

Techno India NJR Institute of Technology



Course File

Design of Steel Structures (6CE4-04)

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Department of CE

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

3rd Year - VI Semester: B.Tech. (Civil Engineering)

6CE-04: DESIGN OF STEEL STRUCTURES

Credit: 3

Max. Marks: 150(IA:30, ETE:120)

3L+0T+0P

End Term Exam: 3 Hours

SN	CONTENTS	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Types of Steels and their broad specifications. Structural steel forms- hot rolled, tubular, light gauge etc and their applicability. Classification of cross sections as per IS 800-2007- Plastic, compact, semi compact and slender- characteristics	2
3	Plastic analysis of steel structures, fundamentals, shape factor, static and mechanism method of analysis, bending of beams of uniform cross sections (any shape)	3
4	Connections: Types of bolts, load transfer mechanism, prying action. Design of bolted and welded connections under axial and eccentric loadings with IS provisions	3
5	Tension Members: Design strength in gross section yielding, net section rupture and block shear. Design of axially loaded members.	3
6	Compression Members: Types of buckling, Imperfection factor, Buckling curves for different cross sections as per IS. Design of compression members: Axially loaded members including made up of angle section: single and in pair; built up columns including design of lacings and battens as per IS.	6
7	Beams: Design of beams: simple and compound sections. Design of laterally supported and unsupported beams including for web buckling, web crippling, lateral torsional buckling.	6
8	Member design under combined forces: Compressive load and uniaxial moment. tension and uniaxial moment	3
9	Column Bases: Design of column bases for axial and eccentric compressive loads: Slab and gusseted base.	2

Office of Dean Academic Affairs
Rajasthan Technical University, Kota

Syllabus of 3rd Year B. Tech. (CE) for students admitted in Session 2017-18 onwards.

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Syllabus

3rd Year - VI Semester: B.Tech. (Civil Engineering)

10	Design of plate girder: Design of welded and bolted sections including web and flange splicing, horizontal, intermediate and bearing stiffeners. Shear strength determination by post critical and tension field action methods. End panel design options and procedure as per IS 800. Curtailment of flange plates. Connections for flange plate to flange angles and flange angles to web, etc. Design of welded connections	7
11	Design of gantry girder	2
12	Design of roof trusses members for combined forces, wind loading etc. Purlin design	2
13	Introduction to Prefabricated Buildings, characteristics and their application	1
14	Introduction of truss girder bridges-its members including portal and sway bracings etc. Design aspects of foot over bridges.	1
	TOTAL	42

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Course Overview:

Student will learn basics of DSS from these 40 hours course. The subject has the significance to understand the types of structural steel members. Students will be able to analyse the structural behaviour and design under the different loading like Gravity forces, lateral forces (wind & seismic loads), temperature effects, vibrations etc. Students will learn about the types of structural steel elements as connections, tension and compression members, members subjected to bending or beams, roof truss, steel bridges, steel tanks etc. with correlating to Indian standards.

DSS is the main requirement for the job role in the companies like Tata Steel, Jindal steel & Power Ltd, L&T construction etc. Most of the questions asked during the placement drive for these Company are created from this subject. Student should learn and develop problem solving abilities using DSS in order to get a good job in top civil engineering company.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Comprehension	Learner will be able to solve the designing of tension and compression members.
2	Analysis	Learner will be able to solve the designing of beams and beam columns.
3	Synthesis	Learner will be able to solve the designing of bolt and weld connections.
4	Synthesis	Learner will be able to solve the designing of the gantry girder.
5	Synthesis	Classify and design the structural steel components of industrial building.

Prerequisites:

- Students will be able to Understand the basic elements of steel structure and its components.
- Students will be able to Understand the fundamentals of structural steel fasteners (connections) and design of riveted and welded connections.
- Students be able to design basic element of a structure like tension member and compression member.
- Students be able to design the laterally supported and laterally unsupported beams.
- Students be able to design a Gantry Girder and Plate Girder to be used in the industrial buildings to carry heavy loads to from cranes and gantry rails.

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Course Outcome Mapping with Program Outcome:

DESIGN OF STEEL STRUCTURES															
Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO364.1	3	3	3	3	2	2	2	1	1	1	2	3	2	1	1
CO364.2	3	2	2	3	2	1	2	1	1	1	1	1	2	1	1
CO364.3	2	2	2	1	2	2	2	2	1	1	2	1	2	1	1
CO364.4	3	2	2	2	2	2	1	1	2	1	2	2	2	1	1
CO364.5	3	3	3	32	1	2	1	1	1	1	2	2	2	1	1
CO364 (AVG)	2.8	2.4	2.4	8.2	1.8	1.8	1.6	1.2	1.2	1	1.8	1.8	2	1	1

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	1	Introduction: Objective, scope and outcome of the course
2	2	Student should be able to understand about types of steel and their broad specifications. Also, Structural steel forms- hotrolled, tubular, light gauge etc.
3	2	Student should be able to identify the classification of cross sections as per IS 800-2007- Plastic, compact, semi compact and slender- characteristics
4	3	Plastic analysis of steel structures
5	3	Student should be able to analyze Shape factor for different shapes of elements
6	3	Student should be able to understand Static and mechanism method of analysis
7	3	Student should be able to analyze beams, using method of analysis
8	3	Student should be able to analyze beams, using method of analysis
9	3	Student should be able to calculate bending of beams of uniform cross sections (any shape)
10	4	Connections: Student should be able to understand Types of bolts, load transfer mechanism, prying action
11	4	Student should be able to design of bolted connection under axial & eccentric loadings
12	4	Student should be able to design of welded connection under axial & eccentric loadings

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13	5	Tension Members. Student should be able to design of strength in gross section yielding
14	5	Student should be able to design of section rupture and block shear strength
15	5	Student should be able to design of axially loaded members
16	6	Compression Members: Student should be able to understand behavior of compressive members, buckling forms, Imperfection factor, buckling curves for different cross sections as per IS codes
17	6	Student should be able to design of compression members: Axially loaded columns
18	6	Student should be able to design of compression members: Axially loaded columns
19	6	Student should be able to design Built up columns including design of lacings and battens as per IS
20	6	Student should be able to design Built up columns including design of lacings and battens as per IS
21	7	Beams or Flexural Members Student should be able to understand the behavior of flexural members and boundary conditions.
22	7	Student should be able to design of beams: simple and compound sections
23	7	Student should be able to design of laterally supported and unsupported beams
24	7	Student should be able to design of laterally supported and unsupported beams
25	7	Students should able to define the failure mode of beams as Web crippling, lateral torsional buckling
26	8	Member design under combined forces: Students should able to compute Compressive load and Uniaxial moment
27	8	Students should able to analyze Compressive load and Uniaxial moment
28	9	column bases: Student should be able to classify column bases for axial and eccentric compressive loads: slab and gusseted base
29	9	Student should be able to design of slab base
30	9	Student should be able to design of gusseted base
31	10	Design of plate girder: Student should be able to design of welded and bolted sections including web and flange splicing
32	10	Student should be able to design of plate girder

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33	10	Student should be able to design of plate girder
34	10	Student should be able locate Curtailment of flange plates and design of connections for flange plate to flange angles and flange angles to web
35	11	Design of gantry girder: Students should able to compute horizontal, vertical, impact and surge load
36	12	Student should be able to design of Gantry Girder
37	12	Design of roof trusses members: Students should able to compute combined forces, wind loading
38	12	Student should be able to design of Purlins
39	13	Introduction to Pre-Engineered Buildings
40	14	Introduction of truss girder bridges-its members including portal and sway bracings etc.

TEXT/REFERENCE BOOKS

1. Design of Steel Structures by S.K. Duggal, TMH Publication
2. Design of Steel structures by S. S. Bhavikatti, I.K. International Pvt. Ltd.
3. Design of Steel Structures by Dr. B.C Punmia , Lakshmi Publication (P) Ltd.
4. Design of Steel Structures (By Limit state method as per IS 800:2007 by Dr. N.R. Chandak, S.K. Kataria & Sons

Course Level Problems (Test Items):

CO.NO.	Problem description
1	A. Explain shape factor and its applications. Find the shape factor of a Diamond B. Discuss the design philosophy to identify limit state method of designing of steel structural members. C. Explain the classification of cross sections as per IS 800-2007.
2	A. Describe the static and mechanism methods to compute plastic moment. B. Discuss bending theory of beam to compute ultimate plastic moment.
3	A. Write design steps of bolted connection to calculate efficiency of bolted connection. B. Write design steps of welded connection to calculate efficiency of bolted connection. C. Discuss the failure modes of tension member and compression members to identify its structural behaviour. D. Design a tension and compression member using IS 800:2007.

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4	<p>A. Write a brief comparison of laterally supported and unsupported beams.</p> <p>B. Define web crippling and web buckling to understand the concept of failure of beams.</p> <p>C. Design a laterally unsupported beams by using design curves as per IS 800:2007</p>
5	<p>A. Explain the concept of gantry girder in industrial building.</p> <p>B. Find the value of horizontal, vertical and surge forces on gantry girder.</p> <p>C. Design steps of welded plate girder and write the types of stiffeners.</p>

Assessment Methodology:

1. Practical exam in lab where they have to analyze the problem statement. (Once in a week)
2. Assignments one from each unit.
3. Midterm subjective paper based on topics as mentioned in the modules. (Twice during the semester)
4. Final paper at the end of the semester subjective.

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TEACHING AND LEARNING RESOURCES UNIT-WISE

1) INTRODUCTION TO STRUCTURAL STEEL SECTION AND DESIGN PHILOSOPHY

VideoTutorials:

<https://www.youtube.com/watch?v=CqdKcPMVC28>

<https://www.youtube.com/watch?v=pO3SXqarIHw>

https://www.youtube.com/watch?v=x291kIVq-ao&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=6

Theory concepts:

https://drive.google.com/drive/u/0/folders/1d99FJrMxJV_D0qeEhs_ee1M-ePf_330M

Sample Quiz:

<https://amon.in/quiz/design-steel-structures-limit-state-method>

<https://www.sanfoundry.com/design-steel-structures-questions-answers-limit-state-method/>

2) PLASTIC ANALYSIS OF STEEL STRUCTURES

VideoTutorials:

https://www.youtube.com/watch?v=HJVegAjHPu4&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc

https://www.youtube.com/watch?v=m7u2x5xgySQ&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=2

https://www.youtube.com/watch?v=u6aopwbdwxY&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=3

Theory concepts:

https://drive.google.com/drive/u/0/folders/1d99FJrMxJV_D0qeEhs_ee1M-ePf_330M

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Plastic-Analysis-1/1f16b5fa-147c-4314-8a4f-f3ede77fab11

3) INTRODUCTION OF CONNECTIONS:

Video Tutorials:

https://www.youtube.com/watch?v=8IsnrpNzcF8&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=7

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https://www.youtube.com/watch?v=uANirTSfaD8&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=8

https://www.youtube.com/watch?v=XROv1xoLrKM&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=10

https://www.youtube.com/watch?v=uEpRXfmI9iM&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=11

https://www.youtube.com/watch?v=Cgu1ZripS5U&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=14

https://www.youtube.com/watch?v=KLUW6E8sRo0&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=15

Theory concepts:

https://drive.google.com/drive/u/0/folders/1rFpUwNSWovyL_xTxqvzKD-8JYcPNvd0N

<https://nptel.ac.in/courses/105/106/105106112/>

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Structural-Fasteners-1/562d0da9-50fd-4cf5-b80e-fc15950a2230

https://edurev.in/course/quiz/attempt/-1_Test-Structural-Fasteners-2/222d6e37-953a-4e82-bd2c-e6f19cbeb75e

4) TENSION MEMBERS:

Video Tutorials:

https://www.youtube.com/watch?v=6c74vHH6nDw&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=18

https://www.youtube.com/watch?v=IEJN3JJeIQ4&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=19

https://www.youtube.com/watch?v=m7tybwu0znk&list=PLSNhedsleX1335_jU9sx8sW7_LcMW4EZc&index=20

https://www.youtube.com/watch?v=vHRx_eO70FQ&list=PL2TmfDOSn86-v4hnd3ckvv3nt_5QqaF1&index=5

Theory concepts:

https://drive.google.com/drive/u/0/folders/1rFpUwNSWovyL_xTxqvzKD-8JYcPNvd0N

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<https://nptel.ac.in/courses/105/106/105106112/>

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Tension-Members-1/08c0f958-997b-46a2-878d-c3fa869c5711

https://edurev.in/course/quiz/attempt/-1_Test-Tension-Members-2/2273b51c-5593-4168-a823-f31045ee5996

5) COMPRESSION MEMBERS:

Video Tutorials:

<https://www.youtube.com/watch?v=q4LWncvEQv4>

https://www.youtube.com/watch?v=USS21sWd0WE&list=PL2TmfDOSn86-v4hnid3ckvv3nt_5QqaF1&index=8

Theory concepts:

<https://drive.google.com/drive/u/0/folders/1qNDOH3a5ZB55MmZycjnOp5JfBnPeNQrT>

<https://nptel.ac.in/courses/105/106/105106112/>

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Compression-Members-1/91b09166-74f0-46f8-9bf0-92bbdb90afb3

https://edurev.in/course/quiz/attempt/-1_Test-Compression-Members-2/795f3c08-88fc-4e4b-a8ac-2eed4bff40b

https://edurev.in/course/quiz/attempt/-1_Test-Compression-Members-3/dfbafde6-e7d0-4500-b63a-e6fada3f58ed

6) BEAMS OR FLEXURE MEMEBERS:

Video Tutorials:

<https://www.youtube.com/watch?v=bGIIGaoKI7A>

<https://www.youtube.com/watch?v=gWy3ovNXtuk&t=86s>

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<https://www.youtube.com/watch?v=D3isrefgYZY>

<https://nptel.ac.in/courses/105/105/105105162/>

Theory concepts:

<https://drive.google.com/drive/u/0/folders/13xhh4GTTtyEgti3hLhJEPzGW4Bq-ED->

<https://nptel.ac.in/courses/105/106/105106112/>

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Beams-1/76c8388c-ead4-4c90-9162-39ebf218d5b0

https://edurev.in/course/quiz/attempt/-1_Test-Beams-2/741c24b0-4d69-4142-baca-d533b816d1c7

7) COLUMN BASE

Video Tutorials:

<https://www.youtube.com/watch?v=tTEZpElnIfg>

<https://www.youtube.com/watch?v=ybyHz6M-r9Y>

<https://www.youtube.com/watch?v=8SR70c6uX3A>

Theory concepts:

https://drive.google.com/drive/u/0/folders/1o2IIFd4WZLweYTdnWkcK4n1p0_5wcfJ

<https://nptel.ac.in/courses/105/106/105106112/>

<https://nptel.ac.in/courses/105/105/105105162/>

Sample Quiz:

https://nptel.ac.in/content/storage2/courses/downloads_new/105105162/Week_12_Assignment_12.pdf

8) PLATE GIRDER

Video Tutorials:

https://www.youtube.com/watch?v=4-v_1GDe60Y&t=1030s

<https://www.youtube.com/watch?v=158a061c2BA&t=693s>

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<https://www.youtube.com/watch?v=Tj8Xzt-tku0>

Theory concepts:

<https://drive.google.com/drive/u/0/folders/1T3tA8k8iU7GE8HjngCp0sTMbOPd0gw-K>

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Plate-Girders-1/69359dd4-27e8-4f08-9898-8b76aa7964cf

https://edurev.in/course/quiz/attempt/-1_Test-Plate-Girders-2/c627d4e4-3ed6-494e-ba6a-66f3802aec37

9) GANTRY GIRDER

Video Tutorials:

https://www.youtube.com/watch?v=JPeN7xV0-fk&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt

https://www.youtube.com/watch?v=ONC4c60a1-k&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt&index=2

Theory concepts:

<https://drive.google.com/drive/u/0/folders/1T3tA8k8iU7GE8HjngCp0sTMbOPd0gw-K>

Sample Quiz:

<https://testbook.com/objective-questions/mcq-on-gantry-girder--5eea6a0b39140f30f369dd89>

<https://www.madeeasy.in/uploads/examsolution/StructuralSteelDesign.pdf>

10) DESIGN OF ROOF TRUSSES MEMBERS

Video Tutorials:

https://www.youtube.com/watch?v=Pwm-qxmIO5I&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt&index=3

https://www.youtube.com/watch?v=9RMa3kcoOkU&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt&index=4

https://www.youtube.com/watch?v=HPC9SeKV1Uw&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt&index=5

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Theory concepts:

<https://drive.google.com/drive/u/0/folders/1T3tA8k8iU7GE8HjngCp0sTMbOPd0gw-K>

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Industrial-Roofs-1/398467b1-f3be-4b28-8262-edc5c25c8a71

https://edurev.in/course/quiz/attempt/-1_Test-Industrial-Roofs-2/894b8fad-eb50-42b7-b2c0-f44f0bd9fdb4

11) INTRODUCTION TO PRE-ENGINEERED BUILDING AND TRUSS GIRDER BRIDGES

Video Tutorials:

https://www.youtube.com/watch?v=Pwm-qxmIO5I&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt&index=3

https://www.youtube.com/watch?v=9RMa3kcoOkU&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt&index=4

https://www.youtube.com/watch?v=HPC9SeKV1Uw&list=PL5DYIL_VeL0v9SXHRp-aUAriiwR3ypTOt&index=5

Theory concepts:

<https://drive.google.com/drive/u/0/folders/1T3tA8k8iU7GE8HjngCp0sTMbOPd0gw-K>

Sample Quiz:

https://edurev.in/course/quiz/attempt/-1_Test-Industrial-Roofs-1/398467b1-f3be-4b28-8262-edc5c25c8a71

https://edurev.in/course/quiz/attempt/-1_Test-Industrial-Roofs-2/894b8fad-eb50-42b7-b2c0-f44f0bd9fdb4

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Previous Year Question Papers:

7005318

7E7062	Roll No.	[Total No. of Pages : 4]
	7E7062	
B.Tech VII Semester (Main/Back) Examination, November - 2019		
Civil Engg.		
7CE2A Design of Steel Structures - I		

Time : 3 Hours

Maximum Marks : 80
Min. Passing Marks : 26

Instructions to Candidates:

Attempt any five questions, selecting one question from each unit. All questions carry equal marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205).

1. IS 800-2007
2. Steel Tables

Unit - I

1. a) Discuss briefly types of steels used in structures. (4)
b) How a cross section is classified as per the code? Briefly state their characteristics. (4)
c) Using kinematical method or otherwise compute the collapse load for the beam shown in fig. 1. (8)

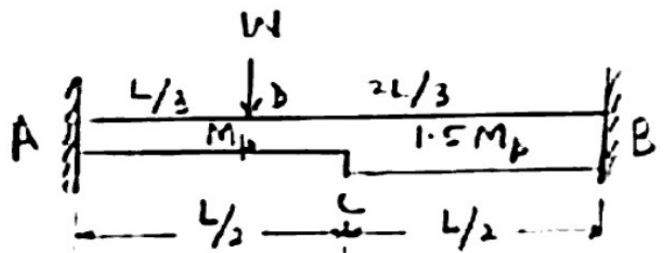


Fig. - 1

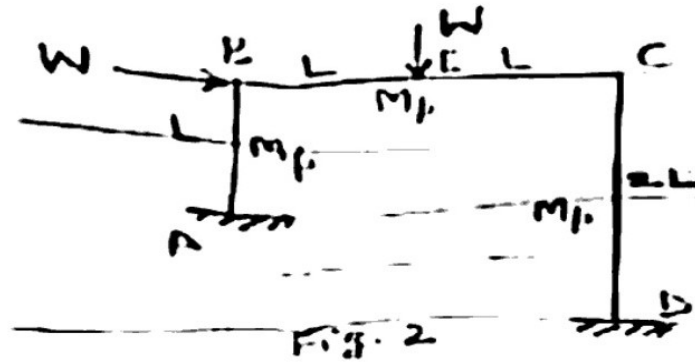
7E7062/2019

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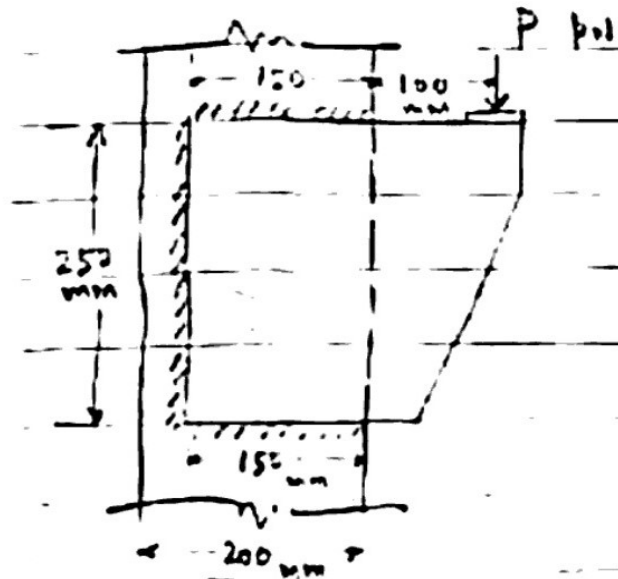
[Contd....

- OR
1. a) Calculate the shape factor for a diamond section. (4)
- b) A portal frame is loaded as shown in Fig. 2. Compute the true value of collapse load. (12)



Unit - II

2. a) Calculate the strength of a 20 mm diameter bolt of grade 4.6 to be used in a lap joint. The main plates are 12 mm thick each. (4)
- b) Fig. 3 shows an eccentrically loaded fillet weld connection. Calculate the maximum value of factored load P to be applied as shown so that the connection is safe. The weld sized throughout is 6 mm. (12)



7E7062

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OR

2. a) Briefly explain 'prying action' in bolted connection. (4)
- b) Design a single angle section for a tension member to carry a factored axial load of 200 kN. Use unequal angle and 18 mm. bolts. (12)

Unit - III

3. a) What are buckling classes and how do they affect compressive carrying capacity of columns? (6)
- b) An angle section ISA 100-75-10 has been used in a steel roof truss as a strut. Find the maximum factored axial load which it can take safely. The length between centres of connections may be taken as 1.5 m. (10)

OR

3. Design a built up column taking two channels placed face to face, to carry an axial compressive load of 1300 kN. the height of the column is 3.5 m and is hinged at both ends. Also design a single system of lacings for the column. (16)

Unit - IV

4. a) What is 'lateral torsional buckling' with reference to a beam design. (4)
- b) A beam of span 4.0 m is simply supported at the ends. It carries a super imposed load of 20 kN/m over the whole length. Design a suitable I section for the beam if it is laterally supported. (12)

OR

4. a) Differentiate between "web buckling" and "web crippling" in a beam design. (6)
- b) A simply supported beam of span 5 m consists of a section ISI. B 450 @ 65.26 kg/m. The compression flange of the beam is laterally unrestrained. Determine the design moment of the beam. Also calculate maximum u.d.l. which it can carry safely. (10)

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[Contd....

- Unit - V
5. a) Write a brief note on slab base for a column. (4)
- b) A column ISHB 250 @ 54.72 kg/m has a length 4.0 m. It is subjected to an axial load of 800 kN and a moment of 30 kN · m about x - x axis. Taking $K = 0.85$, determine whether the section is safe? (12)

OR

5. Design a two tier grillage foundation for a column consisting of section ISHB 400 @ 82.16 kg/m, and carrying an axial load of 1600 kN. The column rests symmetrically on a square base plate 700 mm · 700 mm. Take bearing capacity of the soil as 150 kN/m². (16)

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