ASSIGNMENT-1: SINGLY REINFORCED BEAM

Ex.1. For limiting singly reinforced section 400 mm x 500 mm effective, calculate the followings: Take Fe 415 and M 20.

(1) Maximum depth of N.A. (2) Total compression (3) Lever Arm

(ANS: $X_{u\text{-}max}$ = 240 mm, C = 691.20 kN, Z = 399.20 mm)

Ex.2. A R.C. Beam rectangular in section 300 mm x 500 mm effective is reinforced with 4 nos. of 20 mm diameter. Take: Fe 415 and M 20. Find moment of resistance of section.

(ANS: X_u = 210.05 mm, M_u = 187.42 kN.m)

Ex.3. Design a singly reinforced beam for factored moment of 160 kN.m. Effective width to depth ratio is 0.7. Take: Fe 415 and M 20. Check for shear and deflection is not required.

(ANS: d = 435.88 mm (say) 450 mm, b = 315 mm, A_{st} = 1190.7 mm^2, provide 4-20 mm bars)

Ex.4. A singly reinforced beam is subjected to bending moment of 150 kN.m. Design the beam for flexure. Take: Fe 415 and M 20. Take: b/d = 0.5

(ANS: b = 275 mm, d = 550 mm, A_{st} = 1403.6 mm^2)

Ex.5. A rectangular beam 200 mm x 400 mm has to resist a moment of 40 kN.m. Find the reinforcement required for tension by basic concept. Take: Fe 250 and M 15.

(ANS: M_u = 60 kN.m, $M_{u\text{-}lim}$ = 71.04 kN.m, URS, A_{st} = 833.6 mm^2)

Ex.6. A singly reinforced beam of size 250 mm x 500 mm effective depth is reinforced with 0.76 % of steel. Take: Fe 500 and M 20. Find (1) Depth of N.A., (2) No. of bars for dia-18 mm, (3) Moment of resistance.

(ANS: X_u = 229.58 mm, 4 nos-18 mm, M_u = 166.25 kN.m)

Ex.7. Find tension steel area required for a rectangular beam 300 mm x 550 mm effective. The beam is subjected to factored moment of 220 kN.m. Take: Fe 415 and M20.

(ANS: A_{st} = 1329.9 mm^2, 4 Nos- 22 dia)

Ex.8. A singly reinforced beam of size 250 mm x 500 mm (effective) is reinforced with 0.7 % steel. Calculate moment of resistance of beam. Take: Fe 415 and M 20.

(ANS: X_u = 175.51 mm , M_u = 135 kN.m)

Ex.9. A singly reinforced beam of 3.6 m span is simply supported. It carries LL = 10 kN/m and DL = 20 kN/m (includes self weight) Take: Fe 415 and M 20.

(ANS: M_u = 72.9 kN.m, d = 296.72 mm (say) 300 mm, A_{st} = 835.20 mm^2, provide 3-20 mm bars)

ASSIGNMENT-2 DOUBLY REINFORCED BEAM

Ex.1. Find moment of resistance of a rectangular beam 300 mm x 550 mm overall. It has a effective cover of 50 mm as tension reinforcement with 5 nos. of 22 mm diameter. It has a effective cover of 50 mm as compression reinforcement with 3 nos. of 16 mm diameter. Take: Fe 415 and M 15.

(ANS: X_u = 294.55 mm, $X_{u\text{-}max}$ = 240 mm, M_u = 249.17 kN.m)

Ex.2. A R.C. beam rectangular section 230 mm x 530 mm overall. It is reinforced with 5 nos of 20 mm diameter as tension and 5 nos of 16 mm diameter as compression. Both side effective cover is 55 mm. Take: Fe 415 and M 15. Find depth of N.A. and moment of resistance.

(ANS: X_u = 185.07 mm, $X_{u\text{-}max}$ = 228 mm, M_u = 232.44 kN.m)

Ex.3. Find the moment of resistance of the doubly reinforced beam:

(1) Width = 250 mm,
(2) Effective depth = 450 mm
(3) Compressive reinforcement = 3 nos – 16 mm diameter
(4) Tension reinforcement = 6 nos – 16 mm diameter
(5) Cover of compressive reinforcement = 25 mm
(6) Fe 250 and M 15.

(ANS: X_u = 100.14 mm, $X_{u\text{-}max}$ = 238.5 mm, URS, M_u = 109.17 kN.m)

Ex.4. Find the area of tensile and compressive steel required for a rectangular beam of 250 mm x 450 mm (overall) it has a factored moment of 160 kN.m. The effective cover for tensile is 50 mm and effective cover for compression is 40 mm. Take: Fe 415 and M 20.

(ANS: A_{sc} = 400.42 mm^2, A_{st1} = 960 mm^2, A_{st2} = 381.60 mm^2)

Ex.5. Find the area of tensile and compressive steel required for a rectangular beam of 300 mm x 580 mm (overall) it has a factored moment of 350 kN.m.

The effective cover for tensile is 40 mm and effective cover for compression is 40 mm. Take: Fe 415 and M 15.

(ANS: A_{sc} = 975.54 mm^2, A_{st1} = 1166.4 mm^2, A_{st2} = 935.71 mm^2)

Ex.6. Design for tension and compression reinforcement of a beam of 300 mm x 700 mm overall. It is simply supported on 6 m span. It is subjected to LL = 80 kN/m. Take: Density of concrete = 25 kN/m^3, Fe 415, M 20, Effective cover = 40 mm (each side)

(ANS: M_u = 575.44 kN.m, M_{u2} = 214.76 kN.m, f_{sc} = 353 N/mm^2, f_{cc} = 8.92 N/mm^2, A_{sc} = 1006.70 mm^2, A_{st1} = 1900.8 mm^2, A_{st2} = 959.38 mm^2, A_{st} = 2860.18 mm^2)

Ex.7. Design for tension and compression reinforcement of a beam of 250 mm x 440 mm overall. It is subjected to factored B.M. of 180 kN.m. Take Fe 250, M 20, Effective cover = 40 mm (each side)

(ANS: $M_{u\text{-}lim}$ = 118.4 kN.m, M_{u2} = 61.6 kN.m, f_{sc} = 217.5 N/mm^2, f_{cc} = 8.92 N/mm^2, A_{sc} = 820.36 mm^2, A_{st1} = 1760 mm^2, A_{st2} = 786.72 mm^2, A_{st} = 2546.72 mm^2)

ASSIGNMENT-3 TEE - BEAM

Ex.1. Calculate flange width of a Tee-beam from the following data:

(1) Depth of flange = 120 mm
(2) Width of rib = 350 mm
(3) Effective span = 7500 mm

(ANS: b_f = 2320 mm)

Ex.2. A Tee-beam section reinforced for tension has the following data:

(1) Flange width = 1500 mm
(2) Effective depth = 750 mm
(3) Thickness of flange = 120 mm
(4) Width of rib = 350 mm. Take Fe 415 and M 20.

(ANS: $M_{u\text{-}lim}$ = 1400.21 kN.m)

Ex.3. Find moment of resistance of a Tee-beam using following data:

(1) Flange width = 1500 mm
(2) Web width = 300 mm
(3) Effective depth = 600 mm
(4) Depth of flange = 150 mm
(5) Tension steel – 4 nos. of 20 mm diameter
(6) Fe 415 and M 20

(ANS: F_c = 1620 kN, F_t = 453 kN, X_u = 41.98 mm, $X_{u\text{-}max}$ = 288 mm, M_u = 264.20 kN.m)

ASSIGNMENT-4 DEVELOPMENT LENGTH& BOND STRESS

Ex.1. Find the development length for 16 mm diameter of the following cases:**(Using SP 16)**

(1) M 20, Fe 250, Tension bar
(2) M 20, Fe 415, Tension bar
(3) M 25, Fe 415, Compression bar
(4) M 20, Fe 250, Compression bar

(ANS: (1) L_d = 725 mm, (2) L_d = 752 mm,(1) L_d = 516 mm,(1) L_d = 580 mm)

Ex.2. Find the development length for 20 mm diameter of the following cases: **(Using IS: 456-2000)**

(1) M 20, Fe 415, Compression bar
(2) M 20, Fe 250, Compression bar

(ANS: (1) L_d = 752.18 mm, (2) L_d = 725 mm)

Ex.3. Find design bond stress of the following cases: **(Using IS: 456-2000)**

(1) M 20, Fe 250, Tension bar
(2) M 20, Fe 415, Tension bar
(3) M 25, Fe 415, Compression bar
(4) M 20, Fe 250, Compression bar

(ANS: (1) T_{bd} = 1.2 N/mm^2, (2) T_{bd} = 1.92 N/mm^2 (3) T_{bd} = 2.8 N/mm^2 (4) T_{bd} = 1.5 N/mm^2)

ASSIGNMENT-5 SHEAR REINFORCEMENT

Ex.1. A simply supported beam of 250 mm x 500 mm effective is supported on 5 m span and it is subjected to UDL of 44 kN/m (includes self-weight) over entire span. It is reinforced with 4 nos. of 22 mm diameter in tension. Take: Fe 415 and M 20. Effective cover = 50 mm. Design shear reinforcement of beam. Use mild steel vertical stirrups.

(ANS: w = 66 kN/m, V_u = 165 kN, T_v = 1.32 N/mm^2, T_c = 0.66 N/mm^2, V_{us} = 82.5 kN, S_v = 132.49 mm, 2-legged- 8 mm diameter)

Ex.2. A simply supported beam of 300 mm x 500 mm effective is subjected to factored shear force of 180 kN. The beam is reinforced with 1.2% of tension steel. Take: Fe 415 and M 20. Effective cover = 50 mm. Design shear reinforcement of beam.Use Fe 415 steel vertical stirrups.

(ANS: T_v = 1.2 N/mm^2, T_c = 0.66 N/mm^2, V_{us} = 81 kN, S_v = 224 mm, 2-legged- 8 mm diameter)

ASSIGNMENT-6 AXIALLY LOADED COLUMN

EX.1. A short R.C.C. column of size 300 mm x 400 mm is reinforced with 6 nos. of bars of 20 mm diameter. Find safe load of column. Take: Fe 250 and M 20. Use factor of safety is 1.5. Also design lateral ties.

(ANS: A_g = 120000 mm^2, A_{sc} = 1885 mm^2, A_c = 118115 mm^2, P_u = 1260.65 kN, P_{safe} = 840.43 kN, 6 mm lateral ties @ 300 mm c/c)

Ex.2. Design rectangular R.C.C. column for a axial load of 1500 kN. Unsupported length of column is 3.5 m. Use: Fe 250 and M 20. Assume 0.8% steel.

(ANS: A_{sc} = 2600 mm^2, Main steel: 6-22 mm diameter + 2-16 mm diameter,

6 mm lateral ties @ 250 mm c/c)

Ex.3. Design a square R.C.C. column for axial load of 1200 kN. Use: Fe 415 and M 20. Assume 1% steel.

(ANS: A_g = 168224 mm^2, Size: 415 mm x 415 mm, A_{sc} = 1722 mm^2, Main steel: 4-18 mm diameter + 4-16 mm diameter, 6 mm lateral ties @ 250 mm c/c)

Ex.4. Design a circular column for axial load of 1600 kN. Use: Fe 415 and M 25. Assume 0.8% steel and clear cover is 40 mm.

(ANS: A_g = 188280 mm^2, Size: 500 mm diameter, A_{sc} = 1570 mm^2, Main steel: 8-16 mm diameter, D_c = 420 mm, A_{cr} = 138544 mm^2, pitch = 29.91 mm, use: 6 mm mild steel for helix @ 30 mm c/c)

ASSIGNMENT-7 ISOLATED COLUMN FOOTING

EX.1. Design an isolated square pad footing for a square column 400 mm x 400 mm. It is subjected to axial load of 800 kN. Use: Fe 250 and M 20. Take SBC = 120 kN/m^2. All Checks arerequired. Draw plan and elevation.

(ANS: Size: 2700 mm x 2700 mm, p = 164.61 kN/m^2, w = 444.45 kN/m, M_u = 293.89 kN.m, d = 191.76, $d_{provided}$ = 500 mm, D = 565 mm, P_t = 0.34%, A_{st} = 4590 mm^2, Use: 15-20 mm diameter bars as main steel, (one-way): V_u = 288.90 kN, T_v = 0.214 N/mm^2, T_c = 0.408 N/mm^2 , (Two-way): V_u = 1066.67 kN, T_v = 0.592 N/mm^2, T'_c = 1.11 N/mm^2 ,L_d = 1100 mm, No dowel bars)

Ex.2. Design an isolated square sloped footing for a square column 500 mm x 500 mm. It is subjected to axial load of 2000 kN. Use: Fe 415 and M 20. Take SBC = 250 kN/m^2. Check for cracking and development length only. Assume edge depth is 300 mm. Draw plan and elevation.

(ANS: Size: 3000 mm x 3000 mm, p = 333.33 kN/m^2, w = 1000 kN/m, M_u = 781.25 kN.m, d = 752.4 mm, $d_{provided}$ = 950 mm, D = 1015 mm, P_t = 0.54%, A_{st} = 2565 mm^2, Use: 23-12 mm diameter bars as main steel, L_d = 564 mm, $L_{d\text{-}provided}$ = 1200, Clear spacing between bars = 119.27 mm)

ASSIGNMENT-8 ONE WAY SLAB & TWO WAY SLAB

Ex.1. Design one-way simply supported slab for office building of size 3.2 m x 9.2 m. Wall thickness is 300 mm. LL = 2.5 kN/m^2 and FF = 1 kN/m^2. Take: Fe 415 and M 20. Check for deflection and cracking. Draw details of reinforcement. Assume 0.6% steel and 10 mm bars. Use clear cover is 20 mm.

(ANS: l = 3200 mm, M.F. = 1.15, d = 139.13 mm, $d_{provided}$ = 150 mm, D = 175 mm,l_{eff} = 3350 mm, DL = 4.375 kN/m, LL = 2.5 kN/m, FF = 1 kN/m, w = 11.82 kN/m, M_u = 16.58 kN.m, d = 77.50 mm, $d_{provided}$ = 150 mm, P_t = 0.215%, A_{st} = 322.5 mm^2, provide: 10 mm-240 mm c/c (Main steel), A_{st} = 210 mm^2, provide: 6 mm-130 mm c/c (distribution steel), Cracking: (Main) – 240 mm, (Distribution)- 130 mm, M.F. = 1.6, Allowable l/d = 32, Actual l/d = 22.33)

Ex.2. Design one-way continuous slab for three equal span of 3.5 m. Wall thickness is 300 mm. LL = 5 kN/m^2 and FF = 1 kN/m^2. Take: Fe 415 and M 20. Check for deflection and cracking. Draw details of reinforcement. Assume 0.6% steel and 10 mm bars. Use clear cover is 20 mm.

(ANS: l = 3500 mm, M.F. = 1.15, d = 117.05 mm, $d_{provided}$ = 150 mm, D = 175 mm, l_{eff} = 3500 mm, DL = 5.375 kN/m, LL = 7.5 kN/m, FF = 1 kN/m, w_{DL} = 8.1 kN/m, w_{LL} = 7.5 kN/m, $M_{u\text{-}max}$ = 20.13 kN.m, d = 85.40 mm, $d_{provided}$ = 150 mm, P_t = 0.217%, A_{st} = 325.5 mm^2, provide: 10 mm-240 mm c/c (Main steel), A_{st} = 210 mm^2, provide: 6 mm-130 mm c/c (distribution steel), Cracking: (Main) – 240 mm, (Distribution)- 130 mm, M.F. = 1.6, Allowable l/d = 41.6, Actual l/d = 22.33)

Ex.3. Design Two-way simply supported slab for office building of size 3 m x 3 m. Wall thickness is 300 mm. LL = 3.0 kN/m^2 and FF = 1 kN/m^2. Take: Fe 415 and M 20. Check for deflection and cracking. Draw details of reinforcement. Assume 0.3% steel and 10 mm bars. Use clear cover is 20 mm. Corners are not held down.

(ANS: l = 3000 mm, M.F. = 1.5, d = 71.42 mm, $d_{provided}$ = 110 mm, D = 135 mm, $l_x = l_y$ = 3110 mm, DL = 3.375 kN/m, LL = 3.0 kN/m, FF = 1 kN/m, w = 11.06 kN/m, $M_x = M_y$ = 6.63 kN.m, d = 49 mm, $d_{provided}$ = 110 mm, P_t = 0.155%, A_{st} = 264 mm^2,(along L_x) provide: 8 mm-190 mm c/c, A_{st} = 265 mm^2, (along L_y) provide: 8 mm-200 mm c/c , Cracking: 190mmand 200 mm, M.F. = 2.0, Allowable l/d = 56, Actual l/d = 28.27)

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