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COIMBATORE

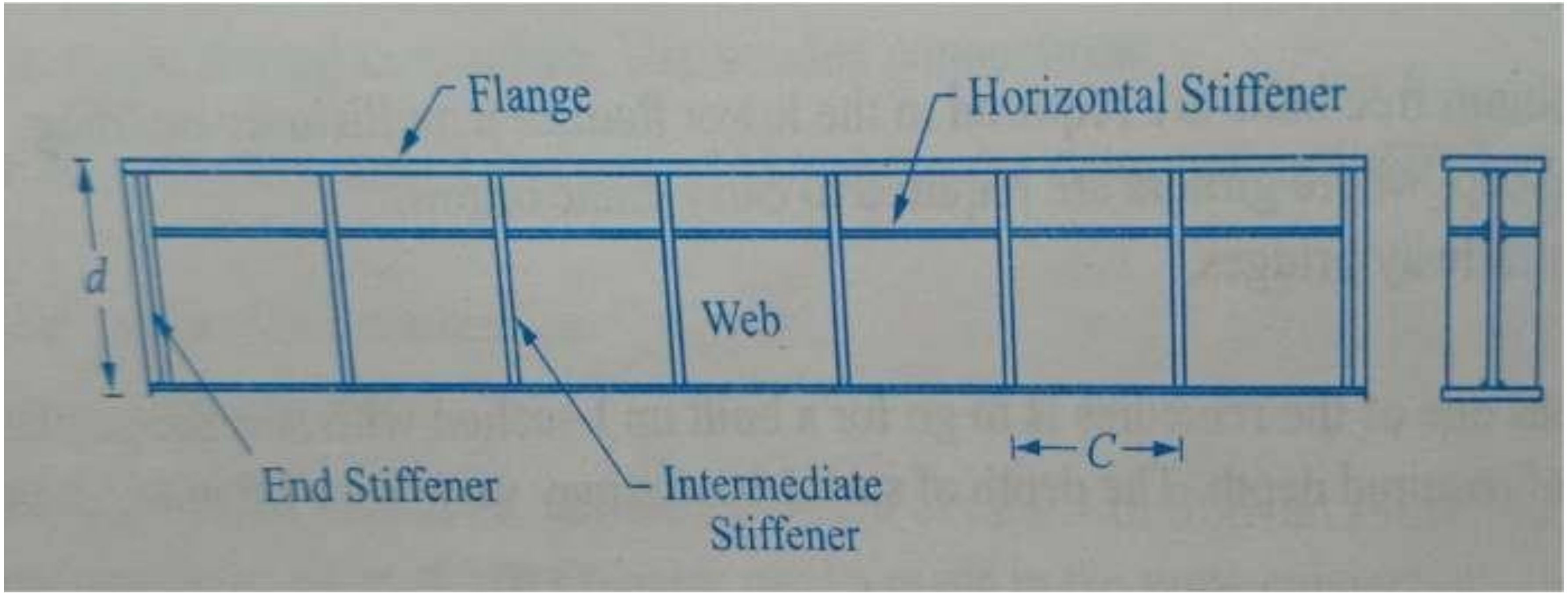
DEPARTMENT OF CIVIL ENGINEERING

19CET304-DESIGN OF STEEL STRUCTURES

III YEAR / VI SEMESTER

Unit 5 :DESIGN OF PLATE GIRDERS, GANTRY GIRDERS & ROOF TRUSSES

Topic – Design of Welded Plate girder



Flange
Horizontal Stiffener
d
Web
End Stiffener
Intermediate Stiffener
C

ar Studs
Flange
stiffener
e to web
illet weld
Web
Bottom

- A plate girder is a beam built up from plate elements to achieve a more efficient arrangement of material than is possible with rolled beams.
- Plate girders are economical where the spans are long enough to permit saving in cost by proportioning for the particular requirements.
- Plate girders may be of riveted, bolted, or welded constructions.

ELEMENTS OF PLATE GIRDER

1. WEB
2. FLANGE
3. STIFFENERS

Webs of required depth and thickness are provided to

a) Keep flange plates at required distances.

b) Resist the shear in beam.

Flanges of required width and thickness are provided to resist bending moment developing compressive force in one flange and tensile force in another flange.

Stiffeners are provided to safeguard the web against local buckling. Stiffeners are provided along transverse(vertical) and longitudinal(Horizontal) direction.

Transverse Stiffeners are of two types.

A) End Bearing Stiffeners and B)intermediate stiffeners

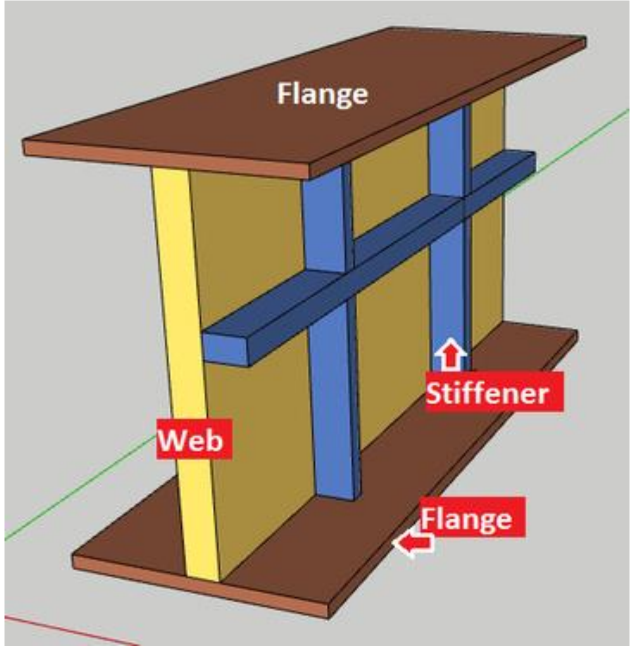
A) End Bearing Stiffeners-These are provided to transfer the load from beam to support. Near the support, certain portion of web is subjected to compression, so there is possibility of crushing of web.Web needs some stiffeners to transfer load to support.

B)Intermediate stiffeners: To resist shear, the required thickness of web may be very small. As thickness is small. To avoid buckling, intermediate stiffeners may be required.

Design a welded plate girder of span 24 m to carry a super imposed load 35 kN/m. Avoid using of bearing and intermediate stiffeners. Use Fe415 steel.

Solution:

1. Calculation of moment and shear Force:



Span=24 m, Super imposed load= 35 kN/m,

Factored super imposed load=35*1.5=52.5 kN/m

Total factored super imposed load=1.5*35*24=1260 kN

Self weight= 1260/200=6.3 kN/m

Total load=52.5+6.3=58.8 kN/m

Bending moment= $58.8*24^2/8$

=4233.6 kNm

SF=58.8*24/2 =705.6 kN

2. Depth of web Plate

Avoiding stiffeners, d/t_w 67

Economical depth of web

$$d=[Mk/f_y]^{1/3}$$

D={4233.6*103*67/250}^1/3=1043 mm

Taking 1000 mm plate $t_w \geq$[1000/67=14.92 mm] Take t_w=16 mm

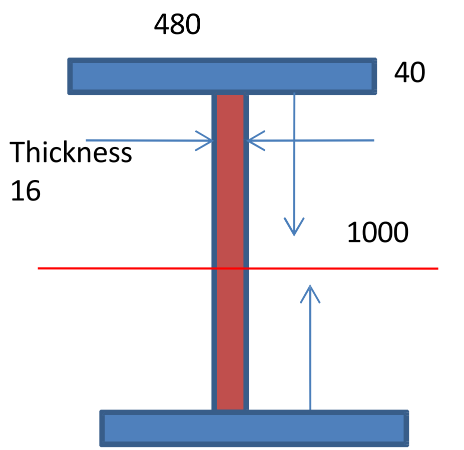
Web plate is 1000 mm *16 mm

3. Selection of Flange:

Assuming moment to be taken by flange

alone $[A_f*f_y*d/1.1] \geq M$

$A_f \geq M*1.1/[f_y*d]$



$A_f \geq [4233.6*106*1.1/\{250*1000\}] \geq 18628$ mm2

For making it a plastic section $b/t_f \leq 8.4$

$b_f/(2*t_f) \leq 8.4$

$b_f=16.8t_f$

$A_f=b_f*t_f=16.8\ tf*tf \geq 18628\ mm^2$

which gives t_f=33.3 mm

Taking 40 mm thick plate ,

b_f=18628/40=465.7 mm

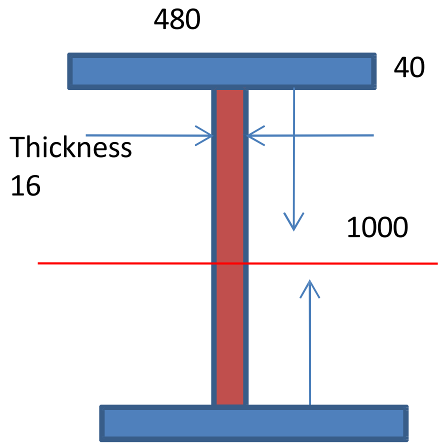
Use flange plate=480 mm*40 mm.

4. Checking Moment Capacity of Girder

Md=[Zp*fy/1.1] ≤ 1.2*Ze*fy/1.1

Md= =[Zp*fy/1.1] =[480*40*(1000+40/2+40/2)*250/1.1]

=4538.182 kN ≤ 1.2*Ze*fy/1.1



$$I_{zz} = 2 * [\frac{1}{12} * 480 * 40^3 + 480 * 40 * \left(\frac{1000+40}{2}\right)^2 =$$
$$= 2 * 5601.28 * 10^6 mm^4$$

$$1.2 * Z_e * \frac{f_y}{1.1} = 1.2 * [I_{zz}/y_{max}] * 250/1.1 ==$$
$$= 1.2 * [2 * 5601.28 * 10^6/540] * 250/1.1$$
$$= 5657.82\, kNm$$

Md=4538.182 > [M=4233.6 kNm]

5.Shear Resisting Capacity:

$$V_d = \frac{A_v * f_{yw}}{1.1 * \sqrt{3}} = \frac{d * t_w * f_{yw}}{1.1 * \sqrt{3}} = \frac{1000 * 16 * 250}{1.1 * \sqrt{3}}$$
$$= 2099.45\ kN > 705.6\ kN$$

No stiffener is required.

6.Check for End Bearing:

Bearing strength of web: $F_w=(b_1+n_2)t_w*f_{yw}/1.1$

Assuming width of bearing 200 mm and stiff bearing length 100 mm

$n_2=2.5*bf=2.5*40=100$ mm

$F_w=(100+100)16*250/1.1=727$ kN>705.6 kN

So, safe.

7.Weld Design to join web to Flange:

Shear force=705.6 kN

Shear force per mm length in the junction=0.512*480=245.76 N

If s is the size of the weld, providing weld on both sides

$$2*0.7*s*\frac{410}{\sqrt{3}*1.25} = 265.1\,s = 245.76\ , s = 0.92\ mm$$

As minimum weld thickness is 5 mm for web thickness 16 mm, so provide intermittent welds.

Percentage of weld=0.92*100/5=18.4 %,

Taking 20% weld length

As minimum weld length 40 mm, unweld length will be 40*4=160 mm

Maximum unweld length=12*t=12*16=192> 160 so OK>

Thank you