SYLLABUS

UNIT I INTRODUCTION AND ALLOWABLE STRESS DESIGN

Structural steel types – Mechanical Properties of structural steel- Indian structural steel products-Steps involved in the Deign Process -Steel Structural systems and their Elements- -Type of Loads on Structures and Load combinations- Code of practices, Loading standards and Specifications - Concept of Allowable Stress Method, and Limit State Design Methods for Steel Structures-Relative advantages and Limitations-Strengths and Serviceability Limit states. Allowable stresses as per IS 800 section 11 -Concepts of Allowable stress design for bending and Shear –Check for Elastic Deflection-Calculation of moment carrying capacity –Design of Laterally supported Solid Hot Rolled section beams-Allowable stress deign of Angle Tension and Compression Members and estimation of axial load carrying capacity

UNIT II CONNECTIONS IN STEEL STRUCTURES

Type of Fasteners- Bolts Pins and welds- Types of simple bolted and welded connections Relative advantages and Limitations-Modes of failure-the concept of Shear lag-efficiency of joints- Axially loaded bolted connections for Plates and Angle Members using bearing type bolts –Prying forces and Hanger connection– Design of Slip critical connections with High strength Friction Grip bolts.- Design of joints for combined shear and Tension- Eccentrically Loaded Bolted Bracket Connections-Welds-symbols and specifications- Effective area of welds-Fillet and but Welded connections-Axially Loaded connections for Plate and angle truss members and Eccentrically Loaded bracket connections.

UNIT III TENSION MEMBERS

Tension Members - Types of Tension members and sections –Behaviour of Tension Members-modes of failure-Slenderness ratio- Net area – Net effective sections for Plates ,Angles and Tee in tension –Concepts of Shear Lag- Design of plate and angle tension members-design of built up tension Members-Connections in tension members – Use of lug angles – Design of tension splice

UNIT IV COMPRESSION MEMBERS

Types of compression members and sections–Behaviour and types of failures-Short and slender columns- Current code provisions for compression members- Effective Length, Slenderness ratio –Column formula and column curves- Design of single section and compound Angles-Axially Loaded solid section Columns- Design of Built up Laced and Battened type columns – Design of column bases – Plate and Gusseted bases for Axially loaded colums- Splices for colums.

UNIT V DESIGN OF FLEXURAL MEMBERS

Types of steel Beam sections- Behaviour of Beams in flexure- Codal Provisions – Classification of cross sections- Flexural Strength and Lateral stability of Beams – Shear Strength-Web Buckling, Crippling and defection of Beams- Design of laterally supported Beams- Design of solid rolled section Beams- Design of Plated beams with cover plates - Design Strength of Laterally unsupported Beams – Design of laterally unsupported rolled section Beams- Purlin in Roof Trusses-Design of Channel and I section Purlins.

TEXTBOOKS:

1. Subramanian.N, "Design of Steel Structures", Oxford University Press, New Delhi, 2013.
2. Gambhir. M.L., "Fundamentals of Structural Steel Design", McGraw Hill Education India Pvt. Ltd., 2013
3. Duggal. S.K, "Limit State Design of Steel Structures", Tata McGraw Hill Publishing Company, 2005

ONLINE RESOURCES:

- www.nptel.ac.in

CE8601 - DESIGN OF STEEL STRUCTURAL ELEMENTS		
COURSE OUTCOMES		
After successful completion of the course, the students should be able to		
CO NO	Course Outcomes	Highest Cognitive Level
C310.1	Recognize IS codes of practice for the design of steel structural elements.	k2
C310.2	Solve the bolt and welded connections problems	K3
C310.3	Compute tension members using rolled steel sections	k3
C310.4	Summarize compression members using rolled steel sections	K2
C310.5	Compute and design the flexural member as laterally restrained and unrestrained beams	K3

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Introduction

- Steel is by far the most useful material for building structures with strength of approximately ten times that of concrete, steel is the ideal material for modern construction.
- Due to its large strength to weight ratio, steel structures tend to be more economical than concrete structures for tall buildings and large span buildings and bridges.
- Steel structures can be constructed very fast and this enables the structure to be used early thereby leading to overall economy.
- Steel structures are ductile and strong and can withstand severe loadings such as earthquakes.
- Steel structures can be easily repaired and retrofitted to carry higher loads.
- Steel is also a very eco-friendly material and steel structures can be easily dismantled and sold as scrap.
- Thus the lifecycle cost of steel structures, which includes the cost of construction, maintenance, repair and dismantling, can be less than that for concrete structures

- A steel structure, like any other, is an assemblage of a group of members which contribute to resist the total load and thereby transfer the loads safely to ground.
- This consist members subjected to various actions like axial forces (Compression & Tension), bending, shear, torsion etc. or a combination of these.
- The elements are connected together by means of rivets, bolts or welds.
- Depending on the fixity of these joints, the connections are classified as rigid, semi rigid and flexible.

Structural steel types &properties

- **Structural steel** is a category of steel used for making construction materials in a variety of shapes. Many structural steel shapes take the form of an elongated beam having a profile of a specific cross section.
- Structural steel shapes, sizes, chemical composition, mechanical properties such as strengths, storage practices, etc., are regulated by standards in most industrialized countries.
- Most structural steel shapes, such as **I**-beams, have high second moments of area, which means they are very stiff in respect to their cross-sectional area and thus can support a high load without excessive sagging.

Following properties of structural steel are considered before using them for a construction. These properties are useful for determining the quality of steel. High quality steel is used so that dependable and long-lasting construction is possible. The most important components include the following:

Density

Density of a material is defined as mass per unit volume. Structural steel has density of 7.75 to 8.1 g/cm^3.

Elastic Modulus

Elastic modulus or modulus of elasticity is the measurement of tendency of an object to be deformed when force or stress is applied to it. Typical values for structural steel range from 190-210 gigapascals.

Poisson's Ratio

It is the ratio between contraction and elongation of the material. Lower the value, lesser the object will shrink in thickness when stretched. Acceptable values for structural steel are 0.27 to 0.3.

Tensile Strength

Tensile strength of an object is the determination of limit up to which an object can be stretched without breaking. Fracture point is the point at which an object breaks after application of stress. Structural steel has high tensile strength so is preferred over other materials for construction.

Yield Strength

Yield strength or yield point is the stress at which an object deforms permanently. It cannot return to its original shape when stress is removed. Structural steel made of carbon has yield strengths of 187 to 758 megapascals. Structural steel made of alloys has values from 366 to 1793 megapascals.

Melting Point

There is no defined value for melting point due to the wide variations in types of structural steel. Melting point is the temperature at which object starts to melt when heated.

Specific Heat

Specific heat or heat capacity is the amount of heat which needs to be applied to the object to raise its temperature by a given amount. A higher value of specific heat denotes greater insulation ability of the object. Values are measured in Joules per Kilogram Kelvin. Structural steel made of carbon has values from 450 to 2081 and that made from alloys has values ranging from 452 to 1499.

Hardness

Hardness is the resistance of an object to shape change when force is applied. There are 3 types of hardness measurements. Scratch, indentation and rebound. Structural steel made by using alloys has hardness value between 149-627 Kg. Structural steels made of carbon has value of 86 to 388 Kg.

ADVANTAGES OF STEEL

- It has high strength per unit mass
- The size of steel elements are lesser resulting in space savings an aesthetic view
- It has assured quality and high durability
- Speed of Construction
- It can be strengthened any later time.
- Easy dismantling of steel structures is possible (Mainly by using bolted connection)
- The material is reusable
- If the joints are taken care of, it has good resistance against water and gas.

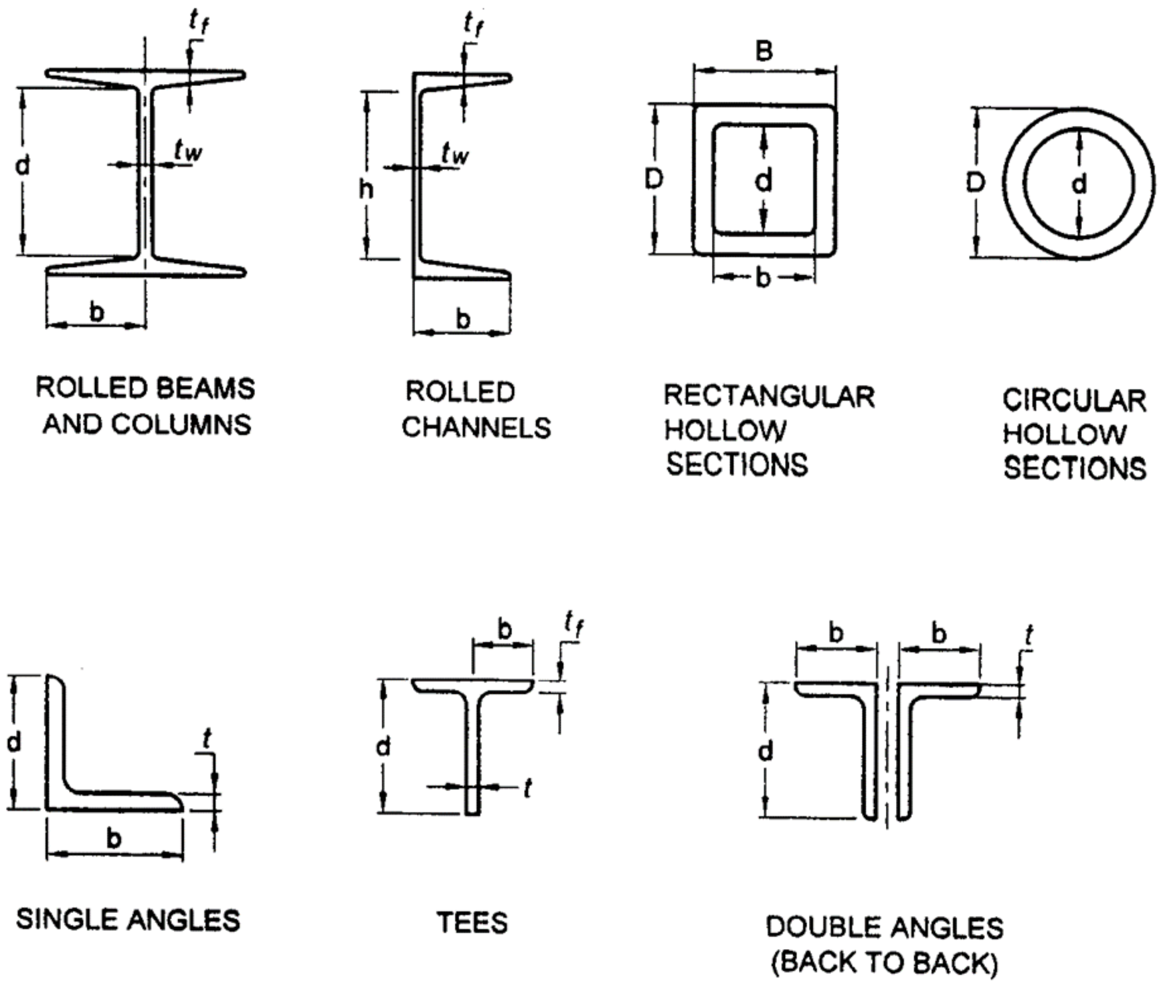
DISADVANTAGES OF STEEL

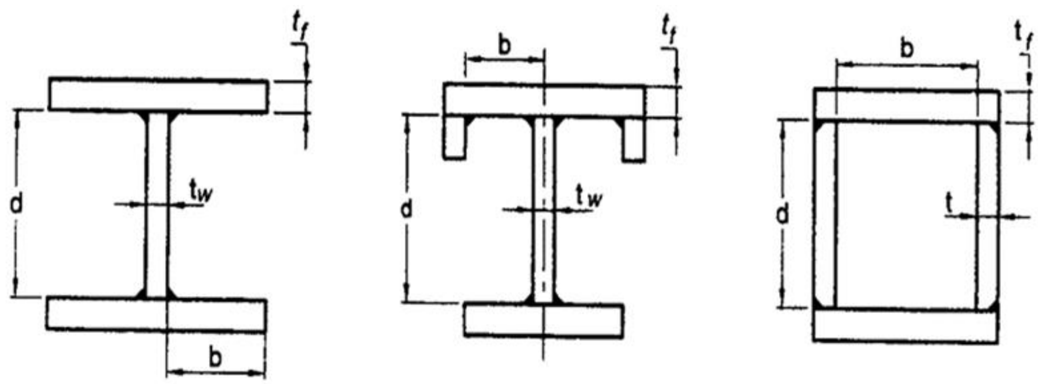
- It is susceptible to corrosion
- Maintenance cost is significant (frequent painting is read to prevent corrosion)
- Steel members are costly (Initial cost)

Examples of Steel structures in Practice

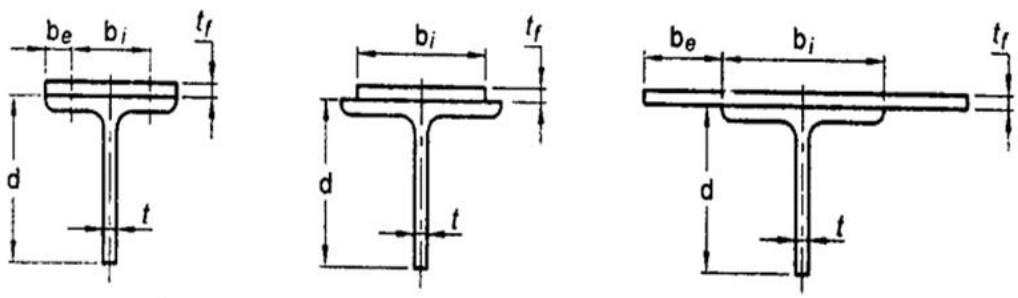
Structural steel sections has been classified by Indian standard based on its ultimate strength

1. Rolled steel section
2. Built up section





BUILT-UP SECTIONS



COMPOUND ELEMENTS

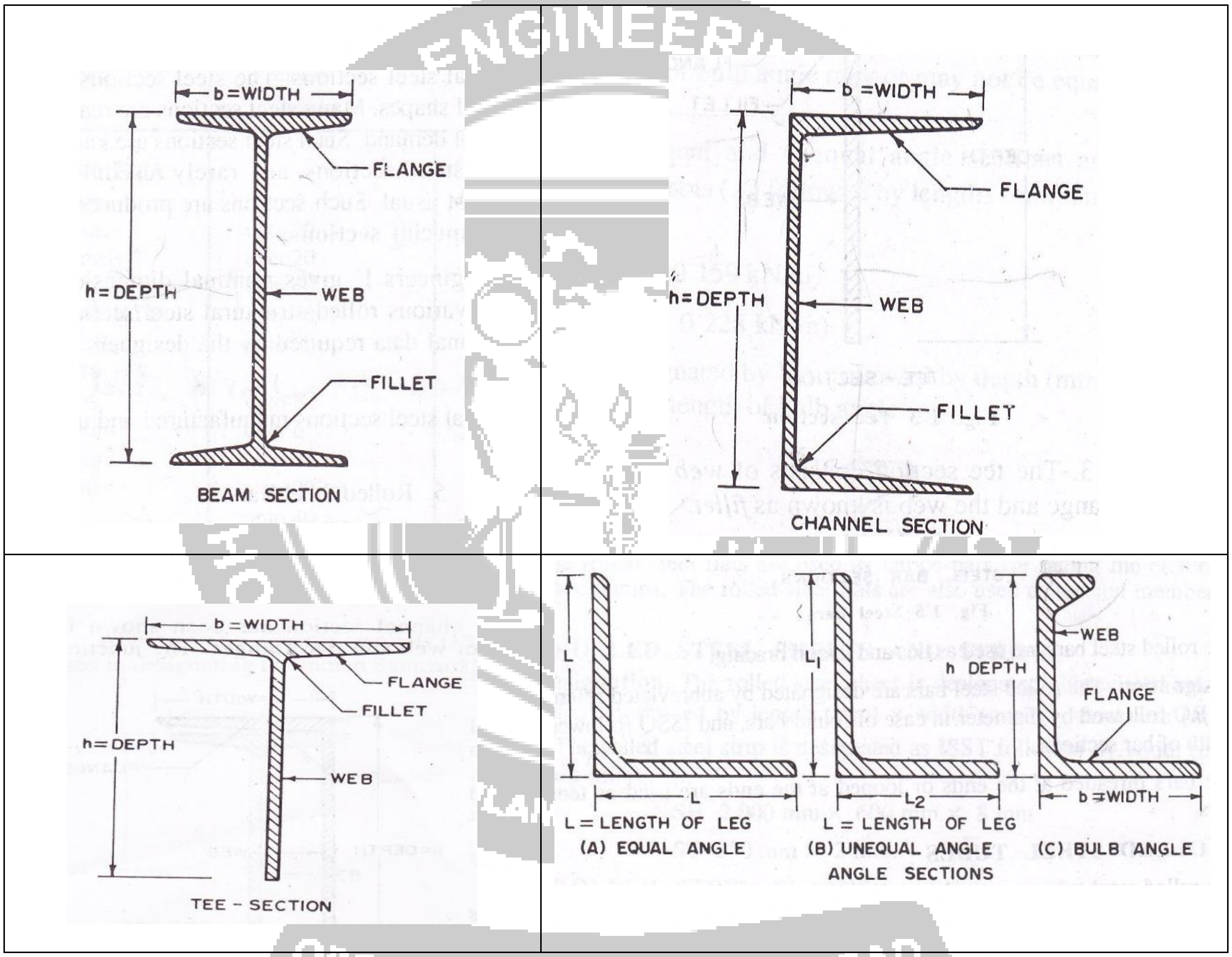
b_i — Internal Element Width

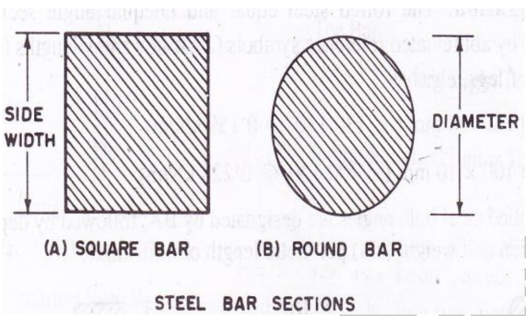
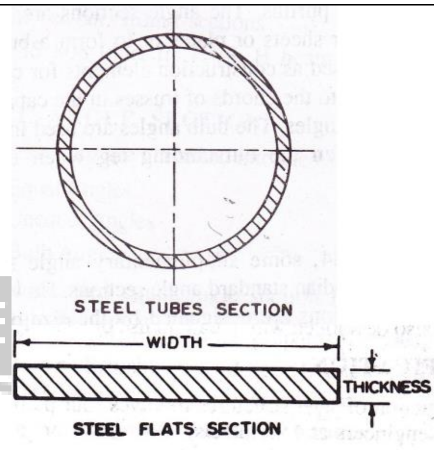
b_e — External Element Width

RECENT DEVELOPMENTS IN SECTIONS

The rolled steel beam sections with parallel faces of flanges are recently developed. These beam sections are called as parallel flange sections. These sections have increased moment of inertia, section modulus and radius of gyration about the weak axis. Such sections used as beams and columns have more stability. Theses sections possess ease of connections to other sections as no packing is needed as in beams of slopping flanges. The parallel flange beam sections are not yet rolled in our country.

New welded sections using plates and other steel sections are developed because of welding. The development of beams with tapered flanges and tapered depths is also due to welding. The open web sections and the castellated beams were also developed with the rapid use of welding.



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
- Ductility
- Weldability
- Durability.

The mechanical properties of structural steel is w.r.to the yield stress & ultimate stress of the steel sections conforming to IS 2062.

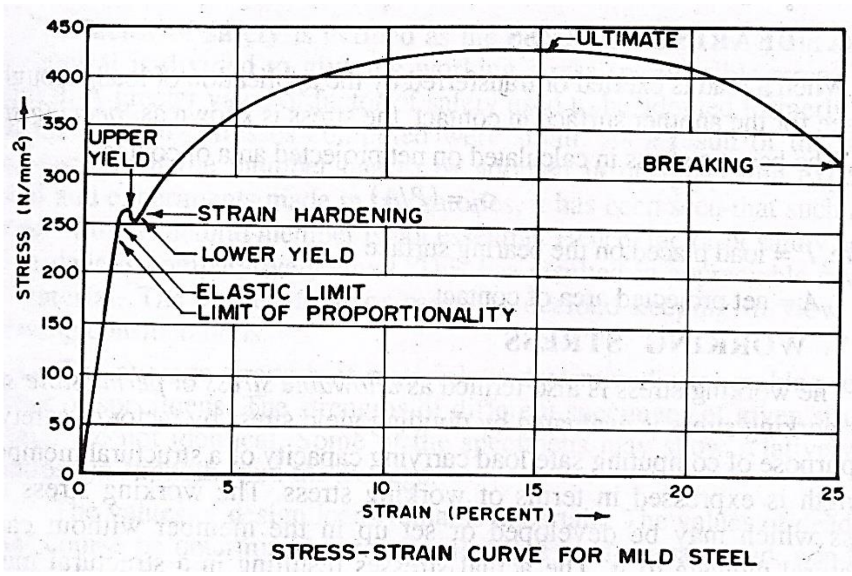
Ex: E250 grade of steel - yield stress 250 N/mm^2

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

Stress Strain Curve for mild steel:

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.



From the diagram one can see the different mark points on the curve. It is because, when a ductile material like mild steel is subjected to tensile test, then it passes various stages before fracture.These stages are;

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 material takes place at this point. The point E is the breaking point in the graph.