Load due to sunshade $1.2 \times 2.25 = 2.7$ kN/m

Live load $1.2 \times 0.75 = 0.9$ kN/m

Total load $= 4.725$ kN/m

Weight of the triangular masonry is

$$= \frac{1}{2} \times 1.65 \times 1.43 \times 0.3 \times 21.7$$

$$= 7.68 \text{ kN}$$

Design bending moment at mid-span is

$$= 1.5 \times \left( \frac{4.725 \times 1.65^2}{8} + \frac{7.68 \times 1.65}{2 \times 2} - \frac{7.68 \times 1.65}{2 \times 6} \right)$$

$$= 5.58 \text{ kN-m}$$

For the lintel, b = 300 mm and $f_{ck}$ 15 N/mm²
Equating

$$0.138\, f_{ck}\, b\, d^2 = 5.58 \times 10^6 \text{ N-mm}$$

or

$$0.138 \times 15 \times 300\, d^2 = 5.58 \times 10^6 \text{ N-mm}$$

$$d = 97.8 \text{ mm, say } 95 \text{ mm.}$$

Tension reinforcement

$$A_{st} = 0.479 \times 10^{-3} f_{ck}\, b\, d$$

$$= 0.479 \times 10^{-3} \times 15 \times 300 \times 95$$

$$= 204.8 \text{ mm}^2$$

Provide 8 mm diameter bars, 4 Nos. Keep overall depth of the lintel to be 125 mm. this will ensure a cover of 26 mm on the bars. See fig. 2.43 for details of reinforcement.

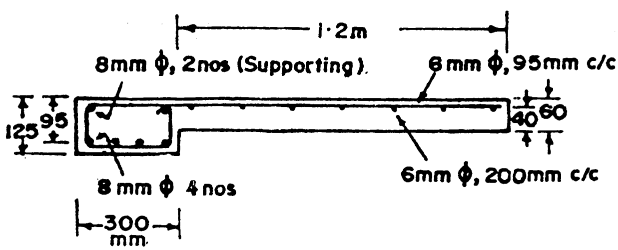


Fig. 2.43 Reinfrocement details for the sunshade.

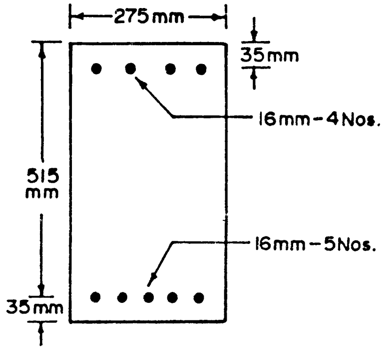


**Fig. 3.4**

*Solution:*

$$b = 275 \text{ mm}, \quad d = 515 \text{ mm},$$

$$A_{st} = 5 \times 201.06 = 1005.3 \text{ mm}^2$$

and $$A_{sc} = 4 \times 201.06 = 804.24 \text{ mm}^2.$$

let the depth of neutral axis be $X_u$. Then, compressive forces are written as

$$C_1 = 0.36 \times 15 \times 275\, X_u$$

$$= 1485\, X_u \quad \text{N}$$

$$C_2 = 804.24\, f_{sc} \quad \text{N}$$

Tensile force in reinforcement is

$$T = 0.87 \times 415 \times 1005.3$$

$$= 362.96 \times 10^3 \text{ N}$$

Equating compressive force to tensile force

$$1485\, X_u + 804.24\, f_{sc} = 362.96 \times 10^3 \quad (3.13)$$

Strain in compression reinforcement is

$$\varepsilon_{sc} = 0.0035 \frac{(X_u - 35)}{X_u} \quad (3.14)$$

From Fig 1.16 the design stress at the limit of proportionality is

$$= \frac{0.8\, f_y}{1.15}$$

$$= \frac{0.8 \times 415}{1.15}$$

$$= 288.7 \text{ N/mm}^2$$

Since $D_f > \frac{3}{7} X_u$ it can be easily shown that $\varepsilon_c < 0.002$. Therefore, the stress $f_c$ in concrete corresponding to the strain $\varepsilon_c$ would lie on the parabolic portion of the stress block.

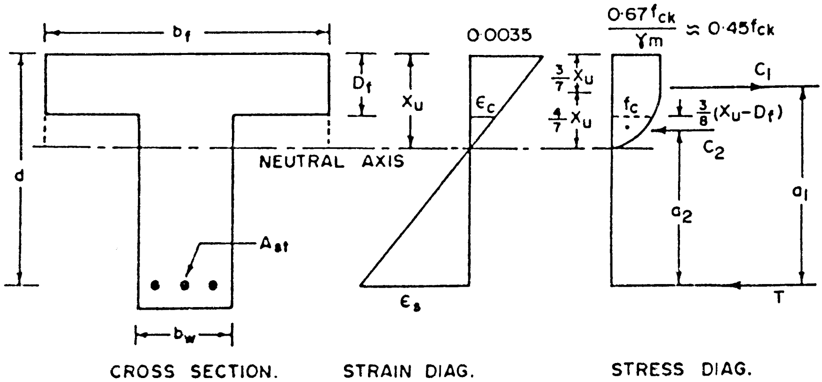


**Fig. 4.5**

As such, $f_c$ can be expressed as a function of $\varepsilon_c$ with the help of Eq. (1.12a) i.e.

$$f_c = 0.45 f_{ck} \{10^3 \varepsilon_c - 0.25 \times 10^6 \varepsilon_c^2\}$$

$$= 0.45 f_{ck} \left\{10^3 \times 0.0035 \left(1 - \frac{D_f}{X_u}\right) - 0.25 \times 10^6 \times 0.0035^2 \left(1 - \frac{D_f}{X_u}\right)^2\right\}$$

$$= 0.1969 f_{ck} \left\{1 + 6 \frac{D_f}{X_u} - 7 \left(\frac{D_f}{X_u}\right)^2\right\} \tag{4.17}$$

Compressive force on the bigger rectangular area is

$$C_1 = 0.36 f_{ck} X_u b_f \tag{4.18}$$

Opposite force on the smaller rectangular area is

$$C_2 = \frac{2}{3} f_c (b_f - b_w)(X_u - D_f) \tag{4.19}$$

∴ Total compressive force in concrete is

$$C = C_1 - C_2$$

$$= 0.36 f_{ck} X_u b_f - \frac{2}{3} f_c (b_f - b_w)(X_u - D_f) \tag{4.20}$$

Distances of the points of application of the forces $C_1$ and $C_2$ from the centre of tension reinforcement are

$$a_1 = (d - 0.42 X_u) \tag{4.21}$$

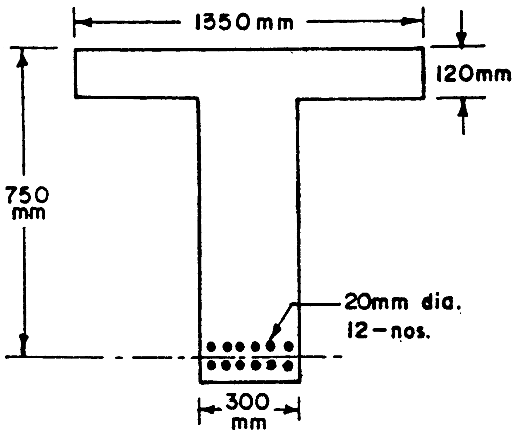


Fig. 4.8

*Solution:*

$$A_{st} = 12 \times 314.16 = 3769.92 \text{ mm}^2, \; f_y = 415 \text{ N/mm}^2,$$

$$f_{ck} = 15 \text{ N/mm}^2, \; b_f = 1350 \text{ mm},$$

$$D_f = 120 \text{ mm and } d = 750 \text{ mm}.$$

As a trial assume that the neutral axis lies outside the flange i.e. $X_u > D_f$.

Further assume that $D_f \leq \frac{3}{7} X_u$

Then, from Eq. (4.7)

$$C_1 = 0.36 \times 15 \times 300 \, X_u$$

$$= 1620 \, X_u$$

and from Eq. (4.8)

$$C_2 = 0.45 \times 15 \, (1350 - 300) \times 120$$

$$= 850500 \text{ N}$$

From Eq. (4.14) $\quad T = 0.87 \times 415 \times 3769.92$

$$= 1361130 \text{ N}$$

Equating $\quad C = T$

i.e. $\quad 1620 \, X_u + 850500 = 1361130$

$$X_u = 315.2 \text{ mm} > D_f \text{ i.e. } 120 \text{ mm}.$$