Al-Mustansiriya University

College of Engineering

Mechanical Department

PRODUCTION

Lectuer NO. 3:

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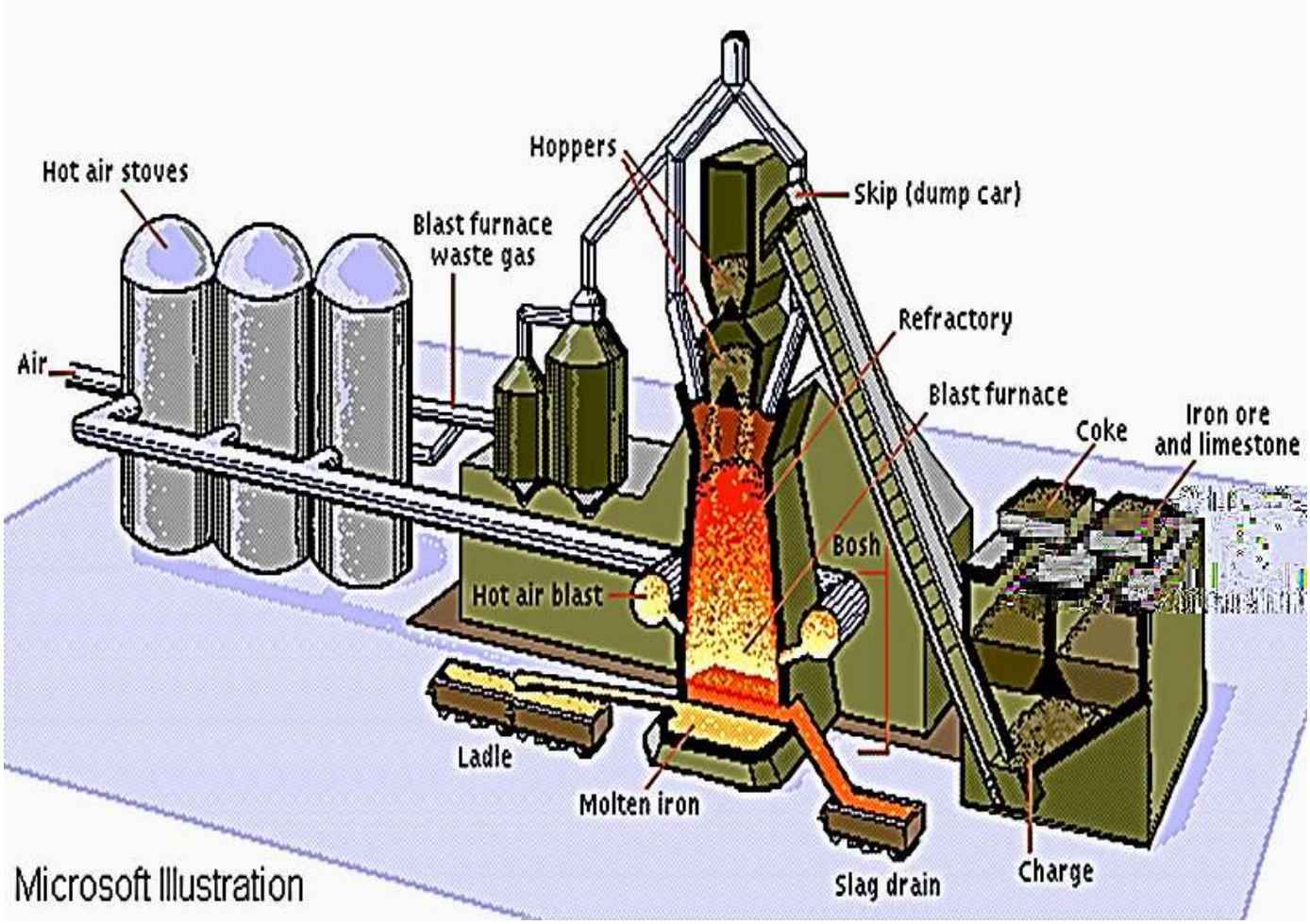
Production of Ferros Metals

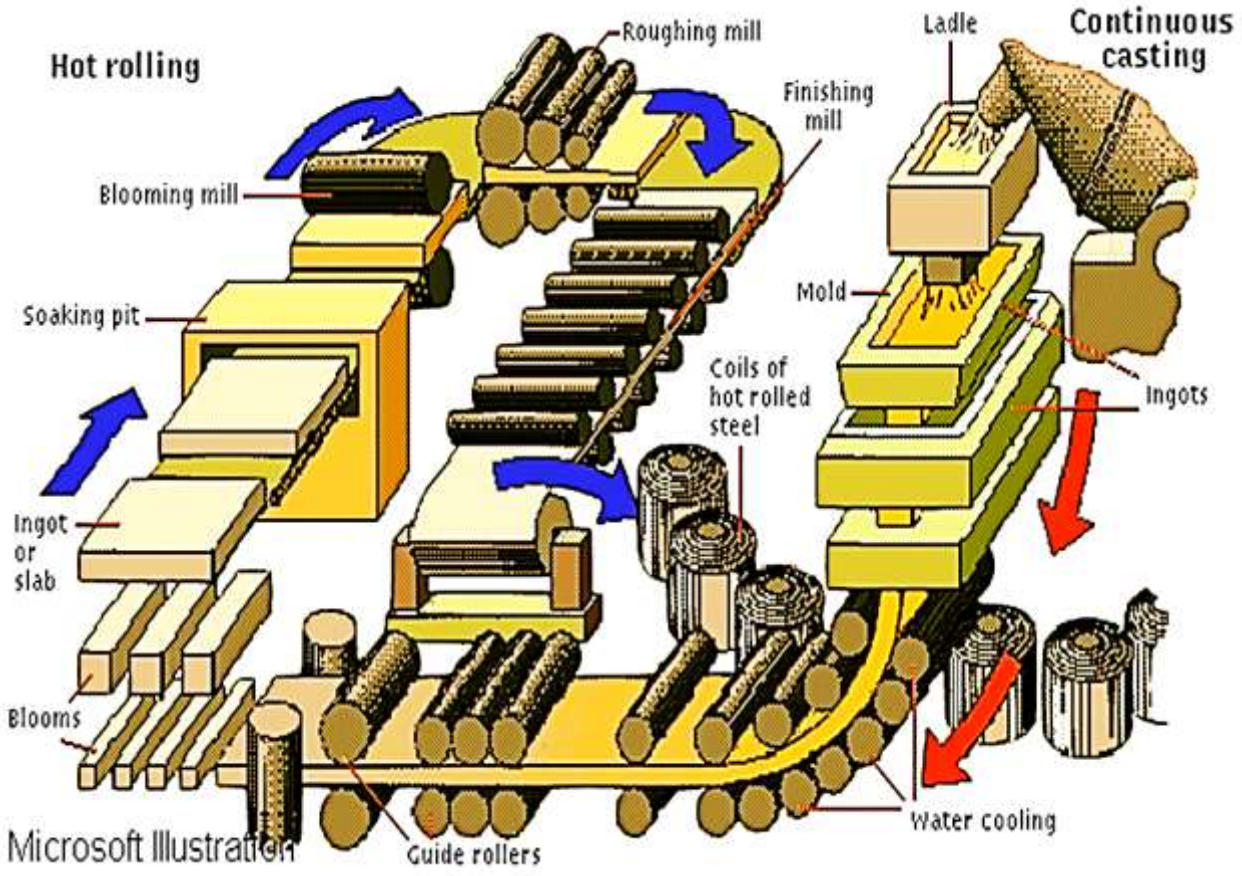
Iron and Steel Manufacture:

Iron contain only a few hundredths of 1 percent of carbon. Steels of various types contain from 0.04 percent to 2.25 percent of carbon. A special group of iron alloys, known as ferroalloys, is used in the manufacture of iron and steel alloys; they contain from 20 to 80 percent of an alloying element, such as manganese, silicon, or chromium.



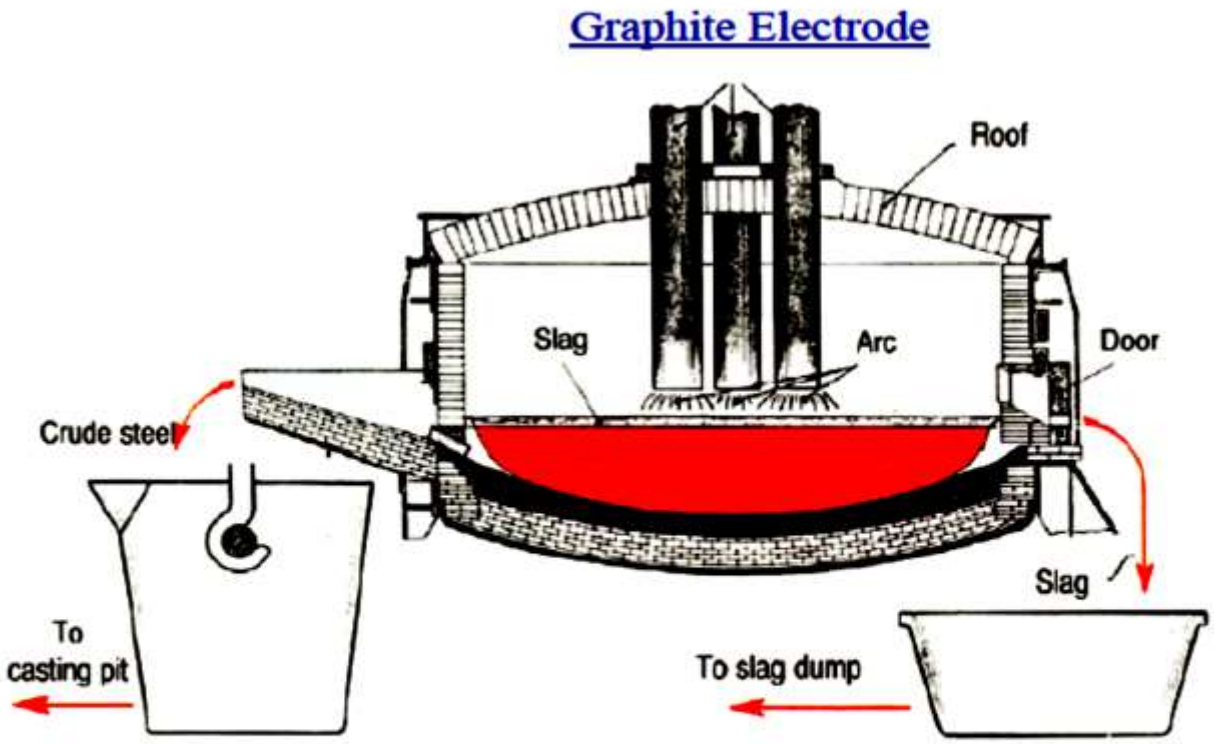
The basic materials used for the manufacture of pig iron are iron ore, coke, and limestone. The coke is burned as a fuel to heat the furnace; as it burns, the coke gives off carbon monoxide, which combines with the iron oxides in the ore, reducing them to metallic iron. This is the basic chemical reaction in the blast furnace; it has the equation: $Fe_2O_3 + 3CO = 3CO_2 + 2Fe$. The limestone in the furnace charge is used as an additional source of carbon monoxide and as a "flux" to combine with the infusible silica present in the ore to form fusible calcium silicate. Without the limestone, iron silicate would be formed, with a resulting loss of metallic iron. Calcium silicate plus other impurities form a slag that floats on top of the molten metal at the bottom of the furnace. Ordinary pig iron as produced by blast furnaces contains iron, about 92 percent; carbon, 3 or 4 percent; silicon, 0.5 to 3 percent; manganese, 0.25 to 2.5 percent; phosphorus, 0.04 to 2 percent; and a trace of sulfur.

Modern-day blast furnaces are operated in conjunction with basic oxygen furnaces and sometimes the older open-hearth furnaces as part of a single steel-producing plant. In such plants the molten pig iron is used to charge the steel furnaces. The molten metal from several blast furnaces may be mixed in a large ladle before it is converted to steel, to minimize any irregularities in the composition of the individual melts.



Electric-Furnace Steel

In some furnaces, electricity instead of fire supplies the heat for the melting and refining of steel. Because refining conditions in such a furnace can be regulated more strictly than in open-hearth or basic oxygen furnaces, electric furnaces are particularly valuable for producing stainless steels and other highly alloyed steels that must be made to exacting specifications. Refining takes place in a tightly closed chamber, where temperatures and other conditions are kept under rigid control by automatic devices. During the early stages of this refining process, high-purity oxygen is injected through a lance, raising the temperature of the furnace and decreasing the time needed to produce the finished steel. The quantity of oxygen entering the furnace can always be closely controlled, thus keeping down undesirable oxidizing reactions.



Scheme of an Electric Arc Furnace

Carbon content:

- Steel – alloy consisting mostly of iron with a little carbon (0.05% - 2.04% by weight)
- Also have:
- Iron = iron-carbon alloy with less than 0.005% carbon.
- Cast iron = carbon content between 2.1% - 4.0%
- Wrought iron – contains 1 – 3% by weight of slag in the form of particles elongated in one direction – more rust resistant than steel and welds better

– Steel Making Raw Material:

- Carbon in the form of coke
- Iron ore (Fe_2O_3)
- Limestone ($CaCO_3$)

– The iron are:

- Consists of oxides in nature of iron and oxygen
- Primarily magnetite (Fe_3O_4) or hematite (Fe_2O_3)
- The blast furnace basically separates the iron from the oxygen in a reduction process

The Blast Furnace:

Stands 300 feet tall
Designed to run continuously for 4 -5 years before being relined.
Heat generated by burning coke in the preheated air.
Coke acts as reducing agent and changes to carbon monoxide (the reducing agent) which removes the oxygen from the iron oxide.

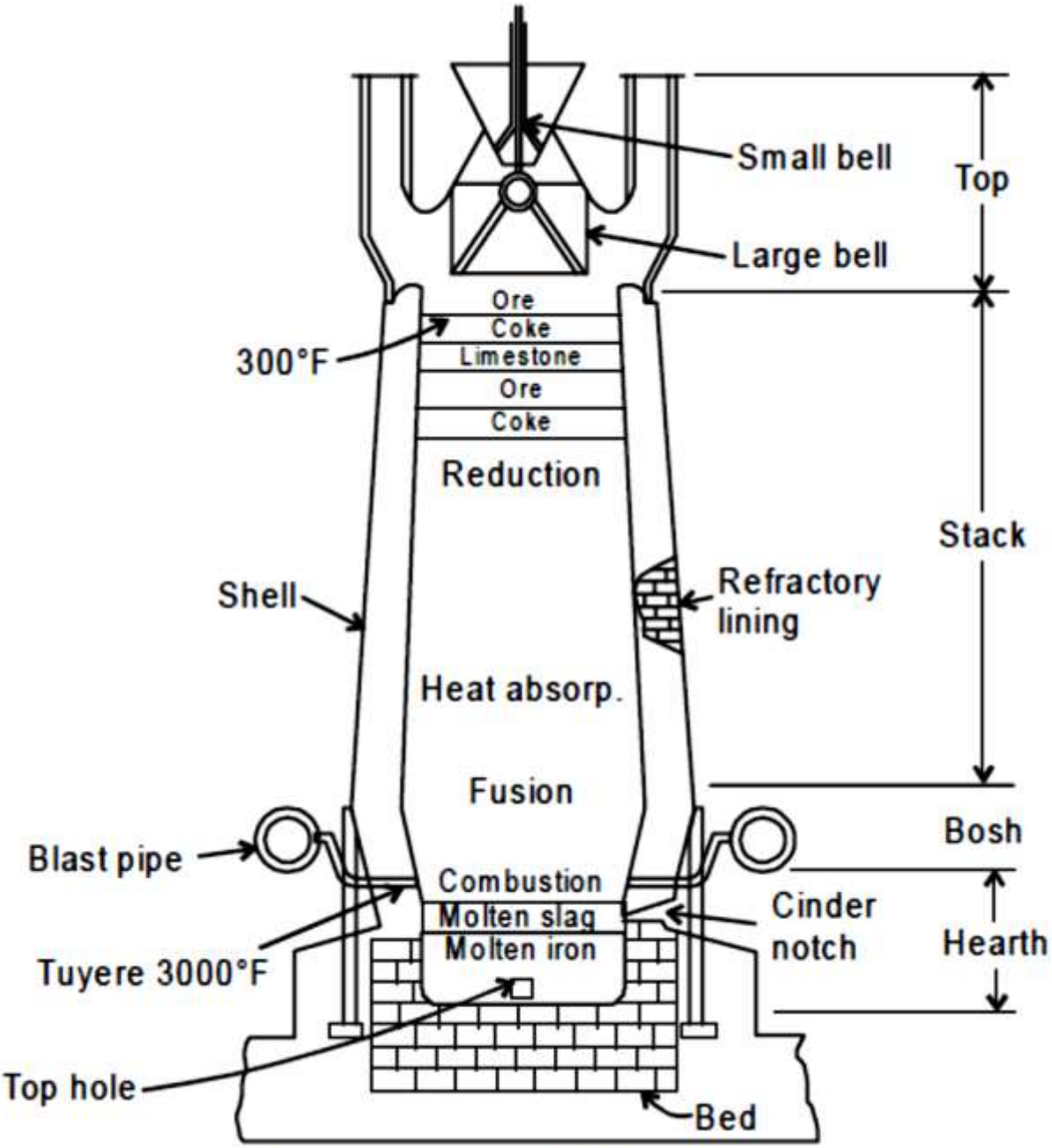


Fig. 6.1 Typical blast furnace

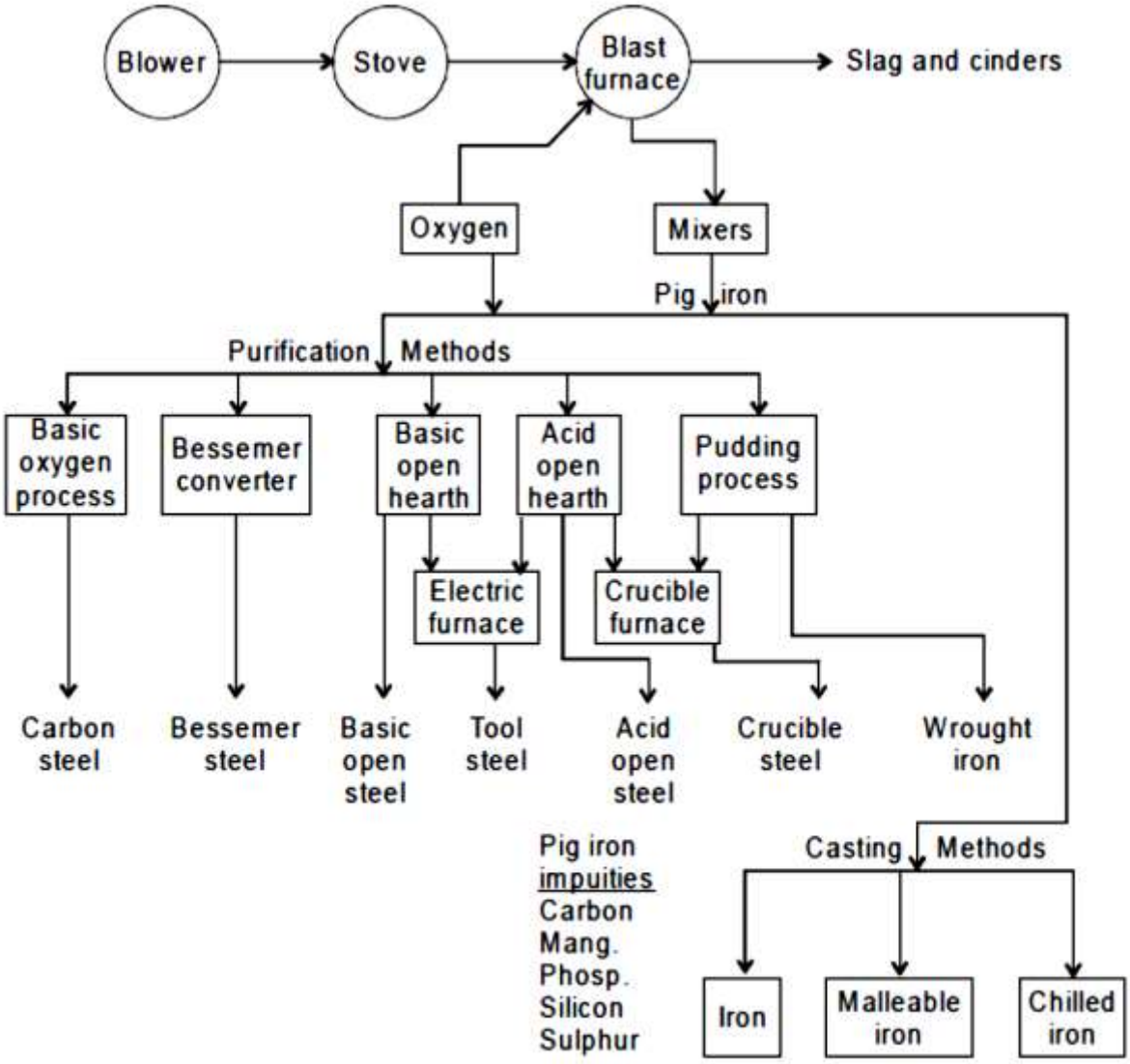


Fig. 6.2 Flow chart for converting pig iron into useful iron and steel

Ex. Classification pf steel….. as (AISI)

classifies alloys by chemistry

started by Society of Automotive Engineers (SAE)

provide standardization of steel used in the automotive industry

expanded by AISI to include all engineering materials

4 digit number

1st number is the major alloying agent

2nd number designates the subgroup alloying agent

last two numbers approximate amount of carbon

expresses in 0.01%

1080 steel would be plain carbon steel with 0.80% carbon

4340 steel would be Mo-Cr-Ni alloy with 0.40% carbon

Alloy

- **Alloy Steel**

What classifies a steel as an Alloy Steel

> 1.65%Mn, > 0.60% Si, or >0.60% Cu

Definite or minimum amount of an alloying element is specified

Most alloying elements added to steel are < 5%

to increase strength and hardenability

Most alloying elements added to steel are > 20%

to improve corrosion resistance or stability at high or low temps

Stainless Steel *is corrosion resistant*

due to chromium oxide on the surface of the metal

S.S. Series

200 and 300 … Austenitic

nonmagnetic

high formability

very high corrosion resistance

twice the cost of ferritic S.S.

400 … Ferritic or Martensitic

poor ductility and formability

lowest cost S.S.

500 … Martensitic

high strength

1.5 times the cost of ferritic S.S.

Wear Resistant, High Strength and Tough

High Carbon steels

Modified by alloy additions

AISI-SAE Classification

Letter & Number Identification

Classification

Letters pertain to significant characteristic

W,O,A,D,S,T,M,H,P,L,F

E.g. A is Air-Hardening medium alloy

Numbers pertain to material type

1 thru 7

E.g. 2 is Cold-work

An A2 is an Air-Hard enable, Cold-worked material.

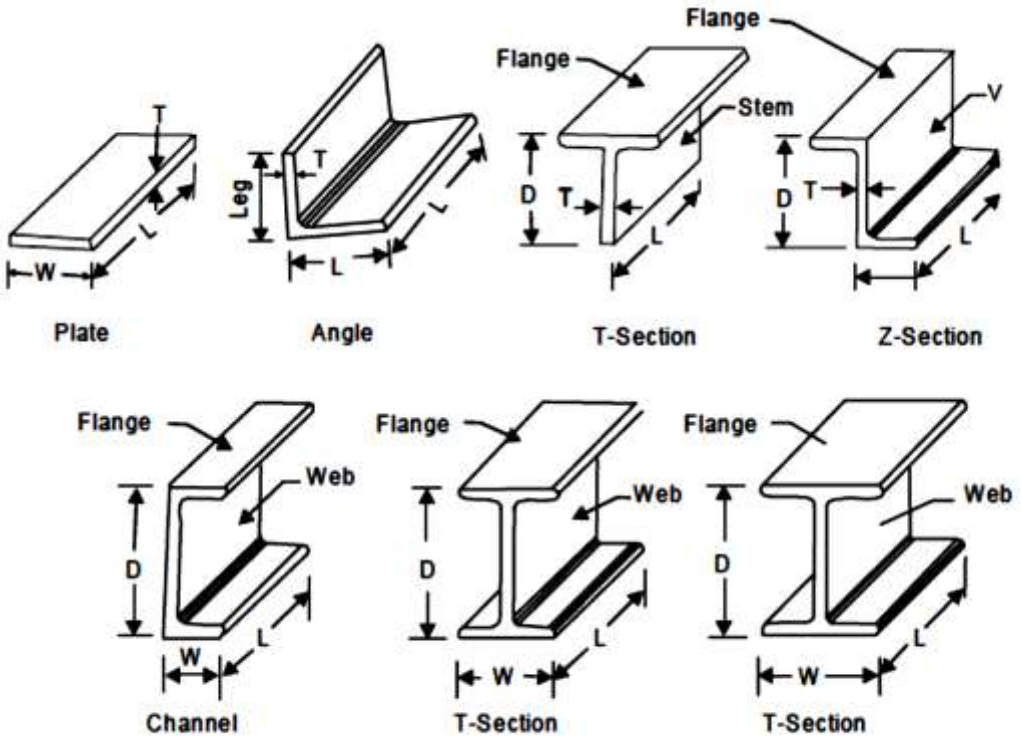


Fig. 4.5 Market forms of steel structure shapes

5.10 COMPOSTION AND APPLICATIONS OF FEW TYPICAL MATERIALS

The composition and applications of few typical materials is given in Table 5.1.

Table 5.1 Composition and Applications of Few Typical Materials

S. No	Alloy	Composition	Uses
1	Duralmin,	95% Aluminium + 4% Copper+ 0.5% Manganese + 0.5% Magnesium	Light structures, extruded sections and sheet
2	Gun metal	90% copper + 10% zinc	Small valves, fittings for water services
3	Monel	67% Ni + 28% Copper + remaining carbon, iron and Manganese	Valve parts for superheated steam turbine blades
4	Phosphor bronze	90% Copper + 9.7% Tin + 0.3% Phosphorus	Bearings, worm wheels, rods sheets
5	High carbon steel	0.8% to 1.5% Carbon + remaining iron	Files, dies for wire drawing, clutch disc
6	Spheroidal CI	3.2%-4.5% carbon 1-4% Si 0.1-8% Mn 0.1% P 0-3.5% Ni 0.05-0.1% Mn	For high wear resistance
7	Wrought iron	99% Pig Iron + 0.12% Carbon + 0.25% Phosphorus + 0.05 % Sulphur	Chains, crane hooks, railway couplings