(3 Hours) **Marks: 80**

INSTRUCTIONS:

1. Question number 1 is **COMPULSORY**. Answer any **THREE** from the remaining.
3. Each **full** question carries **20** marks.
4. **ASSUME** any suitable data, if needed & **state** the same clearly.
5. Use of Indian Standard, **IS 456: 2000 is PERMITTED**.

Q. 1) Answer any **FIVE.**

(a) Using Working Stress Method **(WSM)**, calculate Modular Ratio, Neutral Axis constant, Lever Arm constant & Moment of Resistance constant for balanced singly reinforced beam section. Use **M20 concrete** (σ_{cbc} = 7 N/mm^2) & **Fe415 steel** (σ_{st} = 230 N/mm^2). **(04 M)**

(b) Differentiate between Working Stress Method **(WSM)** & Limit State Method **(LSM)**. **(04 M)**

(c) Write a short note on characteristic strength of the material, characteristic load & partial safety factors. **(04 M)**

(d) Why the minimum (or nominal) shear reinforcement is needed even though the nominal shear stress (τ_v) < shear strength of concrete (τ_c)? **(04 M)**

(e) Differentiate between one-way slab & two-way slab. **(04 M)**

(f) Write a note on primary (or equilibrium) torsion & secondary (or compatibility) torsion. **(04 M)**

(g) A short square column of size (400 mm X 400 mm) carries an **axial** compressive load of 1260 kN. Using **M20 concrete** (σ_{cc} = 5 N/mm^2) & **Fe415 steel** (σ_{sc} = 190 N/mm^2), find the area of steel required using **Working Stress Method (WSM)**. Also find the steel area required by **Limit State Method (LSM)**. Give your comments. **(04 M)**

Q. 2) (a) A simply supported beam of size (235 mm width X 600 mm overall depth) is reinforced with 4 bars of 12 mm diameter. Find the safe Uniformly Distributed Load on the beam, in addition to its self weight, on a span of 4 m. Take clear cover to the tension steel as 30 mm (mild exposure). Adopt **M20 concrete** & **Fe415 steel**. Use **Working Stress Method (WSM).** **(09 M)**

(b) A doubly reinforced beam has width of 230 mm & effective depth of 450 mm. Tension steel has 3 bars of 25 mm diameter & compression steel has 2 bars of 20 mm diameter. Effective cover to compression steel is 40 mm. Using **M20 concrete** & **Fe415 steel**, determine the Moment of Resistance of section. Adopt **Working Stress Method (WSM).** **(09 M)**

(c) In **Working Stress Method (WSM)**, why larger factor of safety is adopted for permissible stress in direct compression **(σ_{cc})** than that adopted for permissible stress in bending compression **(σ_{cbc})** for any grade of concrete? **(02 M)**

Q. 3) (a) Design a singly reinforced rectangular beam for an applied **factored** moment of 125 kNm. Assume the beam width as 235 mm. Use **M20 concrete** & **Fe415 steel**. Draw a neat sketch. Adopt **Limit State Method (LSM).** **(09 M)**

(b) A rectangular beam of size 230 mm wide & 490 mm effective depth is subjected to a **factored** moment of 215 kNm. Find the steel for the flexure. Use **M20 concrete** & **Fe415 steel**. Ensure that the design leads to an under-reinforced section. Adopt **Limit State Method (LSM).** **(09 M)**

(c) Maximum strains in an extreme fibre in concrete & in the tension reinforcement (Fe415 & E_s = 200 kN/mm^2) in a balanced section in **limit state of flexure** are, respectively (write the correct option):

i) 0.0035 & 0.0038 ii) 0.002 & 0.0018
iii) 0.0035 & 0.0041 iv) 0.002 & 0.0031 **(02 M)**

Q. 4) (a) A T-beam floor system has 130 mm thick slab supported on beams. Width of rib b_w = 295 mm, effective depth d = 590 mm & tension steel has 6 bars of 20 mm diameter. The beams are spaced at 3 m c/c. The beam has an effective span of 3.4 m. Using **M20 concrete** & **Fe415 steel**, find the Moment of Resistance. Adopt **Limit State Method (LSM).** **(09 M)**

(b) A beam has a rectangular section with a width of 360 mm & an overall depth of 750 mm. It is subjected to a **factored** bending moment of 220 kNm, **factored** torsion of 100 kNm & **factored** shear force of 145 kN. Adopt effective cover of 50 mm on all the 4 sides. Adopting **M20 concrete** & **Fe415 steel**, design suitable reinforcement for the section. Use **Limit State Method (LSM)**. **(09 M)**

(c) A singly reinforced beam has a width of 300 mm & an effective depth of 600 mm. It is reinforced with 3 bars of 12 mm diameter, Fe415 steel. Verify whether the steel area provided is less than the minimum steel area specified or more than that. **(02 M)**

Q. 5) (a) Design a slab for a hall having a clear size of (4 m X 5 m). The slab is simply supported on 300 mm wall on all the four sides. Live load is 4 kN/m^2 & floor finish is 1.2 kN/m^2. Use **M20 concrete** & **Fe415 reinforcement**. The corners of the slab are **held down**. Carry out the check for limit state of serviceability for **deflection**. Draw a neat diagram indicating reinforcement details. Use **Limit State Method (LSM).** **(12 M)**

(b) A beam has a support section with width of 280 mm & an effective depth of 575 mm. It is reinforced with 5 bars of 12 mm diameter. Two-legged, 8 mm stirrups are provided at 170 mm c/c near the support section. Using **M25 concrete** & **Fe415 steel**, determine the shear resistance of the support section. Use **Limit State Method (LSM).** **(06 M)**

(c) A slab has an overall depth of 150 mm. Can we provide 20 mm diameter bars as tension steel? If yes, give reason. If no, give reason. **(02 M)**

Q. 6) (a) A short column of size (300 mm X 600 mm) is subjected to an **axial working load** of 640 kN & **factored moment** of 300 kNm about major axis. Determine the reinforcement in the column if the moment due to minimum eccentricity is less than the applied moment. Adopt **M20 concrete** & **Fe415 steel**. Use effective cover to the main steel as 60 mm. Provide the necessary lateral ties. Draw a neat sketch showing the details. Use **Limit State Method (LSM).** **(07 M)**

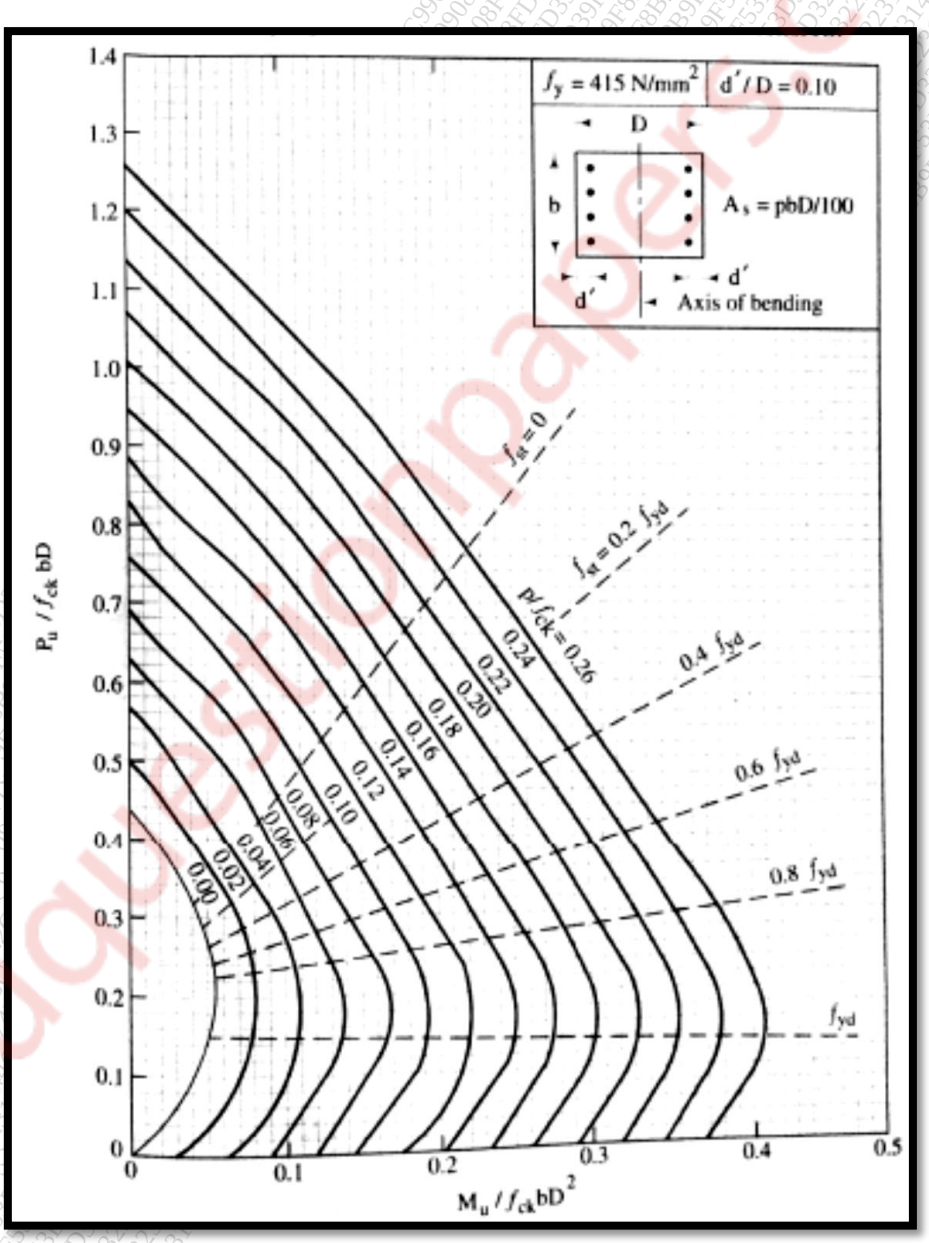
(b) Design a **square footing** for a short axially loaded column of size (300 mm X 300 mm), carrying 650 kN **working load**. Use **M20 concrete** & **Fe415 reinforcement**. Safe bearing capacity of soil is 185 kN/m^2. Sketch the reinforcement details. Use **Limit State Method (LSM).** **(11 M)**

(c) A beam has **M25 concrete** & **Fe415 steel**. Its width is 280 mm & effective depth is restricted to 560 mm. The **factored** bending moment is 330 kNm. Prove that doubly reinforced section needs to be provided. If the depth is not restricted, find the effective depth to be provided to make it singly reinforced section. **(02 M)**

Stress in Compression Steel (f_{sc}) N/mm^2, in Doubly Reinforced Beam: Limit State Method

f_y (N/mm^2)	(d'/d)			
	0.05	0.10	0.15	0.20
415	355	353	342	329

Q. 6 (a): Compression with Bending: Rectangular Section: Reinforcements Distributed Equally on Two Sides



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