

SUBJECT - DESIGN OF STEEL STRUCTURES

Course Name : Civil Engineering
Course Code : CE / CS / CR / CV
Semester / Year : Fifth for CE/CS/CR
Subject Title : **Design of Steel Structures**
Subject Code :

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	Paper Hrs.	TH	PR	OR	TW	Total
03	-	02	04	100	-	-	50 @	150

- External

@ - Internal

* On Line Examination

Note:-

- 1) Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
- 2) Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head sessional work (SW).

RATIONALE:

Design of Steel Structures is a technological subject. Steel is commonly used as a construction material for various steel structures such as steel girders, steel bridges, steel trusses, columns, towers, gantry girders, chimney, railway bridges, industrial buildings, water tanks, etc. For the design of steel structures, the properties of steel, different steel sections, various grades and strength characteristics of steel are required. The analysis and design of the steel members in the curriculum is to be done as per IS:800-2007.

The topic on different types of loads will be useful for finding different stresses, members and then deciding the section for the members of the structures. The topic on design of joints will be useful for designing bolted and welded connections. The topic on design of tension and compression members will be useful for the design of relevant members in roof trusses.

The topic on design of beams, columns with column bases and steel roof truss will be useful for the complete design of steel structure.

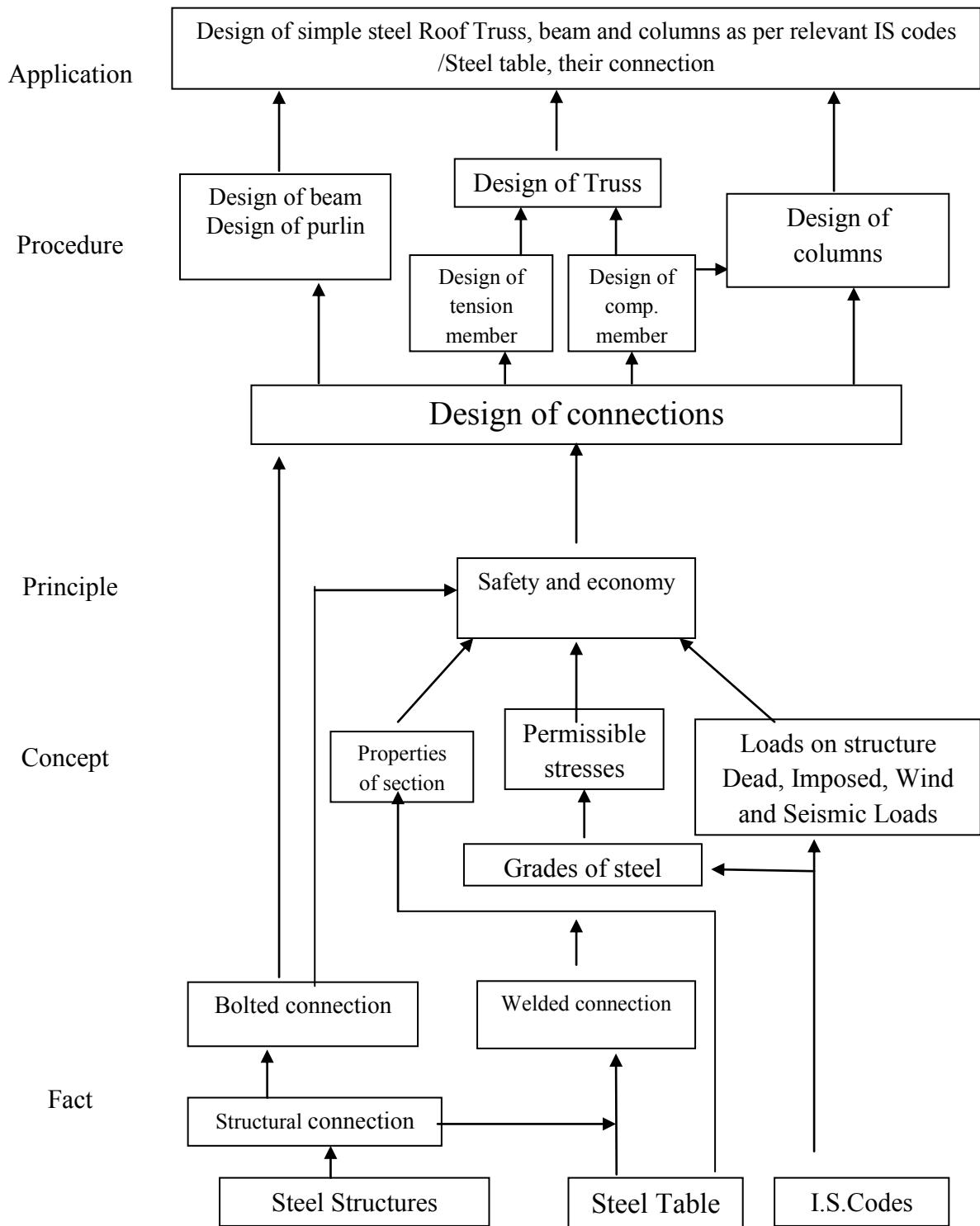
The total content of this subject will be useful for developing insight for the design concepts and will help student in effective supervision and quality control on site.

GENERAL OBJECTIVES:-

Students will be able to:-

- 1) Understand the analysis of forces acting on different members and select proper material and sections from steel table.
- 2) Understand the design of tension members, compression members, beams, purlins, column bases and steel roof trusses and understand design values for members using IS 800-2007.
- 3) Understand and interpret the fabrication drawings and structural drawings.
- 4) Understand the drawings of designed sections of steel roof truss and its connections.
- 5) Understand the use of IS 875-1987 part I to IV, provisions for dead loads, live loads and wind loads and seismic loads (Earthquake loads)

Learning structure:



CONTENTS: - THEORY

Topic and contents	Hours	Marks
<p>Topic:1 Introduction Specific Objectives –</p> <ul style="list-style-type: none"> ➤ State various grades of steel and their strength parameters ➤ List various properties of steel sections used for steel structures. ➤ Use steel table and IS code for finding different properties of steel sections. <p>Contents :</p> <ul style="list-style-type: none"> • Advantages and disadvantages of steel as construction material. <ul style="list-style-type: none"> • Overview of common steel structures : Functions and components of common steel structures like steel towers, roof trusses, steel water tanks, steel bridges, gantry and crane girders, steel columns, steel chimney, building frames • Types of sections used, Grades of steel and strength Characteristics use of steel table IS 808-1989. Typical stress-strain graph for mild steel and salient points in it • Types of loads coming on steel structures according to IS 875-1987 part I to IV a) Dead loads b) Live loads c) Impact load d) Snow loads • Loads due to seismic forces - Definition, Methods of calculating seismic forces (IS 1893-2002), Zone factor (Z), Importance factor (I), Response reduction factor (R), Fundamental natural period (T). (No numerical problems) • Methods of Design : Working stress method, Limit State Method. • Introduction to Limit State Method of design : Meaning and types of limit states, loads, design criteria, limit states of strength, limit states of serviceability. Factors of safety and load factors. 	03	08

<p>Topic 2 Joints in Steel Structures (Limit State Method) :-</p> <p>Specific Objectives :-</p> <ul style="list-style-type: none"> ➤ State types of steel joints and their modes of failure. ➤ Design bolted and welded steel joints. <p>Content :-</p> <p>a) Bolted connections :</p> <ul style="list-style-type: none"> • Type of bolts : Black bolts and High strength bolts and their use. Types of joints and failure modes. Specifications for cross-sectional area, pitch, spacing, gauge, end distance, edge distance, bolt holes for bolted connections • Design strength of bolt in shear, tension and bearing • Analysis and design of bolted joints for axially loaded single and double angle members • Diagrams of beam-to-beam and beam-to-column bolted connections (No numerical problems) <p>b) Welded connections :</p> <ul style="list-style-type: none"> • Introduction and types of welds – butt and fillet. Advantages and disadvantages of welded connections, size of weld, throat thickness • Analysis and design of welded joint (only fillet weld) for single and double angle members subjected to axial load 	06	16
<p>Topic 3 Design of Tension Members (Limit State Method)</p> <p>Specific Objectives :</p> <ul style="list-style-type: none"> ➤ State different types of tension members. ➤ List types of steel sections used for tension members. ➤ Analyze and design tension member connected by bolted and welded joints <p>Contents :-</p> <ul style="list-style-type: none"> • Design of Tension Members: Types of sections used. Design strength governed by yielding of section, rupture of net cross-section and block shear. • Analysis and design of axially loaded single angle and double angle tension members with bolted and welded connections. 	08	16
<p>Topic 4 Design of Compression Members (Limit State Method)</p> <p>Specific Objectives :-</p> <ul style="list-style-type: none"> ➤ State different types of steel sections used for compression members ➤ Analyze and design compression member connected by bolted and welded joints <p>Contents :-</p> <ul style="list-style-type: none"> • Types of steel sections used for compression members, effective length, radius of gyration, slenderness ratio and its limits, design compressive stress. • Analysis and design of axially loaded continuous angle struts connected by bolted and welded connections with gusset plate. Limits of width to thickness ratios to prevent local buckling. • Stanchions and columns – Meaning and diagrams of simple and built-up sections (two angles, two I-sections, two channels placed back to back and toe to toe). No numerical problems. 	08	16

<ul style="list-style-type: none"> • Introduction to lacing and battening: Meaning and purpose. Diagrams of single and double lacing and battening system. No design. 		
<p>Topic 5 Beams (Limit State Method)</p> <p>Specific Objectives :-</p> <ul style="list-style-type: none"> ➤ List different sections used for beams. ➤ Draw loading, shear force and bending moment diagram developed in beam due to udl ➤ Analyze and design of simple beam sections subjected to udl <p>Contents :-</p> <ul style="list-style-type: none"> • Different steel sections used for beams, simple and built-up sections. • Meaning of Plastic (Class-1), Compact (Class -2), Semi-compact (Class-3) and Slender (Class-4 sections). • Flexural analysis and design of simple beams (only for Class-4 sections) which are laterally supported and subjected to uniformly distributed load • Check for shear and deflections : Meaning and purpose. Diagrams of typical cross sections of bolted and welded plate girder. Diagrams showing components of plate girder. 	06	12
<p>Topic 6 Column Bases (Limit State Method)</p> <p>Specific Objectives :-</p> <ul style="list-style-type: none"> ➤ Draw components parts of steel foundations. ➤ Draw the sketch of slab base and gusseted base foundations ➤ Analysis and design slab base foundation. <p>Content :-</p> <ul style="list-style-type: none"> • Types of steel foundations- Slab Base foundations, Gusseted base foundations • Design of Slab base foundations • Introduction to Gusseted base Foundations: Meaning and purpose. No numerical problems on design of gusseted base foundations. 	06	12
<p>Topic 7 Steel Roof Truss (Limit State Method)</p> <p>Specific Objectives :-</p> <ul style="list-style-type: none"> ➤ List types of Steel Roof trusses used in Industries. Analyze and design component parts of Steel Roof truss. ➤ Calculate dead load, live load and wind load acting on steel roof truss. ➤ Draw the detailed connections of different members at nodal points, connections at column supports. <p>Contents :-</p> <ul style="list-style-type: none"> • Types of Steel Roof trusses for different spans (Simple and Compound Fink, Pratt, Howe, Fan, North Light roof truss) • Calculation of panel point loads for dead load, live load and wind load as per IS 875-1987. • Graphical method of finding forces in different members of truss due to dead load, live load and wind load • Force combination table, design of members of truss. • Design of angle purlin as per IS recommendations. • Arrangement of members at supports and at joints. 	11	20

TOTAL	48	100
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PRACTICALS:

Skills to be developed

Intellectual Skills :

- i) Design of structural components of steel structures.
- ii) Interpretation of structural drawings for the components designed.

Motor Skills :

- i) Preparing structural drawings for execution of steel structures.

Term work is to be prepared by each student as below.

Term work shall consist of sketchbook and design report of steel roof truss for an industrial building, two full imperial size sheet shall be used for drawings.

1. Sketch Book :-

Sketch book shall consist of any eight plates out of the below mentioned.

- 1) Types of steel sections (like angles, channels, girders, plates, etc)
- 2) Sketches of different types of built up sections used as tension and compression members.
- 3) Types of trusses for different span.
- 4) Lap bolted joint and butt bolted joint, bolt failure in single and double shear.
- 5) Gusseted base foundation,
- 6) Slab base foundation
- 7) Connections of beam to beam and beam to column.(Framed and seated connections using bolts and welds)
- 8) Cross section of bolted and welded plate girder, sketch of end bearing stiffener.
- 9) Lacing and Battening (Single and double Lacing system)
- 10) Effective length of compression members for different end connections.

2. Design of steel Roof truss:-

- 1) The student should draw two full imperial size sheets covering design of steel roof truss any one of the truss- Fink, Pratt, Fan, Howe truss for span 16 to 20 m , the design shall cover

calculations for the dead load, live load, wind load with a design of various elements. The drawing shall include detailing the truss for below mentioned elements

- a) Key plan showing the details of factory shed.
- b) Graphical analysis of loads due to dead load live load and wind load.
- c) Half section of designed roof truss showing details –
Support connection, connection of ridge tile, connection of purlin, roof covering and cleat angle.

Learning Resources:

1. Books

Sr. No.	Author	Title	Publisher
1	Dr.V.L.Shah and Mrs. Veena Gore	Limit State Design of Steel Structures	Structures Publications, Pune
2	Dr. M. R. Shiyekar	Limit state design of steel structures	PHI Learning
3	P Dayarathnam	Design of steel structures	S. Chand and Company
4	Ghose	Analysis and Design practices of Steel Structures	PHI Learning
5	Sairam	Design of steel structures	Pearson publication.

2. IS, BIS and International code

1. IS800-2007 Indian Standard code of practice for use of structural steel in general building construction, BIS New Delhi.
2. IS-875-1987 Part-1 to 5 : Indian Standard Code for Loading Standards
3. IS hand book No. 1 Properties of structural steel rolled section.
4. Steel tables