limonite and siderite".

PIG IRON :— Pig iron is the basic material from which, wrought iron and steel are manufactured It is extracted from the iron ore in a tall continuous working furnace called "Blast Furnace". Pig iron contains carbon - 4%, silicon - 1%, Magnesium - 1% and small percentage of phosphorus and sulphur Pig iron is hard and Brittle.

AST IRON :-

The product of the blast furnace i.e Pig Iron is unsuitable for castings as it contains impurities in high percentage. To make it suitable for desired Purpose, it is refined in the furnace known as "CUPOLA".

The ferrous alloys which have carbon contents of more than 2% are called cast iron. Though cast iron have any carbon percentage between 2 to 6.67 but the practical limit is normally between 2 to 4%.

CLASSIFICATION OF CAST IRON :-

Cast iron may be classified as follows:-

1. Grey Cast Iron
2. White Cast Iron
3. Mottled Cast Iron
4. Nodular Cast Iron
5. Malleable cast Iron
6. Alloy cast Iron.

1. Grey Cast Iron

COMPOSITION :-

Carbon = 2.5% - 3.8%
Silicon = 1.1% - 2.8%
Magnese = 0.4 - 1%
Phosphorus = 0.15%
Silicon = 0.10%

Properties :-

(i) Grey Cast Iron is characterised by Presence of large portion of its carbon in the form of Graphite flakes.

when breaks, it appear Grey.

(iii) It is readily cast into a desired shape in sand Mould.

(iv) It possesses lowest melting point of the Ferrous alloys.

(v) It has high resistance to wear.

(vi) It has high vibration damping capacity.

(vii) It possess high fluidity and high compressive strength.

(ix) It has low ductility and low impact strength as compared with steel.

(x) It possess excellent casting qualities for producing simple and complex shapes.

Uses :-

(i) Machine tool structures eg bed, frame.
(ii) Household appliances.
(iii) Cylindrical blocks and head for I.C. Engines.
(iv) Frames for Electric Motors.
(v) Gas or water pipes for underground purposes.

WHITE CAST IRON :-

COMPOSITION :- Iron = 94%.
Graphite Carbon = 0.5%
Combined Carbon = 3.5%
Remainder other impurities.

Properties :-

(i) Hard, brittle and cannot be machined.
(ii) Highly resistant to wear.
(iii) Tensile strength is good.
(iv) Due to its poor fluidity it does not fill the mould freely.

Uses :-

(i) Used for parts subjected to excessive wear, e.g. in rim of freight car wheel or railway brake blocks.

(ii) Used for inferior castings and does not rust so much.

(iii) Used for making malleable castings also.

(iii) Mottled Cast Iron :-

Composition :-

Iron = 93.5 %

Graphite = 1.75 %

Combined Carbon = 1.75 %

Remainder impurities.

Properties :-

(i) Mixture of the two states, Grey Cast Iron and white cast Iron.

(ii) Less tendency to rust.

(iii) Fluidity is good.

(iv) Hard and brittle.

Uses :- (i) Used for manhole covers and pipes.

(ii) Employed for making fire plugs and lamp posts.

(iv) Nodular Cast Iron :-

Composition :-

Carbon = 3.2 - 4.2 %

Silicon = 1.1 - 3.5 %

Magnese = 0.3 - 0.8 %

phosphorus = 0.08 %

Sulphur = 0.2 %

Properties :-

(i) In nodular cast Iron graphite appears as rounded particles, or nodules or spheroids.

(ii) It possesses very good machinability.

(iii) It possesses damping capacity intermediate between cast Iron and steel.

It possesses excellent castability and wear resistance

Uses:-

(i) steel mill rolls and mill Equipment.
(ii) Valves and Fittings.
(iii) Internal Combustion Engines.
(iv) Paper industries and Machinery.
(v) Pumps and Compressors.

(v) Malleable Cast Iron:-

Composition:-

Carbon = 2-3%
Silicon = 0.6-1.3%
Magnese = 0.2-0.6%
Phosphorus = 0.15%
Sulphur = 0.10%

Properties:- (i) It possesses high yeild strength.
(ii) It can be hammered and rolled to different shapes.
(iii) It is soft, tough and easily machined
(iv) It possesses good wear resistance and vibration damping capacity.
(v) It has high young's Modulus and low co-efficient of thermal Expansion.

Uses:- (i) Differential and steering gear housing.
(ii) Brake pedals, Tractor springs.
(iii) washing Machine parts
(iv) Agriculture implements,
(v) Automotive parts.

(vi) Alloy Cast Iron:-

Cast Iron is supposed to be very hard, brittle, lacking in tensile and transverse strength and weak to withstand shocks hence it is alloyed with other metals to improve its properties.

Amongst the alloying metals, nickel is predominating alloying constituent whose addition to the extent of 0.5 to 1.5% avoids the tendency of chilling or hard spots.

Two typical examples of alloy cast Iron are (i) Acicular (ii) Spheroidal.

Acicular:- Acicular cast Iron has nickel and Molybdenum as the leading constituent and is employed for crankshafts.

Spheroidal:- spheroidal cast iron has graphite content in spherical form, which is converted from flanky form by alloying with a small amount of Magnesium and Cerium. This change in graphite increases the tensile strength and produces a tough metal which can undergo bending and Twisting.

WROUGHT IRON:-

Wrought iron is virtually pure iron containing a large number of minute threads of slag lying parallel to each other, thereby giving the metal a fibrous appearance when broken. It contains practically no carbon and therefore, does not harden when quenched in water.

Composition:-

Carbon = 0.02 - 0.03%
Silicon = 0.02 - 0.10%
Sulphur = 0.008 - 0.02%
Magnese = 0 - 0.02%
Phosphorus = 0.05 - 0.25%
Slag = 0.15 - 1.50%
Iron = Balance.

PROPERTIES :-

(i) It possesses a high resistance towards corrosion.
(ii) It possesses high ductility and can be easily forged and melted.
(iii) It never cast. All shaping is accomplished by hammering, Pressing, forging Etc.

Uses :- (i) Underground service lines and Electrical conduit.
(ii) Bridge railings, Blast plates, sewer outfall lines.
(iii) Condenser tubes, Acid and alkali process lines etc.
(iv) Cooling Tower and spray pond piping.

STEEL :-

(i) steel is essentially an alloy of iron and Carbon.
(ii) It contains sulphur, S, P, O_2, N_2 and H_2 which are not desired.
(iii) It contains Si & Mn which are acceptable.
(iv) It may contain Elements which are added intentionally such as Ni, Mo, Cr, V to Enhance some of properties.

Plain Carbon Steel :-

* The properties of plain Carbon steel are mainly due to the Element Carbon and those of alloy steels are due to alloying Element and Carbon.
* About 90% of total steel produced as plain Carbon steel because of its low cost, good workability, Castability and Machinability.

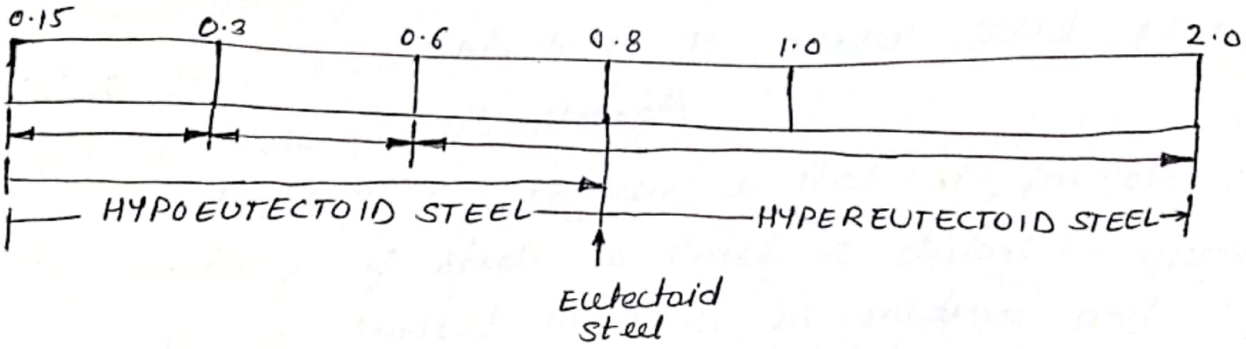
The various applications include wire and wire products, tubular products, sheet and strips, rails, cast or forged products, cutting tools etc.

* A steel containg less than 1.65% Mn and 0.60% Si is referred to as carbon steel.

Classification of Carbon steels:-

Plain carbon steels can be divided into various classes based on carbon content, application and steel manufacturing methods.

(i) Based on carbon content - classification:-



Type of steel	% of C	Properties	Applications
Dead steel	0.05 - 0.15	soft, ductile, easily weldable	Chains & Bolts.
Mild steel	0.15 - 0.3	soft, ductile, less tensile	Screws, nuts, bolts, washers,
Medium steel	0.3 - 0.6	less ductile, highly tensile, hard, highly wear resistant	Agricultural tools, crankshafts, gears, axles, ropes.
High Carbon steel.	0.6 - 0.9	Highly tensile, hard, less ductile, highly wear resistant	Hand tools, cutting tools, railway road wheels.
Tool steel	0.9 - 1.5	Highly tensile, hard less ductile	Dies, ball bearings, lumbering tools.

ALLOY STEEL :-

An alloy steel may be defined as a steel to which Elements other than Carbon are added in sufficient amount to produce an improvement in Properties. The alloying is done for specific purposes to increase wearing resistance, corrosion resistance, and to improve Electrical and magnetic properties. which cannot be obtained in plain Carbon steel. The chief alloying Elements used in steel are Magnese, silicon, sulphur, phosphorus, Nickel, Chromium, Vanadium, Tungsten.

Magnese :- It combines with sulphur to form MnS which is a refractory compound and ensure prodn of sound steel free from blowholes. It raises yeild point and increases Tensile strength.

Disadvantage of Magnese is that it promotes the the tendency of steel to crack & distort on quenching. Thus, it is limited to 0.5% in medium and High Carbon steels which are quenched.

Silicon :- As deoxidant in the form of ferro-silicon. for its low cost and high Efficiency. when in small quantities it does not effect the Mechanical Properties of steel. It opposes the presence of FeO which is harmful. Increase soundness of casting by preventing blow holes.

Sulphur :- Present as iron sulphide or Manganese sulphide or iron sulphide. is insoluble in solid iron and segregates at grain boundaries. and reduce mechanical properties.