

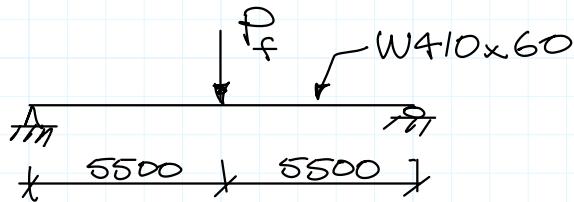
CIVE3205

Example F10

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Mar 11/2020

Revisions

- Mar 11, 2020 - original
- based on example B1, 2012-2019

Example F10Given

Grade 350 W steel
Neglect self weight

Calculate max factored load, P_f for 3 cases

- compression flange fully braced
- " " braced only at ends
- " " braced @ ends & centre

W410x60 :

$$I_x = 216 \times 10^6 \text{ mm}^4$$

$$Z_x = 1190 \times 10^3 \text{ mm}^3$$

$$J = 328 \times 10^3 \text{ mm}^4$$

$$C_w = 468 \times 10^9 \text{ mm}^6$$

$$I_y = 12.0 \times 10^6 \text{ mm}^4$$

$$d = 407 \text{ mm}$$

$$b = 178 \text{ mm}$$

$$t = 12.8 \text{ mm}$$

$$w = 7.7 \text{ mm}$$

$$h = d - 2t = 381 \text{ mm}$$

Local buckling (class 2?)

$$\text{flange } \frac{b_{el}}{t} = \frac{178}{2 \times 12.8} = 6.95$$

$$\text{class 2 lim} = \frac{170}{\sqrt{350}} = 9.09 \quad \text{OK}$$

$$\text{web } \frac{h}{w} = \frac{381}{7.7} = 49.5$$

$$\text{class 2 lim} = \frac{1700}{\sqrt{350}} = 90.9 \quad \text{OK}$$

\therefore section is class 2 or better

a) fully braced

$$\begin{aligned} \S 13.5 \quad M_r &= \phi M_p = \phi F_y Z \\ &= 0.9 \times 350 \times 1190 \times 10^3 \times 10^{-6} \\ &= 374.8 \text{ kN-m} \end{aligned}$$

$$M_r = \frac{P_f L}{4} = \frac{P_f \times 11}{4} = 374.8$$

$$\underline{P_f = 136 \text{ kN}}$$

← a)

b) braced @ ends only (not at load)

$$\S 13.6 \quad L = 11000 \text{ mm}$$

Last para of 13.6 (a) (ii)
says to use $w_2 = 1.0$ & $L = 1.2 \times 11000 = 13200$
(assuming load is applied to top flange)

$$\begin{aligned} M_v &= \frac{w_2 \pi}{L} \sqrt{EI_y GJ + \left(\frac{\pi E}{L}\right)^2 I_y C_w} \\ &= \frac{1.0 \times \pi}{13200} \sqrt{200000 \times 12.0 \times 10^6 \times 77000 \times 328 \times 10^3} \\ &\quad + \left(\frac{\pi \times 200000}{13200}\right)^2 \times 12 \times 10^6 \times 468 \times 10^9 \\ &= 64.45 \times 10^6 \text{ N-mm} \\ &= 64.45 \text{ kN-m} \end{aligned}$$

$$\begin{aligned} M_p &= F_y Z \\ &= 350 \times 1190 \times 10^3 \times 10^{-6} \\ &= 416.5 \text{ kN-m} \end{aligned}$$

$$0.67 M_p = 279 \text{ kN-m}$$

$$M_v < 0.67 M_p$$

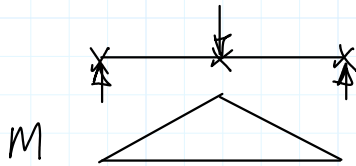
$$\begin{aligned} \therefore M_r &= \phi M_v \\ &= 0.9 \times 64.45 \\ &= 58.0 \text{ kN-m} \end{aligned}$$

$$\frac{11}{4} P_f = 58.0$$

$$\underline{\underline{P_f = 21.1 \text{ kN}}}$$

← b)

c) braced @ ends & mid point.



From Fig 2-15
 $w_2 = 1.75$

$$L = 5500$$

$$M_u = \frac{1.75 \pi}{5500}$$

$$\sqrt{200000 \times 12.0 \times 10^6 \times 77000 \times 328 \times 10^3 + \left(\frac{\pi \times 200000}{5500} \right)^2 \times 12 \times 10^6 \times 468 \times 10^9}$$

$$= 365.8 \times 10^6 \text{ N-mm}$$

$$= 365.8 \text{ kN-m}$$

$$M_p = F_y Z$$

$$= 350 \times 1190 \times 10^3 \times 10^{-6}$$

$$= 416.5 \text{ kN-m}$$

$$0.67 M_p = 279 \text{ kN-m}$$

$$M_u > 0.67 M_p$$

$$\therefore M_r = 1.15 \phi M_p \left[1 - \frac{0.28 M_p}{M_u} \right] \leq \phi M_p$$

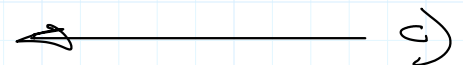
$$= 1.15 \times 0.9 \times 416.5 \left[1 - \frac{0.28 \times 416.5}{365.8} \right] \leq 0.9 \times 416.5$$

$$= 293.6 \leq 374.8$$

$$\therefore M_r = 293.6 \text{ kN-m}$$

$$\frac{11}{4} P_f = 293.6 \text{ kN-m}$$

$$\underline{P_f = 106.8 \text{ kN}}$$



Summary:

a) full support

$$P_f = 136$$

b) support @ ends only

$$P_f = 21.1$$

c) support @ ends & mid-pt.

$$P_f = 107$$