Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Winter Semester: 2021 - 22
Course Code: CIV213
Course Name: Design of Structural Steel Elements
Program & Sem: B.Tech (Civil) & VI

Date: 25 April 2022
Time: 01.30PM to 02.30PM
Max Marks: 30
Weightage: 15%

Instructions:

(i) Read the all questions carefully and answer accordingly.
(ii) Use of IS800: 2007 is permitted. Assume any suitable data if required.

Part A [Memory Recall Questions]

Answer all the questions. Each question carries 04 marks. (2Qx 4M= 8M)

1. List the advantages of steel as a structural material. [4M](C.O.No.1) [Knowledge]

2. Write any four advantages of bolted connection in steel structures. [4M](C.O.No.1) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the questions. Each question carries 06 marks. (2Qx6M=12 M)

3. Discuss briefly the failure modes that control the strength of the bolt.
[5M](C.O.No.2) [Comprehension]

4. The two plates of thickness 12mm and 20mm are to be joined by simply overlapping and connected together by means of bolts. Suggest the suitable size and number of bolts required to transmit the factored load of 70kN. Use bolts of grade 4.6 and Fe410 grade plates.
[5M](C.O.No.2) [Comprehension]

Part C [Problem Solving Questions]

Answer the question. The question carries 10 marks. (1Qx10 M=10M)

5. A single bolted double cover butt joint is used to connect two plates that are 10mm thick. Assuming 16mm diameter bolts of grade 4.6 and cover plates to be 6mm thick. Calculate the strength and efficiency of the joint, if 4 bolts are provided in the single bolt line at a pitch of 45mm. Also determine the efficiency of the joint if two lines of bolts with two bolts in each line have been arranged to result in a double bolted double cover butt joint.

[10M](C.O.No.2) [Application]

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TEST 2

Winter Semester: 2021 - 22
Course Code: CIV 213
Course Name: Design of Structural Steel Elements
Program & Sem: B.Tech (Civil) & VI Sem

Date: 31st May 2022
Time: 01:30 PM to 02:30 PM
Max Marks: 30
Weightage: 15%

Instructions:

(iii) Read the all questions carefully and answer accordingly.
(iv) Assume any suitable data if required.
(v) Data Table is available in the next page.

Part A [Memory Recall Questions]

Answer both the questions. Each question carries THREE marks. (2Qx3M= 6M)

1. List the types of failure in tension members. [3M] (C.O.No.3) [Knowledge]

2. List the various defects in welding. [3M] (C.O.No.2) [Knowledge]

Part B [Thought Provoking Questions]

Answer both the questions. Each question carries SIX marks. (2Qx6M=12 M)

3. A groove weld is to connect two plates 180mm x 18mm each. The joint has to transmit a factored load of 300kN. Assuming single-U shop welding and Fe410 grade of steel, design the groove weld. [6M] (C.O.No.2) [Comprehension]

4. Determine the block shear strength of the tension member shown in Fig 1. The steel is of grade Fe410. [6M] (C.O.No.3) [Comprehension]

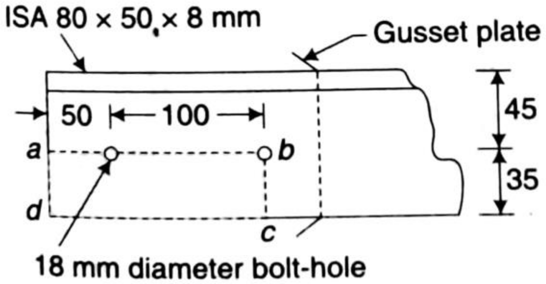

Fig 1

Part C [Problem Solving Questions]

Answer the question. The question carries TWELVE marks. (1Qx12M=12M)

5. Determine the design tensile strength of ISA 80x50x8 (as per Fig. 1) connected to a 10 mm thick gusset plate using 16mm bolts. Assume Fe410 grade steel. Consider only gross section yielding and net section rupture. A_g = 978mm^2. [12M] (C.O.No.3) [Application]

DATA TABLE

5.6.1.1 Where the deflection due to the combination of dead load and live load is likely to be excessive, consideration should be given to pre-camber the beams, trusses and girders. The value of desired camber shall be specified in design drawing. Generally, for spans greater than 25 m, a camber approximately equal to the deflection due to dead loads plus half the live load may be used. The deflection of a member shall be calculated without considering the impact factor or dynamic effect of the loads on deflection. Roofs, which are very flexible, shall be designed to withstand any additional load that is likely to occur as a result of ponding of water or accumulation of snow or ice.

5.6.2 *Vibration*

Suitable provisions in the design shall be made for the dynamic effects of live loads, impact loads and vibration due to machinery operating loads. In severe cases possibility of resonance, fatigue or unacceptable vibrations shall be investigated. Unusually flexible structures (generally the height to effective width of lateral load resistance system exceeding 5:1) shall be investigated for lateral vibration under dynamic wind loads. Structures subjected to large number of cycles of loading shall be designed against fatigue failure, as specified in Section 13. Floor vibration effect shall be considered using specialist literature (*see* Annex C).

5.6.3 *Durability*

Factors that affect the durability of the buildings, under conditions relevant to their intended life, are listed below:

a) Environment,
b) Degree of exposure,
c) Shape of the member and the structural detail,
d) Protective measure, and
e) Ease of maintenance.

5.6.3.1 The durability of steel structures shall be ensured by following recommendations in Section 15. Specialist literature may be referred to for more detailed and additional information in design for durability.

5.6.4 *Fire Resistance*

Fire resistance of a steel member is a function of its mass, its geometry, the actions to which it is subjected, its structural support condition, fire protection measures adopted and the fire to which it is exposed. Design provisions to resist fire are briefly discussed in Section 16. Specialist literature may be referred to for more detailed information in design of fire resistance of steel structures.

SECTION 6
DESIGN OF TENSION MEMBERS

6.1 Tension Members

Tension members are linear members in which axial forces act to cause elongation (stretch). Such members can sustain loads upto the ultimate load, at which stage they may fail by rupture at a critical section. However, if the gross area of the member yields over a major portion of its length before the rupture load is reached, the member may become non-functional due to excessive elongation. Plates and other rolled sections in tension may also fail by block shear of end bolted regions (*see* **6.4.1**).

The factored design tension T, in the members shall satisfy the following requirement:

$$T < T_d$$

where

T_d = design strength of the member.

The design strength of a member under axial tension, T_d, is the lowest of the design strength due to yielding of gross section, T_{dg}; rupture strength of critical section, T_{dn}; and block shear T_{db}, given in **6.2**, **6.3** and **6.4**, respectively.

6.2 Design Strength Due to Yielding of Gross Section

The design strength of members under axial tension, T_{dg}, as governed by yielding of gross section, is given by

$$T_{dg} = A_g f_y / \gamma_{m0}$$

where

f_y = yield stress of the material,
A_g = gross area of cross-section, and
γ_{m0} = partial safety factor for failure in tension by yielding (*see* Table 5).

6.3 Design Strength Due to Rupture of Critical Section

6.3.1 *Plates*

The design strength in tension of a plate, T_{dn}, as governed by rupture of net cross-sectional area, A_n, at the holes is given by

$$T_{dn} = 0.9\, A_n f_u / \gamma_{m1}$$

where

γ_{m1} = partial safety factor for failure at ultimate stress (*see* Table 5),
f_u = ultimate stress of the material, and
A_n = net effective area of the member given by,

$$A_n = \left[b - nd_h + \sum_i \frac{p_{si}^2}{4g_i} \right] t$$

where

b, t = width and thickness of the plate, respectively,

d_h = diameter of the bolt hole (2 mm in addition to the diameter of the hole, in case the directly punched holes),

g = gauge length between the bolt holes, as shown in Fig. 5,

p_s = staggered pitch length between line of bolt holes, as shown in Fig. 5,

n = number of bolt holes in the critical section, and

i = subscript for summation of all the inclined legs.

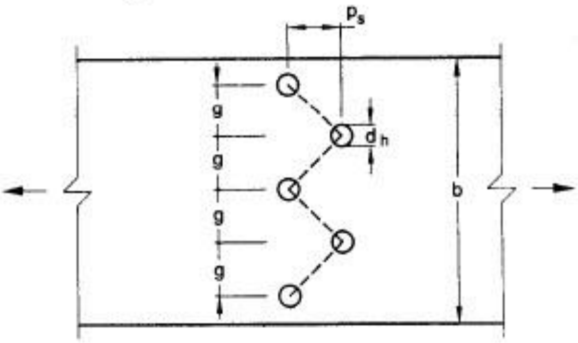

FIG. 5 PLATES WITH BOLTS HOLES IN TENSION

6.3.2 *Threaded Rods*

The design strength of threaded rods in tension, T_{dn}, as governed by rupture is given by

$$T_{dn} = 0.9\, A_n f_u / \gamma_{m1}$$

where

A_n = net root area at the threaded section.

6.3.3 *Single Angles*

The rupture strength of an angle connected through one leg is affected by shear lag. The design strength, T_{dn} as governed by rupture at net section is given by:

$$T_{dn} = 0.9\, A_{nc} f_u / \gamma_{m1} + \beta A_{go} f_y / \gamma_{m0}$$

where

$$\beta = 1.4 - 0.076\,(w/t)\,(f_y/f_u)\,(b_s/L_c) \le (f_u \gamma_{m0} / f_y \gamma_{m1}) \ge 0.7$$

where

w = outstand leg width,

b_s = shear lag width, as shown in Fig. 6, and

L_c = length of the end connection, that is the distance between the outermost bolts in the end joint measured along the load direction or length of the weld along the load direction.

For preliminary sizing, the rupture strength of net section may be approximately taken as:

$$T_{dn} = \alpha A_n f_u / \gamma_{m1}$$

where

α = 0.6 for one or two bolts, 0.7 for three bolts and 0.8 for four or more bolts along the length in the end connection or equivalent weld length;

A_n = net area of the total cross-section;

A_{nc} = net area of the connected leg;

A_{go} = gross area of the outstanding leg; and

t = thickness of the leg.

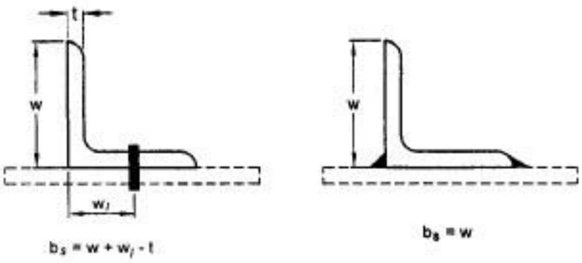

FIG. 6 ANGLES WITH SINGLE LEG CONNECTIONS

6.3.4 *Other Section*

The rupture strength, T_{dn}, of the double angles, channels, I-sections and other rolled steel sections, connected by one or more elements to an end gusset is also governed by shear lag effects. The design tensile strength of such sections as governed by tearing of net section may also be calculated using equation in **6.3.3**, where β is calculated based on the shear lag distance, b_s taken from the farthest edge of the outstanding leg to the nearest bolt/weld line in the connected leg of the cross-section.

6.4 Design Strength Due to Block Shear

The strength as governed by block shear at an end connection of plates and angles is calculated as given in **6.4.1**.

6.4.1 *Bolted Connections*

The block shear strength, T_{db} of connection shall be taken as the smaller of,

$$T_{db} = [\, A_{vg} f_y / (\sqrt{3}\, \gamma_{m0}) + 0.9 A_{tn} f_u / \gamma_{m1} \,]$$

or

$$T_{db} = (0.9 A_{vn} f_u / (\sqrt{3}\, \gamma_{m1}) + A_{tg} f_y / \gamma_{m0})$$

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SCHOOL OF ENGINEERING

END TERM EXAMINATION

Winter Semester: 2021 - 22
Course Code: CIV213
Course Name: Design of Structural Steel Elements
Program & Sem: B.Tech (Civil) & VI Sem

Date: 28th June 2022
Time: 09:30 AM to 12:30 PM
Max Marks: 100
Weightage: 50%

Instructions:

(vi) Read the all questions carefully and answer accordingly.
(vii) Use of IS800: 2007 and SP 6(1): Steel Tables are permitted

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries TEN marks. (3Qx 10M= 30M)

1. Discuss the salient features of Limit state of strength and limit state of serviceability in limit state design. (C.O.No.1) [Knowledge]

2. Write short notes on various defects of welding. (C.O.No.2) [Knowledge]

3. Write short notes on various modes of failures in compression members. (C.O.No.3) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks. (4Qx10M=40M)

4. Compute the design strength of bearing type connection based on shear and bearing for the joint as shown in Fig. Q(4). The bolts are of 4.6 grade and 16mm diameter. (C.O.No.2) [Comprehension]

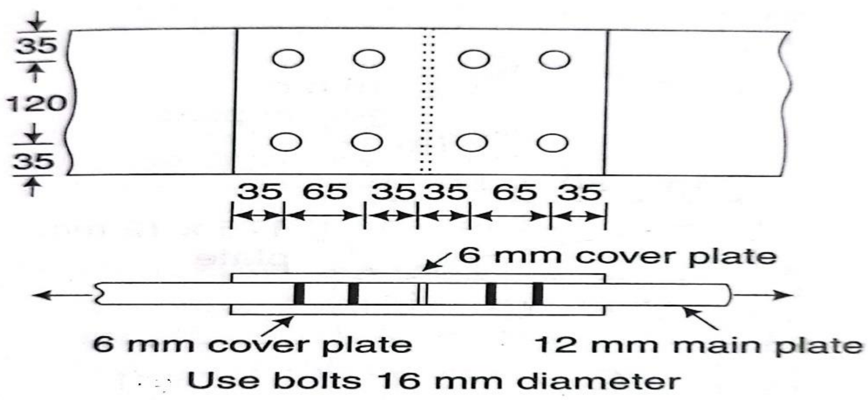

Fig. Q.(4)

5. Determine the design strength of fillet welded joint for the cases as shown in Fig.Q.(5). Take size of the weld as 5mm. (C.O.No.2) [Comprehension]

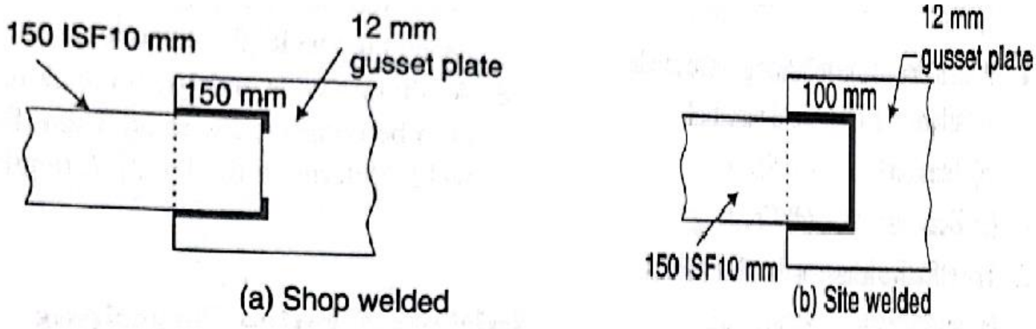

Fig.Q.(5)

6. Determine the tensile strength of a roof truss diagonal 100x75x6mm connected to the gusset plate by 4mm welds as shown in fig. Q(6). Ignore block shear strength.
(C.O.No.3) [Comprehension]

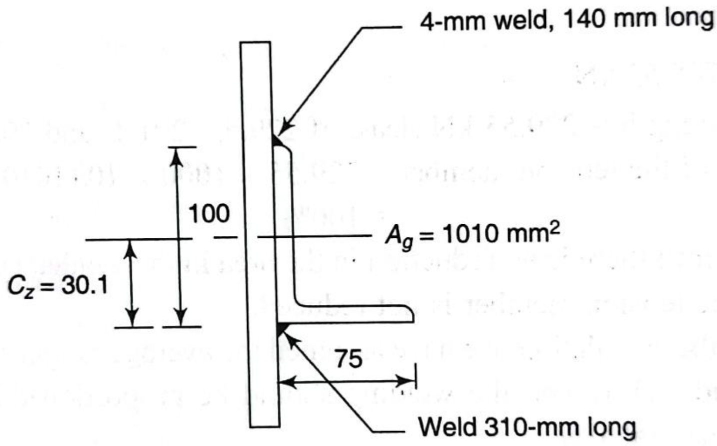

Fig. Q(6)

7. Calculate the design compressive load for a stanchion ISHB 200 @ 392.4 N/m, 6m high. The column is restrained in direction and position at both ends. Use steel of grade Fe410.
(C.O.No.3) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each question carries FIFTEEN marks. (2Qx15M=30M)

8. Select a suitable angle section to carry a factored tensile force of 290kN assuming a single row of 24mm diameter bolts of 4.6 grade. The effective length of the member is 3.5m. The members are subjected to the possible reversal of stress due to the action of wind. Do necessary checks. (C.O.No.3) [Application]

9. Design a suitable section for a column 5m long which is effectively held in position and restrained against rotation at both ends in order to carry factored load of 600kN.
(C.O.No.3) [Application]