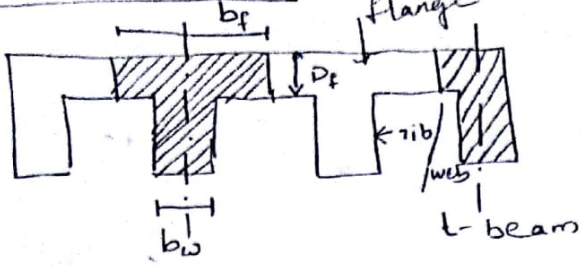
# MODULE-2

## FLANGED BEAMS




$b_f$ :- width of the flange
$D_f$ :- Depth of the flange
$b_w$ :- width of the web

## Parameters of a flanged beam

The most common type of reinforced concrete floor & roof system comprises of concrete slabs monolithically casted with floor beam in the span range of 5-10m. In such cases the compressive flange is made upto of the width of the rib and a portion of the slab length on either side of the rib reinfored to as the effective width of flange. Fig shows the prominent design parameters of flanged (T-beam) beam using the notation used in IS 456:2000 code [cl 23.1 page 36, IS 456:2000

Q) A tee beam slab floor of an office building comprises of a slab 150mm thick spanning b/w ribs spaced at 3m centres. The effective span of the beam is 8m. Live load on floors is $4 kN/m^2$. Using $M_{20}$ concrete and $Fe_{415}$ steel bars, design one of the intermediate T-beam

Solution :-

Given Details

$D_f = 150mm$

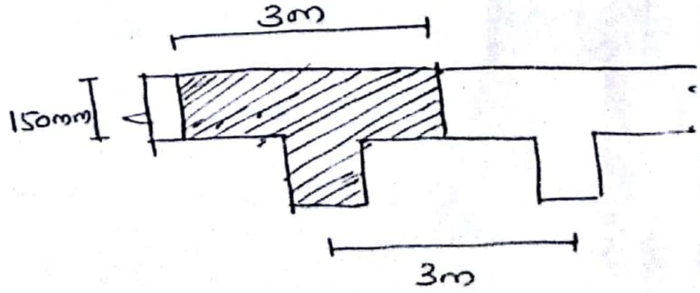
Spacing of tee beam = 3m

$l_{eff}$ of beam = 8m.

$L.L = 4 kN/m^2$

$f_{ck} = 20 N/mm^2$

$f_y = 415 N/mm^2$



Span to depth ratio for S.S beam = 20

[cl. 23.2.1 of IS 456:2000]

Assume width of the rib = 300mm and flanged width = 3m.

∴ ratio of web to flanged width = $\frac{0.3}{3} = 0.1$

[From cl 23.2.1. Fig 6, page 36 of IS 456:2000]

Reduction value = 0.80

$$\frac{l}{d} = 20 \times 0.8$$
$$= \underline{\underline{16}}$$

∴ $\frac{l}{d}$ ratio is taken as 16.

Thus effective depth of T-beam, $d = \frac{8000}{16}$

$= 500mm$

Assume effective cover of 50mm

∴ overall Depth = 500+50

$= \underline{\underline{550mm}}$

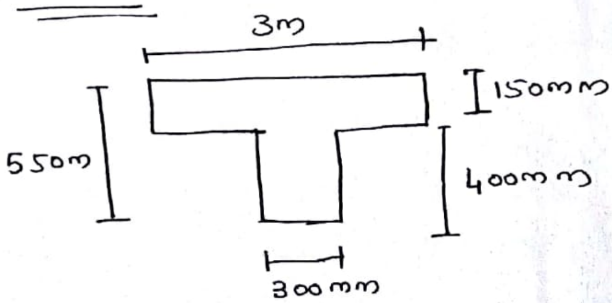
∴ Tee beam parameters are:-

d = 500mm

D = 550mm

$b_w$ = 300mm

$D_f$ = 150mm




**STEP: 2 :- LOADS & BENDING MOMENT**

Self weight of the slab = 3×0.15×25 = 11.25KN/m

Self weight of the rib = 0.3×0.4×25

= 3KN/m

Live load (given) = 4KN/m

Assume finishing load = 1.8KN/m

Total Design Load = ~~20~~ 20.05

~~Ultimate~~

$$BM = \frac{wl^2}{8}$$

$$= \frac{20.05 \times 8^2}{8} = 160.4\,kNm$$

Ultimate moment, $M_u = 240.60\,kNm$

Shear force, $V_u = \frac{wl}{2} \times FOS = \frac{20.05 \times 8}{2} \times 1.5$

$= 120.3\,kN$

STEP : 3 :-

Effective width of flange,

i) $b_f = \frac{l_o}{6} + b_w + 6D_f$ [cl 23.1.2, page 37 of IS 456:2000]

$= \frac{8}{6} + 0.3 + 6 \times 0.15$

$= 2.53m$

$= 2530\,mm$

ii) c/c distance of ribs

$= 3000\,mm$

Least value is considered as effective width of flange

$\therefore b_f = 2530\,mm$

STEP : 4 :-

Moment capacity of the section.

$M_{ulimit} = 0.36 \frac{x_{umax}}{d}\left[1 - 0.42 \frac{x_{umax}}{d}\right] bd^2 f_{ck}$

If N.A lies in the flange.

$= 0.36 f_{ck}\, b_f\, D_f \left[d - 0.42 D_f\right]$

$= 0.36 \times 20 \times 2530 \times 150 \left[500 - 0.42 \times 150\right]$

$= 1194 \times 10^6\,Nmm$

$= 1194\,kNm$

$\therefore M_u < M_{ulimit}$

$246 < 1194$

ie, $x_u < D_f$

Hence, the section is considered as a rectangular section such width = width of flange. $[b = b_f]$

Step: 5 - COMPUTATION OF Ast

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

$$246 \times 10^6 = 0.87 \times 415 \times A_{st} \times 500 \left[1 - \frac{A_{st} \times 415}{2530 \times 500 \times 20}\right]$$

$A_{st} = 1417\ mm^2$, No: of bars = $A_{st} / \frac{\pi}{4} \times 25^2 = 2.9 \simeq 3$ No

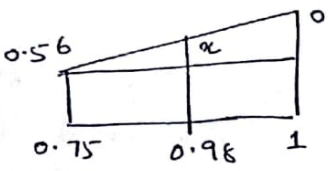
Provide 3 bars of 25mm $\phi$ $\left[A_{st}\ \text{provided} = 3 \times \frac{\pi}{4} \times 25^2 = 1473\ mm^2\right]$

also provide 2 hanger bas of 8mm dia on the compression side.

Step-6 :- Design of shear reinforcement.

$$\tau_v = \frac{V_u}{bd} = \frac{120.24 \times 10^3}{300 \times 500} = 0.802\ N/mm^2$$

$$\tau_c \Rightarrow P_t = \frac{100 A_s}{bd} = \frac{100 \times 1473}{300 \times 500} = 0.98$$




we have, $\tau_c = 0.56 + x$

$$\frac{0.98 - 0.75}{1 - 0.75} = \frac{x}{0.62 - 0.56}$$

$$\therefore x = 0.0552$$

$$\tau_c = 0.56 + 0.0552$$

$$= 0.6152\ N/mm^2$$

$$\tau_{c\,max} = 2.8\ N/mm^2$$

$$\tau_c < \tau_v < \tau_{c\,max}$$

Since $\tau_v > \tau_c$. Provide design shear reinforcement in the form of vertical stirrups.

Balanced shear, $V_{us} = V_u - \tau_c b_w d$

$$= 120.3 \times 10^3 - 0.615 \times 300 \times 500$$

$$= 28050\ N$$

$$= 28.05\ kN$$

Assume 2 legged stirrups of 8mm $\phi$

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

$$= \frac{0.87 \times 415 \times 500 \times 2 \times \frac{\pi}{4} \times 8^2 \times 2}{28050}$$

$$= 646mm.$$

Step: 7 <u>Check for spacing of shear reinforcement.</u>

i) 0.75d = 375 mm.

ii) 300mm

iii) 646mm.

Least value is taken

Provide 2 legged stirrup of 8mm $\phi$ @ 300mm c/c