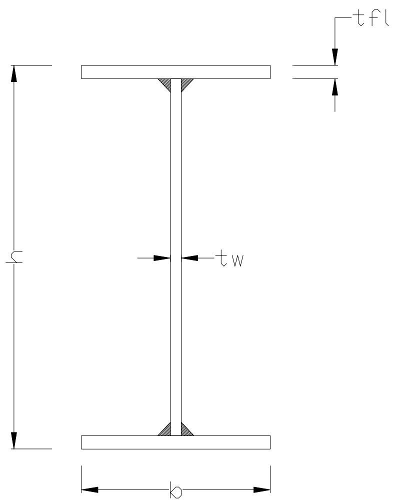
BUILT UP STEEL BEAMS

In designing built up sections , the minimum area of the section must be determined in order to be adequate to the required section modulus (Zreq = M/0.6fy)



Thickness of the web (t):

The thickness of the web can be determined empirically from the following equation :

$$t = 7 + 3h \text{ must be } \geq 3Q/2hFv$$

where t is the web thickness in mm
h is section depth in meter
Q is the max shear force
Fv design shear strength of steel

Or can be taken from the following table :

h(m)	0.8	1	1.25	1.5	1.75	2	2.5	3	4	5
t(mm)	6-8	8-10	9-10	10-12	12-14	14	14-16	16-18	20	22-24
h/t	100-133	100-125	125-140	125-140	125-146	143	156-178	166-187	200	208-227

The minimum thickness of the web is taken $t = 6$ mm , and is increased in steps of 2 mm

Depth of the section (h) :

$h = 1.15\sqrt{Zreq/t} \geq (1/10 \text{ --- } 1/20)*L$ for deflection control
where L is the beam length

Area of flange :

Area of one flange = 3*Zreq/4h for symmetric sections (identical upper and lower flanges)

Area of the two flanges = 3Zreq/2h for unsymmetrical sections

Then Afl = btfl

Where Afl is area of flange
b is width of flange
tfl is thickness of flange

and $b \leq 30$ tfl

tfl $\geq$ t of web
$\leq 2.5*t$

Checks :

$M/Z \leq Fy$
$Q*S/I*t \leq Fv$

Where
Z is the actual section modulus
I actual section moment of inertia
S = Afl*x + Aw*hw/8

EXAMPLE

Design a built up section of the simply supported beam with span L= 12 m
Live load = 16t/m
Own weight of the beam 0.3 t/m

Solution

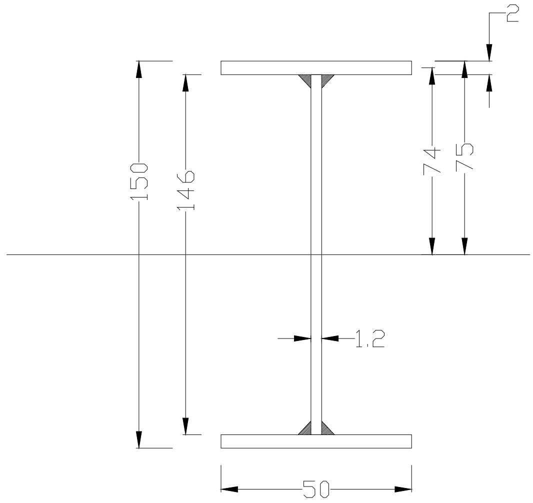
Total load P = LL + DL = 16 + 0.3 = 16.3 t/m
Max bending moment = M = $PL^2/8 = 16.3*12^2/8 = 293.4$ t.m
Max shear force = Q = PL/2 = 16.3*12/2 = 97.8 t
Required Section modulus = Zreq = M/0.6fy = 29340000/0.6*2400 = 20375 cm3

WEB

hmin = L/10 = 12/10 = 1.2m
tmin = 7 +3*h = 7 + 3*1.2 = 10.6 mm
take t = 12 mm
h = $1.15\sqrt{Zreq/t} = 1.15\sqrt{20375/1.2} = 149.8$ cm ≈ 150 cm
choose beam depth = 1.5 m and web thickness = 12 mm

Flange

Afl = 3*Zreq/4*h = 3*20375/4*150 = 101.8 cm2
tfl ≤ 2.5 t = 2.5*12 = 30 mm
take tfl = 20 mm
b*2 = 101.8
b = 50 cm = 500 mm
choose flange section 500*20 mm



section properties

Afl = 100 cm2
$I = t*h^3/12 \; + \; 2*Afl\,X^2$
I = 1432700 cm4
Z = 1432700/75 = 19102 cm3

Check

M/Z = 29340000/19102 = 1012.46 kg/cm2 $<$ Fy = 0.6*2400 = 1440 kg/cm2 ok

S = Afl *x + Aw*hw/8 = 100*74 + 146*1.2*146/8 = 10597.4 cm3

Q*S/I*t =97800*10597.4/1432700*1.2=602.8 kg/cm2 $<$ Fv =0.4*2400=960 kg/cm^2 ok

Design of stiffeners
Stiffeners are usually needed when hw/t > $70\sqrt{2100/Fy}$ Fy in kg/cm2

The max distance between stiffeners is taken equal to a = 2*h for h/t > 100
a = 2.5h for h/t $\leq$ 100

The width of the stiffener is b $\geq$ hw/30 + 40 mm
Where hw is the depth of the web in mm

The thickness of the rib is taken at least b/15