Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3170618 Date: 26/06/2023

Subject Name: Design of Steel Structures

Time: 10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of IS: 800 (2007), SP 6 (1)/ Steel table, IS: 1893 - 1 (2016) and IS: 875 (Part 3) are permitted.**
6. **Consider f_y = 250 N/mm^2 and f_u = 410 N/mm^2, E = 2 x 10^5 N/mm^2 if not mentioned.**

Q.1	**(a)**	State assumptions made in plastic design method.	**03**
	(b)	Express the relation between basic wind speed and design wind speed. Briefly discuss various effects to be included in basic wind speed to obtain design wind speed as per IS: 875 -2015 (Part-3) recommendations.	**04**
	(c)	Design a bolted unstiffened seat angle to connect a beam ISMB 300 which transmits factored end reaction 100 kN to the flange of column ISHB 350 @ 661.2 N/m, using 16 mm diameter bolts of bolt value 29.0 kN/bolt. Take (clearance + tolerance) = 10 mm. Check selected seat angle for moment and shear capacity.	**07**
Q.2	**(a)**	Write advantages and disadvantages of plate girder compared to truss girder.	**03**
	(b)	Based on rigidity classify various types of connections. Illustrate moment vs rotation behavior of each type with sketch.	**04**
	(c)	Design suitable section for welded plate girder of span 20 m and without intermediate stiffeners, carrying U.D.L. of 40 kN/m (including self weight), over the entire span and two point loads 120 kN at 5 m from each support. Check for (i) Moment capacity of girder and (ii) Shear capacity of web plate. Design of connections and stiffeners need not require.	**07**
		OR	
	(c)	A beam ISMB 300 is connected to the flange of a column ISHB 350 @ 661.2 N/m (field weld), using two ISA 90 x 60 x 10 mm and 200 mm long on each side of web of beam (shop weld), transmits factored end reaction of 150 kN. Design fillet weld for a double angle framed connection. Longer leg of angles are connected to the flange of column. Take (clearance + tolerance) = 10 mm.	**07**
Q.3	**(a)**	Discuss various types of stiffeners provided in plate girder, with their specific purpose.	**03**
	(b)	Discuss various load combinations recommended in IS: 800 - 2007 for estimating design load on steel structures.	**04**
	(c)	A welded plate girder consisting web plate of size 1600 mm deep x 8 mm thick, is provided with intermediate transverse stiffeners on both side of web plate at spacing of 2000 mm. Assuming size of steel flat stiffeners 120 mm wide and 10 mm thick, check for buckling of typical stiffener using simple post critical method. Take shear force in web plate at the position of stiffener = 1000 kN. Stiffeners are not subjected to any external load. Take poisson's ratio, μ = 0.3	**07**
		OR	
Q.3	**(a)**	Differentiate between deck type and through type truss bridge. Also draw sketch for both type of truss bridges.	**03**
	(b)	Describe various criteria for minimum web thickness requirements of plate girder based on serviceability, recommended by IS: 800 – 2007.	**04**

(c) Design a cross beam of a steel foot over bridge for the following data and check for the moment and shear capacity of cross girder: **07**
(i) Type of truss: N-type (ii) Span: 24 m with 6 equal panels (iii) Width of walk way: 4 m (iv) Truss height = 4 m (v) Flooring: RCC slab 115 mm thick (vi) Live Load: 5.0 kN/m^2 (vii) Floor Finish: 0.75 kN/m^2 (viii) Self weight of cross beam = 0.5 kN/m.

Q.4 **(a)** Enlist various components of foot over bridge. **03**

(b) Describe tension field method used for computing shear buckling strength of web plate. **04**

(c) Design most heavily loaded top chord member of a through type steel foot over bridge truss for the data given in Q.3 (c) OR above. Assume Rakers are provided at each panel point. Take self weight of truss = 0.75 kN/m. **07**

OR

Q.4 **(a)** Write any three situations, where truss girder is preferred over plate girder. **03**

(b) Give name of any four elements of plate girder with their function. **04**

(c) Determine plastic moment capacity for a portal frame loaded as shown in fig. 1. **07**

Q.5 **(a)** Fill blank spaces with most appropriate option given below and rewrite the sentences: **03**
In through type bridge with N – type truss girder:
(i) Top chord members are subjected to …….. force.
(ii) Bottom chord members are subjected to …… force.
(iii) Web members are subjected to ……. force.
(1) Tensile (2) Compressive (3) Both tensile and compressive (4) Bending (5) Shear

(b) Derive formula for shape factor of rectangular section, with usual notations. **04**

(c) Determine the plastic moment capacity of ISMB 300 with top plate 200 mm x 20 mm. **07**

OR

Q.5 **(a)** A laterally unsupported gantry girder of span 6 m, supports an EOT crane of capacity 130 kN. The span of the crane girder between the rails is 16 m. Weight of crane girder excluding crab is 184 kN, weight of crab is 30 kN and self weight of gantry girder including rail section is 1.34 kN/m. Take maximum hook approach =1.2 m and wheel base = 2.4 m. Determine (i) maximum bending moment and maximum shear force in gantry girder for respective design load positions. (ii) draw bending moment diagram for maximum B.M. design load position. Check for buckling resistance, deflection and connection design need not required. **07**

(b) A gantry girder is made from built up section of ISMB 500 @ 852.5 N/m (tf = 17.2 mm, bf = 180 mm, tw = 10.2 mm) and ISMC 250 @ 298.2 N/m (tf = 14.1, bf = 80 mm, tw = 7.1 mm) as shown in fig. 2. **07**

The elastic and plastic section modulus of built up section @ z –z axis are
Zez = 1.97 x 10^6 mm^3 and Zpz = 2.58 x 10^6 mm^3 respectively.

The elastic and plastic section modulus of compression flange @ y – y axis are
Zey = 0.372 x 10^6 mm^3 and Zpy = 0.5 x 10^6 mm^3 respectively.

Check for (i) class of section (ii) moment capacity of section and combined biaxial bending stresses, if Mz = 440 kNm and My = 12 kNm and (iii) shear capacity of section, if Vz = 366 kN.

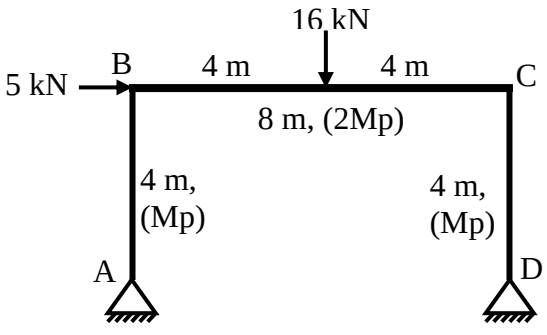

Fig. 1, Q.4(c) OR

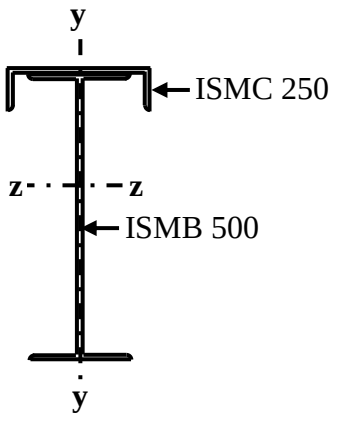

Fig. 2, Q.5 (b) OR

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