MECHANICAL ENGINEERING DEPARTMENT

LECTURE NOTES

FOR

THE SUBJECT

ENGINEERING MATERIAL

3RD SEMESTER

By

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CHAPTER-2: FERROUS MATERIAL AND ALLOYS

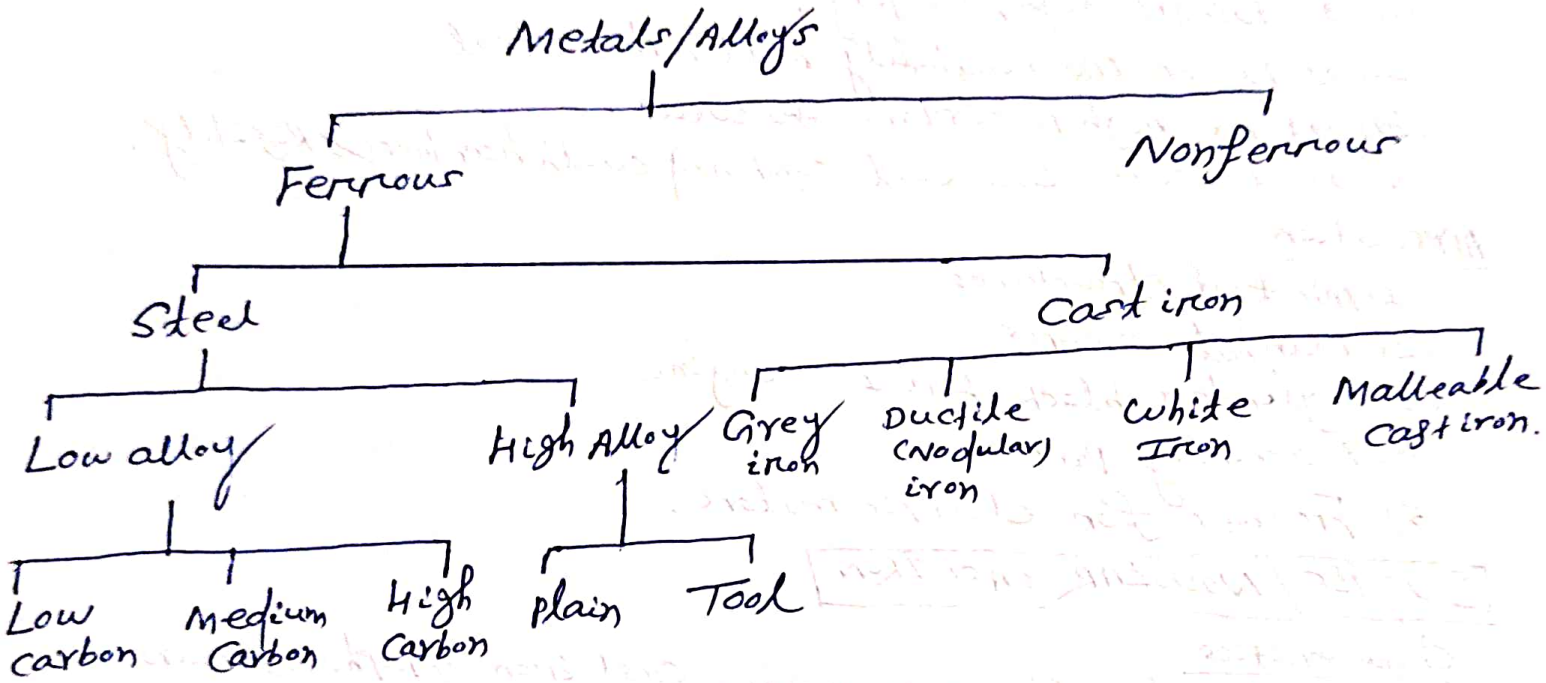
INTRODUCTION

→ Ferrous materials are contain Iron.

→ There are the most important metals/alloys in the metallurgical and mechanical industries because of their very extensive use.

→ Iron containing compounds exist in different quantity with in earth's crust.

CLASSIFICATION OF FERROUS MATERIAL



Steel

(i) It is an alloy of Iron & carbon.

(ii) In Steel iron contain Less than 2% of Carbon.

(iii) Generally steel is stronger than iron & it has better tension and Compression Properties.

Cast iron

(i) It contain carbon between 2 to 5%. There irons are ferrous casting Alloys.

(ii) There are 4 type of cast iron.

(a) Grey cast iron

(b) Ductile (Nodular) cast iron

(c) White cast iron

(d) Malleable cast iron.

Grey cast iron

It is an alloy of carbon, silicon with iron. It readily cast into a desired shape in a sand mould.

It contain 2.5 to 3.8 % C
1.1 to 2.8 % Si
0.4 to 1.1 % Mn
0.5 % P & 0.10 % S.

Characteristics

(i) It is marked by the Presence of graphite in a matrix of Ferrite, Pearlite or Austenite.
(ii) It Possess high Fluidity.
(iii) It Possess machinability better than steel.
(iv) It has high resistance to wear.
(v) It associate Low cost combined with hardness & Rigidity.

Application

(1) M/c tool structures.
(2) Manhole covers
(3) Cylinder block For I.C. engine
(4) Machinary Parts
(5) Frames for electric motor.

DUCTILE / NODULAR CAST IRON

Characteristics

(i) Unlike long flakes as in grey cast iron, graphite appears as round particles or Nodules in Nodular cast iron.
(ii) It contain 3.2-4.2 % C, 1.1-3.5 % Si, 0.3-0.8 % Mn, 0.08 % P and 0.2 % S.
(iii) Excellent wear resistance
(iv) Very good machinability.

Uses

(1) I.C. engines
(2) Pipes
(3) Paper industry machinery
(4) Construction machinery
(5) Pump & compressors
(6) Tractors.

White cast iron

Characteristics

(1) It deriver it's name from the fact that it's freshly broken surface show a bright white fracture.

(2) Unlike grey iron, white cast iron has all most it's carbon chemically bonded with the iron as iron carbide (Fe_3C) which is a very hard & brittle constituents.

(3) Excellent Abrasive wear Resistance.

(4) It contain 1.8-3.6% C, 0.5-2% Si, 0.2-0.8% Mn, 0.18% P & 0.10% S.

(5) The solidification range of white cast iron 2250-2065°F.

USE

→ Producing malleable iron casting

→ Manufacturing those component part which require a hard & abrasion resistant material.

Malleable cast iron

Characteristics:

(1) It is one which can be hammered & Rolled to obtain different shapes.

(2) It is hard & brittle. by heat conversion Process.

(3) It possesses high yield strength.

(4) Low co-efficient of thermal expansion.

(5) It contain 2-3% C, 0.6-1.3% Si, 0.2% Mn, 0.15% P.

(6) Good wear Resistance.

USES

(1) Gear case
(2) Rail Road
(3) Truck tandem Axle
(4) Crankshaft sprocket
(5) Conveyor chain Link.

PLAIN CARBON STEEL

(1) It is an alloy of iron & carbon and it is malleable.

(2) Carbon steels are different from of cast in as regard the percentage of Carbon.

Carbon steel contain carbon 0 to 2%.

Plain carbon steel contain into 3 catagory.

(a) Low carbon steel (Ex:- Mild steel)

(b) Medium carbon steel

(c) High carbon steel.

Low carbon steel contain carbon 0.05 to 0.30 %

Mild steel contain carbon 0.05 to 0.15%. Tensile stress (σ) = 390 N/mm^2 Hardness = 115 BHN Uses (i) Rivet, screw, pipes	Mild steel contain carbon 0.15 to 0.20%. σ = 420 N/mm^2 Hardness = 125 BHN Uses (ii) Forging, welding, cam shaft	Mild steel contain carbon 0.20 to 0.30 σ = 555 N/mm^2 Hardness = 140 BHN Uses (i) connecting Rod gear.

Medium carbon steel contain carbon 0.30 to 0.70 %

Steel contain carbon C = 0.35 to 0.45%. σ = 750 N/mm^2 Hardness = 0 Uses: → Connecting Rod → Gear shaft	Steel contain carbon C = 0.45 to 0.55%. σ = 1000 N/mm^2 Hardnes = 0 Uses: Crank Pin Crank shaft	Steel contain carbon C = 0.55 to 0.70%. σ = 1230 N/mm^2 Hardness = 400 to 450 BHN. Uses: screw, Valve spring Thrust washer

High carbon steels carbon contain 0.70 to 1.5%

Steel contain C = 0.70 - 0.80 σ = 1400 N/mm^2 H = 500 BHN Uses Jaw, drill bit	Steel contain C = 0.80 - 0.90 σ = 660 N/mm^2 H = 600 BHN Uses Rock drill Music wire	Steel contain C = 0.90 - 1% σ = 580 N/mm^2 H = 650 BHN Uses Punches dies keys	Steel contain C = 1 to 1.3% σ = 0 H = 0 Use Files cutting tool	Steel contain C = 1.3 to 1.5% σ = 0 H = 0 Use wire drawing Metal cutting saws

Alloy Steel

Steel is considered to be an alloy steel when the maximum range given for the content of alloying element exceeds one or more having certain limits.

There are 2 types of alloy steels.

(a) High alloy steel
(b) Low alloy steel.

High alloy steel

Alloy steel containing the range between 1 to 3.99% of some element is called high alloy steel.

Ex:- Mn, Al, B etc.

Low Alloy steel

Alloy steel containing the range between 0.2 to 1% of some element, is called Low alloy steel.

Ex:- Cr, Mo, C, Ni, Si etc.

Advantages

→ Less cracking
→ Higher elastic Ratio
→ Better machinability
→ Greater Hardenability

Disadvantage

→ Special Handling
→ Cost is high.
→ Temper brittleness in certain grades
→ Austenite retention.

Objectives of Alloying steel

→ Better hardenability
→ Greater strength.
→ Improved toughness
→ Improved temp. stability
→ Improved cutting Ability.

Effect of Alloying element

(1) Cr :- It joins with carbon to form chromium carbide, thus adds to depth hardenability with improved resistance to abrasion & wear.

(2) Mn :- It contributes markely to strength & hardness.

(3) W :- It Increase hardness & Resist heat.

(4) V :- Powerful carbide formers which improve toughness.

(5) Ni :- Increase toughness & strengthness steel.

Tool steel

It may be defined as special steel which have been developed to form, cut or otherwise change the shape of a material into a finished or semi-finished product.

Properties of Tool steel

(1) Good toughness
(2) Good wear resistance.
(3) Good Machinability.
(4) A definite cooling rate during hardening.
(5) A definite hardening temperature.

Stainless steel

When 11.5% or more chromium is added to iron, a fine film of chromium oxide forms naturally on the surface, exposed to air. The film act as a barrier to retard further oxidation, rust or corrosion. As this steel cannot be stained easily, it is called as stainless steel.

H.S.S. (High speed steel)

(1) As per named the high speed steel remove metal at much higher speed than ordinary carbon steel.
(2) High speed steel were developed & used primarily for making metal cutting tool. (cutting Ability at temp° 540°c)

Properties

→ Excellent hardness
→ Good wear resistance
→ Good machinability.
→ Good shock Resistance.

Uses

(i) For making all types of cutting tool such as Lathe, shaper, Planner tool etc.
(ii) Pump, Bearing part etc.