Machine Design-I

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Standards in Design and Designation of Steels

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Standards in design

- Standard is a set of specifications for parts, materials or processes to achieve uniformity, efficiency and a specified quality.

- Advantages (Follow any ref book)
- *Interchangeability, mass production, cost, availability, quality & reliability.*

- Classification (Follow any ref book)

1. Company, National, International
2. For ***materials***, ***Size***, **Shape**, **Testing**

STANDARDS FOR MATERIALS

Designation of steels

- **Based on strength**
- **Based on Chemical Composition**

Based on strength

For Steel

- Fe 230 (Ultimate Tensile strength in MPa)
- FeE 150 (Yield strength in Mpa)

For Cast Iron

- FG 150 (Tensile strength in Mpa)

Based on Chemical Composition

- Plain Carbon Steel
- Alloy Steel
- High Alloy Steels
- High Speed Tool Steel

Plain Carbon Steel

(*a*) Figure indicating 100 times the average percentage of carbon content,

(*b*) Letter 'C', and

(*c*) Figure indicating 10 times the average percentage of manganese content. The figure after multiplying shall be rounded off to the nearest integer.

For example 20C8 means a carbon steel containing 0.15 to 0.25 per cent (0.2 per cent on an average) carbon and 0.60 to 0.90 per cent (0.75 per cent rounded off to 0.8 per cent on an average) manganese.

Alloy Steel

1. Figure indicating 100 times the average percentage carbon.
2. Chemical symbol for alloying elements each followed by the figure for its average percentage content multiplied by a factor as given below :

Element	*Multiplying factor*
Cr, Co, Ni, Mn, Si and W	4
Al, Be, V, Pb, Cu, Nb, Ti, Ta, Zr and Mo	10
P, S and N	100

For example 40 Cr 4 Mo 2 means alloy steel having average 0.4% carbon, 1% chromium and 0.25% molybdenum.

Notes : 1. The figure after multiplying shall be rounded off to the nearest integer.

2. Symbol 'Mn' for manganese shall be included in case manganese content is equal to or greater than 1 per cent.

3. The chemical symbols and their figures shall be listed in the designation in the order of decreasing content.

High Alloy Steels (e.g. Stainless Steel)

1. Letter 'X'.
2. Figure indicating 100 times the percentage of carbon content.
3. Chemical symbol for alloying elements each followed by a figure for its average percentage content rounded off to the nearest integer.
4. Chemical symbol to indicate specially added element to allow the desired properties.

For example, X 10 Cr 18 Ni 9 means alloy steel with average carbon 0.10 per cent, chromium 18 per cent and nickel 9 per cent.

High Speed Tool Steel

1. Letter 'XT'.
2. Figure indicating 100 times the percentage of carbon content.
3. Chemical symbol for alloying elements each followed by the figure for its average percentage content rounded off to the nearest integer, and
4. Chemical symbol to indicate specially added element to attain the desired properties.

For example, XT 75 W 18 Cr 4 V 1 means a tool steel with average carbon content 0.75 per cent, tungsten 18 per cent, chromium 4 per cent and vanadium 1 per cent.

STANDARDS FOR SIZES

Selection of Preferred sizes (size is a general term)

- A certain range can be covered efficiently when it follows a geometrical progression with a constant ratio. The preferred numbers are the conventionally rounded off values derived from geometric series including the integral powers of 10 and having as common ratio of the following factors:

$$\sqrt[5]{10},\ \sqrt[10]{10},\ \sqrt[20]{10} \text{ and } \sqrt[40]{10}$$

- These ratios are approximately equal to 1.58, 1.26, 1.12 and 1.06. The series of preferred numbers are designated as *R5, R10, R20 and R40 respectively. These four series are called ***basic series. The other series called derived series may be obtained by simply multiplying or dividing the*** basic sizes by 10, 100, etc.

Basic series	*Preferred numbers*
R5	1.00, 1.60, 2.50, 4.00, 6.30, 10.00
R10	1.00, 1.25, 1.60, 2.00, 2.50, 3.15, 4.00, 5.00, 6.30, 8.00, 10.00
R20	1.00, 1.12, 1.25, 1.40, 1.60, 1.80, 2.00, 2.24, 2.50, 2.80, 3.15, 3.55, 4.00, 4.50, 5.00, 5.60, 6.30, 7.10, 8.00, 9.00, 10.00
R40	1.00, 1.06, 1.12, 1.18, 1.25, 1.32, 1.40, 1.50, 1.60, 1.70, 1.80, 1.90, 2.00, 2.12, 2.24, 2.36, 2.50, 2.65, 2.80, 3.00, 3.15, 3.35, 3.55, 3.75, 4.00, 4.25, 4.50, 4.75, 5.00, 5.30, 5.60, 6.00, 6.30, 6.70, 7.10, 7.50, 8.00, 8.50, 9.00, 9.50, 10.00

Selection of materials

- The best material is one which will serve the desired objective at minimum cost.
- The following factors should be considered while selecting the materials

1. **Availability**
2. **Cost:** designer cannot go beyond the limit. He has to select the alternative materials. In cost analysis there are two factors, cost of materials and cost of processing the materials.

3. Mechanical Properties:

The properties are measured in terms of following quantities.

Strength (static load)	UTS or UYS
Strength (fluctuating)	endurance strength
Rigidity	modulus of elasticity
Ductility	Perc. Elongation
Hardness	Brinell H. No.
Toughness	Izod or Charpy test

4. Manufacturing considerations:

Machinability is the important criterion. Sometimes, an expensive material is more economical than a low priced one, which is difficult to machine.

The manufacturing process like casting, rolling, forging, machining, welding govern the selection of materials.