Classification of steels

Objectives: At the end of this lesson you shall be able to
- **state the main classification of steels**
- **explain the effect of carbon content in steel**
- **describe the uses of various types of carbon steel.**

Classification of steel: The classification of steel is mainly based on the chemical composition of various elements like traces of sulphur, phosphorus, silicon, manganese with a percentage of less than 1% carbon content in steel.

Thus, the steel is classified as follows,

1 Carbon steel

2 Alloy steel

Effects of carbon content in steel: Steel can be defined as an alloy of carbon and iron, in which carbon is in a combined state. The carbon content is a very important factor to get the desired properties of steel.

Carbon: Carbon is a very important constituent of steel.

The addition of carbon at varying proportions modifies the characteristics of iron and makes it harder, stronger and of greater use in the engineering industry. Slight variations in the carbon content of steel lead to great differences in the properties of steel. Depending upon the properties it is put to different uses. (Table 1)

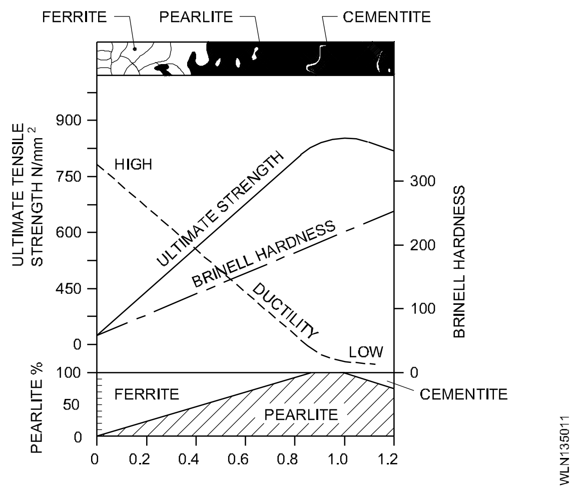
Table 1

Name	Group	Carbon content %	Examples of uses
Wrought iron	Wrought iron	Less than 0.05	Chain for lifting tackle, crane hooks, architectural iron work.
Dead mild steel	Plain carbon steel	0.1 to 0.15	Sheet for pressing out such shapes as motor car body panels. Thin wire, rod, and drawn tubes.
Mild steel	Plain carbon steel	0.15 to 0.3	General purpose workshop bars, boiler plates, girders.
Medium carbon steel	Plain carbon steel	0.3 to 0.5 0.5 to 0.8	Crankshaft forgings, axles. Leaf springs, cold chisels.
High carbon steel	Plain carbon steel	0.8 to 1.0 1.0 to 1.2 1.2 to 1.4	Coil springs, chisels used in woodwork. Files, drills, taps and dies. Fine edge tools (knives etc).

Ferrite is a very weak solid solution of carbon and iron with about 0.006% carbon. This is a very soft and ductile constituent. (Fig 1) Pearlite contains alternate layers of ferrite and cementite. This laminated structure makes pearlite stronger. As the carbon content increases, the pearlite structure formation is also increased, and this increases the tensile strength and hardness.

It may be noted from the figure that addition of carbon beyond 0.83% cementite will not exist in the combined form but appear around the crystal boundaries. Carbon, existing in this form, reduces in tensile strength and ductility but the hardness continues to increase even beyond 0.83% of carbon.

Fig 1



It may be said that plain steel will have a maximum strength at 0.83% carbon - i.e. when the constituent of steel is fully pearlite.

Addition beyond 0.83% reduces its strength and ductility.

Hardness of carbon of plain carbon steel increases proportionately even beyond 0.83% carbon content.

At room temperature in the annealed condition plain carbon steel contains three main constituents.

– Ferrite
– Cementite
– Pearlite

Welding of low carbon steel, medium and high carbon steel

Objectives: At the end of this lesson you shall be able to
- **state the composition of carbon percentage in low carbon steel and medium carbon steel**
- **state the type of flame needed for welding low carbon steel**
- **describe the method of welding low carbon steel**
- **explain the procedure for the welding of medium carbon steel.**

A plain carbon steel is one in which carbon is the only alloying element. The amount of carbon in the steel controls its hardness, strength and ductility. The higher the carbon the lesser the ductility of the steel.

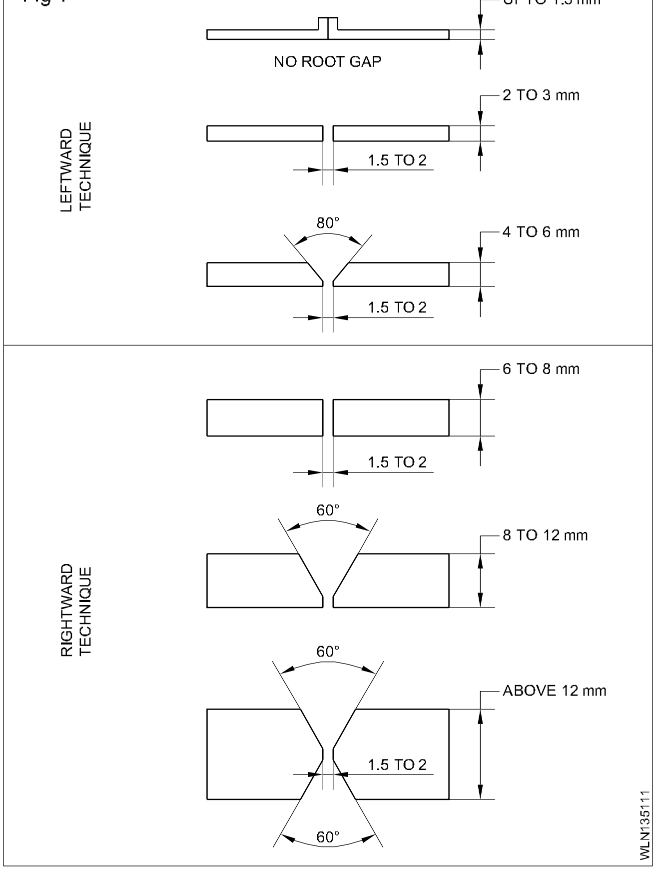
Carbon steels are classified according to the percentage of carbon they contain. They are referred to as low, medium and high carbon steels.

Low carbon steels: Steels with a range of 0.05 to 0.30 per cent are called low carbon steel or mild steel. Steels in this class are tough, ductile and easily machinable and quite easy to weld.

Welding technique: Up to 6 mm, leftward technique is a suitable one. Above 6 mm rightward technique is preferable.

Preparation: (Refer Fig 1 given below)

Fig 1



Type of flame: Neutral flame to be used.

Application of flux: No flux is required

After treatment: Most of them do not respond to any heat treatment process. Therefore except cleaning no post-heat treatment is required.

Medium carbon steel: These steel have a carbon range from 0.30 to 0.6 percent. They are strong and hard but cannot be welded as easily as low carbon steels due to the higher carbon content. They can be heat treated. It needs greater care to prevent formation of cracks around the weld area, or gas pockets in the bead, all of which weaken the weld.

Welding procedure: Most medium carbon steels can be welded in the same way as mild steel successfully without too much difficulty but the metal should be preheated slightly to 160°C to 320°C (to dull red hot). After completion of welding, the metal requires post-heating to the same preheating temperature, and allowed to cool slowly.

After cooling, the weld is to be cleaned and inspected for surface defects and alignment.

Plate edge preparation: Fig 1 shows the plate edge preparation depending on the thickness of the material to be welded.

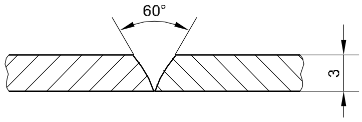
High carbon steel: High carbon steels contain 0.6% to 1.2% carbon. This type of steel is not weldable by gas welding process because it is difficult to avoid cracking of base metal and the weld.

Welding procedure

The type of edge preparation, nozzle size, filler rod size, pitch of tack for different thickness of sheets to be welded are given in Table 1.

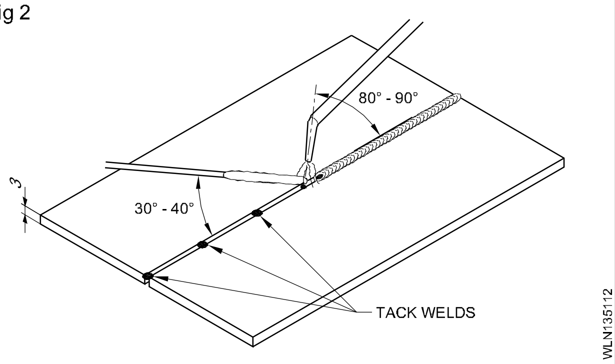
Start welding from the right hand edge of the joint and proceed in the leftward direction.

Table 1

Thickness	Preparation	Assembly	Pitch of tacks (mm)	Nozzle size	Filler rod
1 mm	Square edge	No gap	20	1	1.2 mm
1.2 mm	Square edge	No gap	20	2	1.2 mm
1.5 mm	Square edge	No gap	25	2	1.6 mm
3 mm		No gap	45	5	3 mm

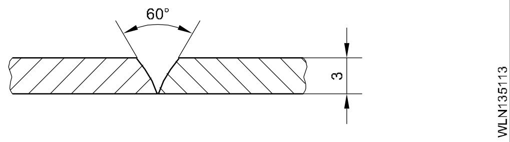
Keep the tip of the inner cone of the flame within 1 to 1.5 mm of the molten puddle, and hold the blowpipe at an angle of 80-90° to the work. (Fig 2)

Fig 2



In this way the filler rod which melts at a lower temperature than steel can flow forward and fill up the groove of the metal as it fuses. Fig 3 shows the type of edge preparation used for 3 mm thick metal.

Fig 3



Add the filler rod by holding it close to the cone of the flame. Upon withdrawing it from the puddle remove it entirely from the flame until you are ready to dip it back into the puddle.

Care must be taken not to direct too much heat on the end of the filler rod to avoid easy melting and flowing.

Complete the weld in one pass on one side and avoid multi-pass welding so as to reduce the effect of heat on the weldment.