Design Problem – T beam

An isolated T-beam has a flange of 1200x100mm, width of rib is 250mm and effective depth is 600mm. Tension steel is 3500mm2. Grade of concrete is M20 and steel grade is Fe415. Compute the ultimate moment of resistance. Span of SS beam = 8m. Also calculate the safe superimposed load the T-beam can carry, if effective cover = 50mm.

Solution:

Given: bw = 250mm,

bf = l200mm,

Df = l00mm,

d = 600mm,

fck = 20N /mm^2,

fy = 415N/mm^2,

Ast = 3500mm^2,

l = 8m,

D = 600 + 50 = 650mm.

For Isolated T-beam Effective flange width is the least of the following:

1. bf = I /[(I/b)+4] + bw

= 8000/((8000/1200)+4)+250 = 1000mm

2. bf = actual width of the flange = 1200 mm

Therefore, bf = 1000 mm.

Assuming Actual Neutral Axis (xu) lies within the flange (i.e, xu ≤ Df)

Xu/d = (0.87.fy.Ast)/ (0.36.fck.b.d) = 0.87x415x3500 / (0.36x1000x20) = 175.51mm > Df (100mm)

Assumption is wrong, neutral axis lies below the flange.

Df / d = 100 / 600 = 0.166 < 0.2

The value of xu by using relation C1+C2=T

C1 = 0.36.fck.xu.bw = 0.36x20x250x xu = 1800 xu

C2 = 0.45.fck.(bf – bw).Df = 0.45x20x100x(1000-250) = 675000 N T = 0.87. fy. Ast = 0.87x415x3500 = 1263675 N

1800 xu+ 675000 = 1263675

xu = 327.04mm

xu,max = 0.48d = 0.48x600

= 288mm xu> xu,max,

section is over reinforced.

Df / xu = 100 / 327.04 = 0.305 < 0.43.

Hence use equation for Mu calculation

Mu= 0.36. fck.bw.d2.($_{xu,max}$/d).(1-0.42.(x $_{xu,max}$ /d)) + 0.45.fck.(bf – bw).Df.(d-(Df/2))

Mu= 0.36x 0.48x(1-(0.42x0.48))x250x6002x20 + 0.45x20x(1000-250)x100x(600- (100/2))

= 248334336 + 371250000

= 619.58x106 N-mm

= 619.58 kN-m.