Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - V EXAMINATION - WINTER 2025

Subject Code: 3150612 **Date: 21-11-2025**

Subject Name: Design of 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 : 456-2000, IS : 800-2007, IS 875 and Steel Table or SP 6 is permitted.**

			Marks
Q.1	**(a)**	Differentiate the limit state method and working stress method of design for Reinforced Cement Concrete structures.	**03**
	(b)	The balanced sections are most preferred over Under-reinforced section and Over-reinforced section. Justify the statement. Also mention which type of section is avoided in design of singly reinforced beam with suitable reason.	**04**
	(c)	A RCC beam section having 230 mm X 500 mm cross section with effective cover of 40 mm in both sides reinforced with 2 Nos 16 mm diameter bars as compression reinforcement and 4 Nos 20 mm diameter bars as tension reinforcement designed using grade M20 and steel with Fe 500 grade. Calculate the Moment of Resistance.	**07**
Q.2	**(a)**	Two plates of thickness 10 mm and 12 mm are connected using HSFG 8.8 grade bolts of 22 mm diameter. Calculate the proof load.	**03**
	(b)	Calculate the design shear force for the bolt designed in Q. 2(a) if slip resistance is designed at ultimate load and assume fasteners in clearance holes. (Take coefficient of friction = 0.5, number of effective interfaces offering frictional resistance to slip = 1)	**04**
	(c)	A pipe of 120 mm diameter and 8 mm thickness is connected to 16 mm thick plate with fillet weld done along its perimeter. The weld is subjected to combined loading and it is found that resultant shear stress of magnitude $\boldsymbol{150/t_e}$ N/mm^2 and bending stress of magnitude $\boldsymbol{500/t_e}$ N/mm^2 are acting on the weld, where $\boldsymbol{t_e}$ is effective throat thickness. Find the minimum size of the fillet weld. (Consider Fe 410 grade of steel and shop welding; coefficient for effective throat thickness, K = 0.7)	**07**

OR

(c) The rectangular beam of width, 300 mm is having overall depth of 400 mm. The concrete grade is M 20 and the grade of reinforcing steel is Fe 415. The tensile reinforcement is provided by 4-20 mm bars. In the compression side, the reinforcement is provided by 2-16 mm bars. The clear cover is 25 mm. Calculate the additional Moment of Resistance. Also evaluate the stress and strain at compression side and verify that the section is under-reinforced or over reinforced. The salient points of design stress-strain curve of Fe 415 is given by (strain, stress, N/mm^2) (0.00144,288), (0.00163,306), (0.00192,324), (0.00241, 342), (0.00276, 351), (0.00380, 360). **07**

Q.3 **(a)** Define (i) Gauge (ii) Pitch (iii) slenderness ratio **03**

(b) A T-beam is having the following dimension: width of flange, b_f= 1000mm; depth of flange, D_f= 125mm, width of web, b_w = 250 mm overall depth of beam, D = 250 mm. The concrete grade is M 20 and the grade of reinforcing steel is Fe 415. The clear cover is 25 mm. Considering a balanced section having 20 mm bars, Calculate the area of reinforcement and moment of resistance. **04**

(c) The details of a rectangular beam are (i) Width, 300 mm. Effective depth, 600 mm. The clear cover is 25 mm. (ii) Tensile reinforcement is provided by 5-25 mm dia bars. (iii) The design shear force is 200 KN' (iv) Concrete grade: M20. Steel grade: Fe415. For M20 grade of concrete, the maximum shear stress permitted is 2.80 MPa. (v) The design shear strength of concrete, τ_c, MPa for M20 grade of concrete is given as (100 Ast/bd, τ_c, MPa) (0.25,0.36), (0.50, 0.48), (0.75, 0.56), (1.00, 0.62), (1.25, 0.67), (1.50, 0.72), (1.75, 0.75), (2.00, 0.79), (2.25, 0.81), (2.50, 0.82). Evaluate the nominal shear stress T_v and check whether it is more or less than the design shear strength. **07**

OR

(a) Differentiate the lap and butt joint with neat sketches. **03**

(b) Plot neat sketch of stress-strain curve of concrete and steel with stress block parameters adopted by IS: 456-2000 and IS 800-2007. **04**

(c) Calculate the value of 'β' for a tension member made of ISA 75×50×8. The larger leg is connected to 10 mm gusset plate with 3 no's of 20 mm nominal diameter bolt of grade 4.6 arranged in single line as shown in figure 1 below. The pitch, the edge distance and the gauge distance are 50 mm, 35 mm and 40 mm respectively. Consider Fe 410 grade of steel. **07**

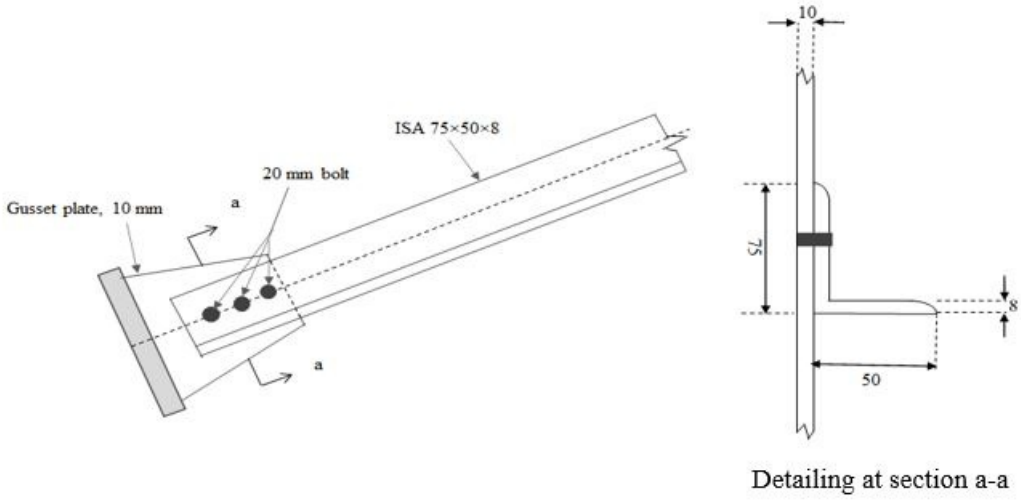

Fig. 1

Q.4 **(a)** Draw neat sketch of battening system. **03**

(b) Calculate the minimum number of bolts required to connect the outstanding leg of lug angle to outstanding leg of main angle if load on outstanding leg of main member is 120 kN and bolt value is 36 kN. **04**

(c) A perfectly axially loaded concrete column of gross dimension 400mm × 400mm is reinforced with 4 bars of 20mm diameter. Determine the design axial load carrying capacity of the column. Consider M25 grade concrete and Fe415 grade steel. **07**

OR

(a) Why are four different buckling curves prescribed to evaluate column strength? **03**

(b) The details of an unrestrained reinforced concrete slab simply supported on all four walls are (i) Effective dimension: 4.5m × 6.0m. (ii) Thickness of the slab: 200 mm. (iii) Carries a characteristic live load of 10 KN/m^2 in addition to the dead load and finishing load of 1 KN/m^2 (iv) Grade of concrete: M25 (v) Grade of steel: Fe415 (vi) Clear cover of 20mm. (vii) Bottom reinforcement: 12mm dia. (viii) Top reinforcement of 10 mm dia. at the mid span of the slab. Calculate the design load on the slab. Classify the nature of slab i.e. two way or one way. Also find the effective depth in short and long span directions. **04**

(c) Calculate the number of M18, grade 4.6 bolts required for the connection of the member **OC** as shown below in the figure 2. Thickness of gusset plate is equal to 14 mm, assume pitch and end distance 50 mm and 35 mm respectively. Consider Fe410 grade of steel. (Assume the given loads are multiplied with suitable factor of safety). **07**

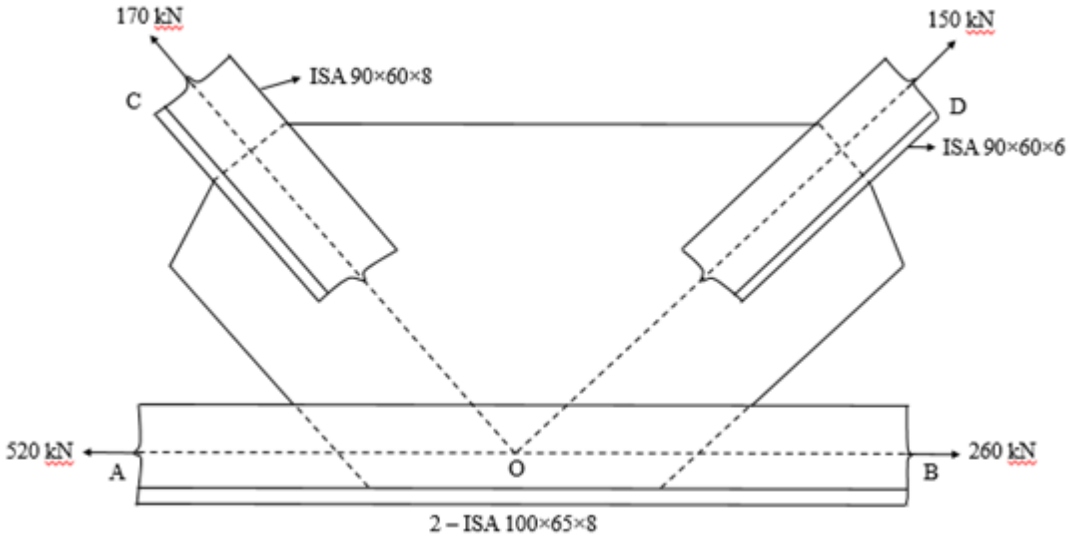

Fig 2

Q.5 **(a)** For a RC footing ratio of its long side to short side is 1.5. Calculate the ratio of reinforcement to be provided in the central band width to total reinforcement in the short direction. **03**

(b) A square isolated footing for a square column of size 350mm × 350mm is made to transfer the characteristic load, P= 600kN to the ground. Consider weight of footing as 10% of the characteristic axial load. The safe bearing capacity of soil is 150 kN/m^2. Calculate the dimension of the square footing. **04**

(c) A slab base is used for a column to transfer a factored load of 1200 kN and this load causes intensity of pressure 7.4 MPa on base plate from concrete pedestal. If larger and smaller projection are 75 mm and 50 mm respectively of the slab base beyond the rectangle circumscribing the column, find the minimum thickness of base plate. (Consider flange thickness of the compression member as 14.1 mm and Fe410 grade of steel) **07**

OR

(a) A column having effective length of 2 m with both ends fixed is made up of ISMB 400 @ 61.6 kg/m. Calculate the value of λ which is used in the calculation of design compressive stress 'f' of the member. Minimum radius of gyration of the member = r = 28.2 mm. (Take Fe 410 grade steel and Young's modulus of elasticity = 2×10 MPa) **03**

(b) Using data and result of Q. No. OR 5(a), calculate the value of design compressive stress 'f_{cd} about yy-axis. Take value of imperfection factor 'α' = 0.34 about y-y axis. **04**

(c) A square isolated footing having dimension 1500mm×1500mm is made to transfer a characteristic load, P=600kN to the ground, through a column of 350mm×350mm. Consider weight of footing as 10% of the characteristic axial load. The load factor is taken as 1.5. The overall depth of footing is 350mm. The clear cover is 40mm.The diameter of reinforcement provided is 12mm. Determine the one-way shear force due to soil reaction at the critical section for design. **07**

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