UNIT I INTRODUCTION AND ALLOWABLE STRESS DESIGN

1.2 Mechanical Properties of structural steel

The properties that need to be considered by designers when specifying steel construction. The properties of structural steel, as per clause 2.2.4 of IS 800:2007, for use in design, may be taken as given in clauses 2.2.4.1 and 2.2.4.2 of the code. They are

- Strength
- Toughness
- Hardness
- Hardenability
- Brittleness
- Malleability
- Ductility
- Creep and Slip
- Resilience
- Fatigue

The mechanical properties of structural steel is w.r.to the yield stress & ultimate stress of the steel sections conforming to IS 2062. Ex: E250 grade of steel - yield stress 250 N/mm^2

Ultimate stress 410 N/mm^2

The mechanical properties of all the grades a given in table 1:1 of IS 800-2007-P.13

Mechanical properties:

The principal mechanical properties of the structural steel important in design, as detailed by the code IS 800:2007 in cl. 2.2.4.2, are the yield stress, f_y; the tensile or ultimate stress, f_u; the maximum percent elongation on a standard gauge length and notch toughness. Except for notch toughness, the other properties are determined by conducting tensile tests on samples cut from the plates, sections, etc, in accordance with IS 1608. Commonly used properties for the common steel products of different specifications are summarized in Table 1 of IS 800:2007.

Strength

It is the property of a material which opposes the deformation or breakdown of material in presence of external forces or load. Materials which we finalize for our engineering products, must have suitable mechanical strength to be capable to work under different mechanical forces or loads.

Toughness

It is the ability of a material to absorb the energy and gets plastically deformed without fracturing. Its numerical value is determined by the amount of energy per unit volume. Its unit is Joule/ m^3. Value of toughness of a material can be determined by stress-strain characteristics of a material. For good toughness, materials should have good strength as well as ductility. For example: brittle materials, having good strength but limited ductility are not tough enough. Conversely, materials having good ductility but low strength are also not tough enough. Therefore, to be tough, a material should be capable to withstand both high stress and strain.

Ductility

Ductility is a property of a solid material which indicates that how easily a material gets deformed under tensile stress. Ductility is often categorized by the ability of material to get stretched into a wire by pulling or drawing. This mechanical property is also an aspect of plasticity of material and is temperature dependent. With rise in temperature, the ductility of material increases.

Hardness

It is the ability of a material to resist to permanent shape change due to external stress. There are various measure of hardness – Scratch Hardness, Indentation Hardness and Rebound Hardness.

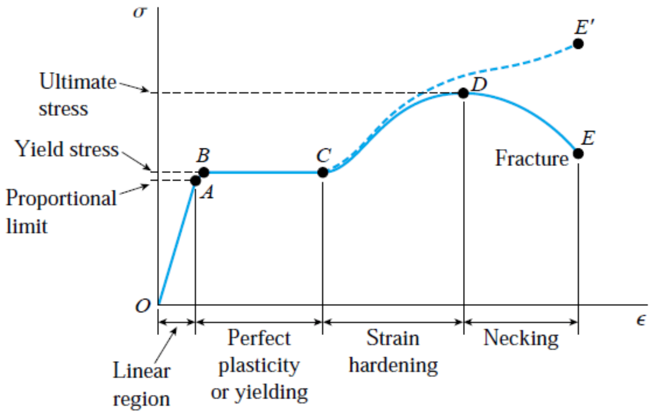
Brittleness

Brittleness of a material indicates that how easily it gets fractured when it is subjected to a force or load. When a brittle material is subjected to a stress it observes very less energy and gets fractures without significant strain. Brittleness is converse to ductility of material. Brittleness of material is temperature dependent. Some metals which are ductile at normal temperature become brittle at low temperature.

Malleability

Malleability is a property of solid materials which indicates that how easily a material gets deformed under compressive stress. Malleability is often categorized by the ability of material to be formed in the form of a thin sheet by hammering or rolling. This mechanical property is an aspect of plasticity of material. Malleability of material is temperature dependent. With rise in temperature, the malleability of material increases.

Stress Strain Curve for mild steel:



Stress-strain diagram for a typical structural steel in tension (not to scale)

Stress strain curve is a behavior of material when it is subjected to load. In this diagram stresses are plotted along the vertical axis and as a result of these stresses, corresponding strains are plotted along the horizontal axis. As shown below in the stress strain curve

1. Proportional Limit
2. Elastic Limit
3. Yield Point- Upper yield and lower yield
4. Ultimate Stress Point
5. Breaking Point

(i). Proportional Limit: It is the region in the strain curve which obeys hooke's law i.e. within elastic limit the stress is directly proportional to the strain produced in the material. In this limit the ratio of stress with strain gives us proportionality constant known as young's modulus. The point OA in the graph is called the proportional limit.

(ii). Elastic Limit: It is the point in the graph up to which the material returns to its original position when the load acting on it is completely removed. Beyond this limit the material cannot return to its original position and a plastic deformation starts to appear in it. The point A is the Elastic limit in the graph.

(iii). Yield Point or Yield Stress Point: Yield point in a stress strain diagram is defined as the point at which the material starts to deform plastically. After the yield point is passed there is permanent deformation develops in the material and which is not reversible. There are two yield points and it is upper yield point and lower yield point. The stress corresponding to the yield point is called yield point stress. The point B is the upper yield stress point and C is the lower yield stress point.

(iv) Ultimate Stress Point: It is the point corresponding to the maximum stress that a material can handle before failure. It is the maximum strength point of the material that can handle the maximum load. Beyond this point the failure takes place. Point D in the graph is the ultimate stress point.

(v). Fracture or Breaking Point: It is the point in the stress strain curve at which the failure of the material takes place. The fracture or breaking of ma

ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY
PALKULAM, KANYAKUMARI
OBSERVE OPTIMIZE OUTSPREAD