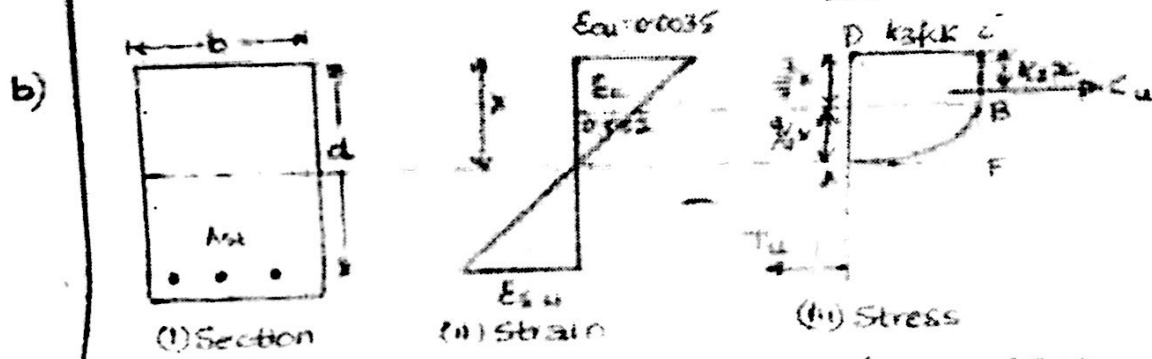


1. a) i) characteristic load :- It means the value of load which has 95% probability of not being exceeded during the life time of the structure.
- ii) Characteristic Strength :- The term characteristic strength means that value of strength of material below which not more than 5% of the test results are expected to fall.
- iii) Partial Safety factor :- When assessing the strength of a structure for the limit state of collapse, the values of 1.5 for concrete and 1.15 for steel is adopted because there are greater chances of variation in strength.

Total = 2+2+2 = 6m



$K_1 = \text{Shape factor} = \frac{\text{Area of ABCD}}{\text{Area of AFCD}} = \frac{\text{Area of ABCD}}{\text{Area}(x \times DC)}$

Ratio $\frac{AE}{AD} = \frac{0.002}{0.0035} = \frac{4}{7}$ Also, $\frac{ED}{AD} = \frac{0.0015}{0.0035} = \frac{3}{7}$

$AE = \frac{4}{7} AD = \frac{4}{7} x$ & $ED = \frac{3}{7} AD = \frac{3}{7} x$

Now Area ABCD = Area ABE + Area BCDE
 $= \frac{9}{21} (AD \times CD) + \frac{9}{21} (AD \times CD)$

$\therefore K_1 = \frac{17}{21} = 0.81$

$K_2 AD = \frac{(\text{Area ABE}) \times \bar{x}_1 + (\text{Area BCDE}) \times \bar{x}_2}{\text{Area ABCD}}$

$K_2 = 0.42$ & $K_3 = 0.67$

total compressive force $C_u = b \times \text{area of ABCD}$
 $C_u = 0.36 \text{ fey} \cdot b \cdot x$

total Tensile force $T_u = 0.87 \text{ fy Ast}$

total = 2+2+2+2+2 = 10m

- 2 a) i) Developmental length:- is defined as the length of the bar required on either side of the Section under consideration to develop the required stress in steel at the Section through bond.
- ii) Short term deflection:- are due to elastic deformations which occur immediately after the member is loaded.
- iii) Long term deflection:- The deflections in the members go on increasing with the life due to creep & shrinkage.
total = 2 + 2 + 2 = 6m

2 b) $b = 300\text{mm}$, $D = 650\text{mm}$, $\text{Cover} = 50$, $f_{ck} = 20\text{N/mm}^2$, $f_y = 415\text{N/mm}^2$
 $L = 5\text{m}$, $IL = 20\text{KN/m}$
 Total Service load $W = 24.875\text{KN/m}$
 $\text{Max B.M} = \frac{WL^2}{8} = 77.734\text{KN}\cdot\text{m}$
 $M_s = \frac{f_{cr} \times I_{gr}}{\gamma_c} = 66.132 \times 10^6\text{Nmm}$, $E_c = 5000\sqrt{f_{ck}} = 22360.681$
 $E_s = 2 \times 10^5\text{N/mm}^2$
 $m = \frac{E_s}{E_c} = 8.944$
 $\frac{bx^2}{2} = m A_{st} (d-x)$, $x = 157.66\text{mm}$
 $I_r = \frac{bx^3}{3} + m A_{st} (d-x)^2 = 2041.26 \times 10^6\text{mm}^4$
 $I_{eff} = \frac{I_r}{1.2 - \frac{M_r \cdot z}{M} \left(1 - \frac{x}{d}\right) \frac{t_w}{b}} = 3297.80 \times 10^6\text{mm}^4$
 $I_r \leq I_{eff} \leq I_{gr}$ Hence OK
 Maxm Deflection = $\frac{5}{384} \frac{WL^4}{EI} = 2.70\text{mm}$

total = 2 + 2 + 2 + 2 + 2 = 10m

MODULE - 2

- 3 a) i) Under Reinforced Section:- In this, the percentage of steel provided is less than that provided in balanced section.
- ii) Over Reinforced Section:- In this section stresses in concrete reaches its permissible value while steel is not fully stressed.
- Balanced Section:- A balanced section is that in which stress in concrete & steel reach their permissible value at the same time
total = 2 + 2 + 2 = 6m

3 b) $b = 300\text{mm}$, $D = 500\text{mm}$, $\text{cover} = 50\text{mm}$, $d = 450\text{mm}$, $f_{ck} = 20\text{N/mm}^2$
 $f_y = 500\text{N/mm}^2$
 $x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b} = 161.92\text{mm}$

$x_{u1m} = 0.46d = 207\text{mm}$ $\therefore x_u < x_{u1m}$ under reinforced Sect.

$$M_u = 133.602 \text{ KNm} \rightarrow$$

$$M_u = \frac{W_u l^2}{8} \quad W_u = 42.752 \text{ KN/m}$$
$$W = 28.501 \text{ KN/m}$$

Super imposed load = $28.501 - 3.75 = 24.751 \text{ KN/m}$

$$\text{total} = 3+3+4 = 10\text{m}$$

4 a) $b = 250\text{mm}$, $D = 450\text{mm}$, $d = 400\text{mm}$, $f_{ck} = 20\text{N/mm}^2$, $f_y = 415\text{N}$

$$V_c = \tau_c \cdot b \cdot d = 0.61 \times 250 \times 400 = 61000 \text{ N} = 61 \text{ KN}$$

Strength due to shear reinforcement

$$V_{us} = \frac{0.87 f_y A_{sv} d}{S_v} = 90.74 \text{ KN}$$

$$V_u = V_c + V_{us} = 61 + 90.74 = 151.74 \text{ KN}$$

$$\text{total} = 3\text{m} + 3\text{m} + 1\text{m} = 7\text{m}$$

4 b) $D_f = 120\text{mm}$, $b_w = 300\text{mm}$, $d = 580\text{mm}$, $A_{st} = 2513\text{mm}^2$

$$b_f = \frac{l_1 + b_w + 6D_f}{6} \geq 0.5(l_1 + l_2) b_w$$

$$1620\text{mm} \geq 3000\text{mm}$$

hence $b_f = 1620\text{mm}$ is OK

Assuming $x_u < D_f$

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b_f} = 77.79\text{mm} < D_f$$

Assumption is correct

$$x_{u1m} = 278.4\text{mm}$$

therefore under reinforced Section

$$M_u = 496.62 \text{ KNm}$$

$$\text{total} = 3\text{m} + 3\text{m} + 3\text{m} = 9\text{m}$$

Module - 3

5) Over all dimension of beam :- $b = 300\text{mm}$ $d = \frac{1}{12}$ th to $\frac{1}{15}$ th span

$$d = 400\text{mm} \quad D = 450\text{mm}$$

$$W_u = 23.06 \text{ KN/m} \quad M_u = \frac{W_u l^2}{8} = 111.88 \text{ KN-m}$$

$$x_{u1m} = 0.48d = 192\text{mm}$$

$$M_{u1m} = 132.45 \text{ KN-m}$$

$M_{u1m} > M_u$ design as

$$M_u = 0.87 f_y A_{st} d \left(1 - \frac{A_{st} f_y}{b d f_{ck}} \right)$$

$$A_{st} = 917.12 \text{ mm}^2$$

Provide 3 bars of 20mm dia.

Design for shear:- Provide 2L-6mm ϕ stirrups @ 300

check for deflection - $\left(\frac{L}{d}\right)_{\text{max}} > \left(\frac{L}{d}\right)_{\text{provided}}$
 mm/c throughout.
 Sketch the details

$$\text{total} = 3\text{m} + 3\text{m} + 3\text{m} + 4\text{m} + 3\text{m} = 16\text{m}$$

6)

$$b = 230 \text{ mm}, D = 600, d = 550, d' = 50, f_{ck} = 20, f_y = 415$$

$$M_u = 293.29 \text{ kN-m}$$

$M_u > M_{u\text{lim}}$ \therefore Doubly reinforced section

$$M_{u\text{lim}} = 196.976 \text{ kN-m}$$

$$A_{st1} = \frac{0.36 f_{ck} b x_{u\text{lim}}}{0.87 f_y} = 1210.9 \text{ mm}^2$$

$$A_{st2} = \frac{M_u - M_{u\text{lim}}}{0.87 f_y (d - d')} = 561.2 \text{ mm}^2$$

$$A_{st} = A_{st1} + A_{st2} = 1772.1 \text{ mm}^2$$

$$A_{sc} = 575.6 \text{ mm}^2 \quad A_{st} \text{ 6\# 20mm \& } A_{sc} \text{ 2\# 20mm}$$

Design for shear:- 2L-8mm ϕ @ 190mm/c

Sketch the details.

$$\text{total} = 4\text{m} + 4\text{m} + 2\text{m} + 4\text{m} + 2\text{m} = 16\text{m}$$

Module - 4

7)

$$d = 120 \text{ mm}, D = 150 \text{ mm}, b = 230 \text{ mm}, L_{\text{eff}} = 3390 \text{ mm}$$

$$M_u = 13.93 \text{ kN-m}$$

$$M_{u\text{lim}} = 39.733 \times 10^6 \text{ N-mm}$$

$\therefore M_u < M_{u\text{lim}}$, design as singly reinforced section.

$$M_u = 0.87 f_y A_{st} d \left(1 - \frac{A_{st} f_y}{b d f_{ck}} \right) \quad A_{st} = 341.7 \text{ mm}^2$$

Provide 10mm dia bars at 225mm/c

check for shear:- $P_t = 0.291$

$$\tau_c = 0.38 = \sqrt{3} \times 0.38 = 0.494 \text{ N/mm}^2$$

$$\tau_c = \frac{V_u}{b d} = 0.197 \text{ N/mm}^2$$

$$\tau_{c\text{max}} = 0.5 \times 2.8 = 1.4 \text{ N/mm}^2$$

$\therefore \tau_v < \tau_c & \tau_c < \tau_{c\text{max}}$

Shear reinforcement is not required.

check for deflection - $\left(\frac{l}{d}\right)_{max} = 40.3$ $\left(\frac{l}{d}\right)_{prov} = 28.25$ -

∴ safe

Sketch the details total = 4+2+4+4+2 = 16m -

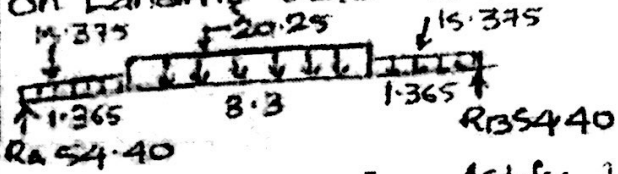
2. Number of Risers = 12, Tread = 11, Eff span = 6.03m

Dead load = 9.7 kN/m, DL + Finishing load in going = 10.5 kN/m

DL Landing portion = 6.25 kN/m + Finishing load = 7.25 kN/m

L/L = 3 kN/m², Factored load on going = 20.25 kN/m

On Landing slab = 15.375 kN/m



$$M_u = 87.5 \text{ kN-m}$$

$$M_{u,lim} = 172.5 \times 10^6 \text{ N-mm}$$

∴ designed as singly reinforced section

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{A_{st} f_y}{b d f_{ck}} \right]$$

$$A_{st} = 1063 \text{ mm}^2$$

Provide 16mm dia bars @ 180mm/c/c

Dist. Steel: - provide 10mm bars @ 230mm/c/c

Sketch the details total = 6+6+4 = 16m

Module-5

3. $P_u = 0.325$ $M_{u,trial} = 252.5 \text{ kN-m}$ $\frac{M_u}{f_{ck} b d^2} = 0.158$

$f_{ck} b d^2$

$$\frac{d'}{D} = 0.15, \text{ Refer chart 45, SP-16 } \frac{P}{f_{ck}} = 0.145$$

$$P = 3.625 \quad A_{sc} = 5800 \text{ mm}^2$$

Provide 12 bars of 25mm dia ∴ $P_{act} = 3.68$

to find $M_{u,x}$

$$M_{u,x} = 0.16 \times 25 \times 400 \times 400^2 = 256 \text{ kN-m}$$

$$\text{to find } M_{u,y} = 256 \text{ kN-m} \quad P_{u,z} = 3567 \text{ kN}$$

$$\alpha_n = 1.273$$

$$\text{check } \left[\frac{M_{u,x}}{M_{u,y}} \right]^{\alpha_n} + \left[\frac{M_{u,y}}{M_{u,y}} \right]^{\alpha_n} = 1.025 > 1 \text{ slightly greater than 1 hence ok.}$$

Sketch details total = 4+4+4+2+2 = 16m

Size of footing 2m x 2m

$q_u = 225 \text{ kN/m}^2$, Depth of footing $d = 360 \text{ mm}$

Check for bending $M_{u,lim} = 715.39 \times 10^6 \text{ N-mm}$

$$M_u = q_u \frac{B(B-b)^2}{8} = 162.563 \times 10^6 \text{ N-mm} < M_{u,lim} \therefore \text{Depth Provided is ok.}$$

Check for two way shear:-

$$A_{st} = 1299 \text{ mm}^2 \text{ Provide 12mm bars @ 170mm/c/c}$$

Sketch the details. total = 4+4+4+2+2 = 16m

— x — x — x — x —