UNIT -II
DESIGN OF BEAMS

2.2 Design of Flanged beams

Problem 1.Find the flange width of the following simply supported T-beam. Effectivespan = 6m, C/C distance of adjacent panels = 3.0m, Breadth of the web =350mm, Thickness of slab = l00mm.

Solutions:

Given: $l = 6m$,

$b_f = 300$,

$D_f = l00mm$.

Since the beam is simply supported, the distance between the points of zero moments $l_0 = l = 6m$

Clear span of the slab to the left or right of the beam

= C/C distance of adjacent panels — b_w

=3000 — 350 = 2650mm

Effective width of the flange is the least of the following:

i) $b_f = l_0/6 + b_w + 6D_f$

$= 6000 + 350 + 6 \times 100 = l950mm$

ii) b_f = b_w + Half of the clear distance to the adjacent beams on either side

$= 350 + 2650/2 + 2650/2 = 3000mm$

Therefore, b_f = **1950**mm.

Problem 2.A T-beam of depth of 450 mm has a flange width of 1000 mm and depth of 120 mm. It is reinforced with 6- 20mmϕ bars on tension side with a cover of 30 mm. If M-20 concrete and Fe415 steel are used. Calculate MR of beam. Take b_w= 300mm.

Solution:

Given : $b_w = 300mm$,

$b_f = l000mm$,

$D_f = 120mm$,

Clear Cover = 30mm,

D = 450mm Effective cover= 30 + 20/2 = 40mm

d = 450 - 40 = 4l0mm

M20, f_{ck} = 20 N/mm^2

Fe415, f_y = 415 N/mm^2

Assuming Actual Neutral Axis (x_u) lies within the flange (i.e, $x_u \leq D_f$)

$X_u/d = (0.87.f_y.A_{st})/ (0.36.f_{ck}.b.d)$

= 0.87x415x1885 / (0.36x1000x20)

= 94.52mm < D_f (120mm)

Assumption is correct

The value of $x_{u,max}$ /d from IS:456-2000 for Fe415

$0.48.x_{u,max}$ = 0.48d = 0.48x410 = 196.8mm

$x_u < x_{u,max}$, section is under reinforced, calculate the moment of resistance by the following expression

M_u =0.87. f_y. A_{st}.d. [1-((f_y. A_{st})/(f_{ck}.b.d))]

= 0.87x415x1885x410x(1-((1885x415)/(1000x410x20)))

= 252.41x10^6 N-mm

M_u= **252.41x10^6** N-mm.

Problem 3.Calculate the Ultimate moment of resistance of a tee-beam having the following section properties. Use M20 and Fe 415 HYSD bars. Width of flange = l300mm, Thickness of flange = l00mm, Width of rib = 325mm, Effective depth = 600mm, Area of steel = 4000mm^2

Solution:

Given: b_w = 325mm,

b_f = l300mm,

D_f = l00mm,

d = 600mm,

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

f_y =415N/mm^2,

A_{st} = 4000mm2.

Assuming Actual Neutral Axis (x_u) lies within the flange (i.e, $x_u \leq D_f$)

$X_u/d = (0.87.f_y.A_{st})/ (0.36.f_{ck}.b.d)$

$= 0.87x415x4000 / (0.36x1300x20)$

$= 154.3mm > D_f (100mm)$

Assumption is wrong, neutral axis lies below the flange.

$D_f / d = 100 / 600 = 0.166 < 0.2$

The value of x_u by using relation $C_1+C_2=T$

$C_1 = 0.36.f_{ck}.x_u.b_w = 0.36x20x325x\ x_u = 2340\ x_u$

$C_2 = 0.45.f_{ck}.(b_f - b_w).D_f$

$= 0.45x20x100x(1300-325)$

$= 877500\ NT = 0.87.\ f_y.\ A_{st}$

$= 0.87x415x4000 = 1444200\ N$

$2340\ x_u + 877500 = 1444200$

$x_u = 242.18mm$

$x_{u,max} = 0.48d = 0.48x600 =$ 288mm $x_u < x_{u,max}$, section is under reinforced.$D_f / x_u = 100 / 242.18 = 0.413$ $< 0.43.$

Hence use equation for M_u calculation

$$M_u = 0.36.\ f_{ck}.b_w.d^2.(x_u/d).(\ 1-0.42.(x_u/d)) + 0.45.f_{ck}.(b_f - b_w).D_f.(d-(D_f/2))$$

$M_u = 0.36x\ (242.18/600)x(1-0.42x(242.18/600))x325x600^2x20 +$

$0.45x20x(1300-325)x100x(600-(100/2))$

$= 282557218 + 482625000$

$= 765.18x10^6$ N-mm

$=$ **765.15** kN-m.