

CIVE 3205

Example F30

N.M. Holtz

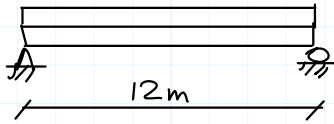
Mar 11, 2020

Revisions:

- Mar 11/20 - original posting.
- Based on example B3, 2013-2019.

Example F30

N. Holtz
March, 2020 1/4



Full lateral support

$$w_d = 6 \text{ kN/m}$$

$$w_e = 11 \text{ kN/m}$$

$$w_f = 1.25 \times 6 + 1.5 \times 11 = 24 \text{ kN/m}$$

- choose economical w section of 350W Steel.

- Deflection:

- commercial

- floor not susceptible to cracking

- defln limit = $\frac{l}{300}$ from table D-1

$$\Delta = \frac{5wl^4}{384EI} \quad (\text{from p 5-146})$$

$$\frac{5wl^4}{384EI} \leq \frac{l}{300}$$

$$I \geq \frac{1500 wl^3}{384E} \quad (w = w_e)$$

$$I \geq \frac{1500 \times 11 \frac{\text{N}}{\text{mm}} \times (12000 \text{ mm})^3}{384 \times 200000 \frac{\text{N}}{\text{mm}^2}}$$

$$I \geq 371 \times 10^6 \text{ mm}^4$$

Moment

$$M_f = \frac{24 \frac{\text{kN}}{\text{m}} \times (12 \text{ m})^2}{8} = 432 \text{ kN/m}$$

Enter Beam Selection Tables

look for $M_r \geq 432$

$$I \geq 371 \times 10^6$$

Example F30

2/4

On page 4-96, we find

$$\begin{array}{lll} W530 \times 72 & M_r = 472 & I = 400 \times 10^6 \\ W530 \times 74 & M_r = 562 & I = 411 \times 10^6 \end{array}$$

- these are the lightest two that appear to be adequate.

$$\begin{array}{ll} \text{Try } W530 \times 74 & Z_x = 1810 \times 10^3 \text{ mm}^3 \\ & d = 529 \text{ mm} \\ & b = 166 \text{ mm} \\ & t = 13.6 \text{ mm} \\ & w = 9.7 \text{ mm} \end{array}$$

Check strength to demonstrate we know how to do it.

Section Class

$$\text{flange: } \frac{b_{el}}{t} = \frac{166}{13.6} = 6.10$$

$$\text{class 2 limit} = \frac{170}{\sqrt{350}} = 9.1$$

\therefore flange is class 2 or better

$$\text{web: } \frac{h}{w} = \frac{529 - 2 \times 13.6}{9.7} = 51.7$$

$$\text{class 2 limit} = \frac{1700}{\sqrt{350}} = 91$$

\therefore web is class 2 or better

\therefore Section is class 2 (or better)

Bending:

$$M_r = \phi Z F_y$$

$$= 0.9 \times 1810 \times 10^3 \text{ mm}^3 \times 350 \frac{\text{N}}{\text{mm}^2} \times \frac{10^{-6} \text{ kN-m}}{\text{N-mm}}$$

$$= 507 \text{ kN-m} > 432 \text{ o.k.}$$

Example F30

3/4

Shear: $\frac{h}{w} = 51.7$

$$\frac{1014}{\sqrt{350}} = 54.2 > \frac{h}{w}$$

$$\therefore F_s = 0.66 F_y = 231 \text{ MPa}$$

$$V_r = 0.9 \times 529 \times 9.7 \text{ mm}^2 \times 231 \frac{\text{N}}{\text{mm}^2} \times 10^{-3} \frac{\text{kN}}{\text{N}} \\ = 1067 \text{ kN}$$

$$V_f = 24 \frac{\text{kN}}{\text{m}} \times \frac{12 \text{ m}}{2} \\ = 144 \text{ kN} \ll 1067 \quad \text{OK.}$$

\therefore W530x74 will work:

Try also W530x72

$$Z_x = 1750 \times 10^3 \text{ mm}^3$$

$$d = 524 \text{ mm}$$

$$b = 207 \text{ mm}$$

$$t = 10.9 \text{ mm}$$

$$w = 8.9 \text{ mm}$$

Section Class

$$\text{flange: } \frac{\frac{207}{2}}{10.9} = 9.5$$

$$\text{class 2 limit} = 9.1 < 9.5 \text{ NG}$$

$$\text{class 3 limit} = \frac{200}{\sqrt{350}} = 10.7 > 9.5 \text{ OK}$$

flange is class 3

Example F30

4/4

$$\text{web: } \frac{h}{w} = \frac{524 - 2 \times 10.9}{8.9} = 56.4$$

$$\text{class 2 limit} = 91 > 56.4 \quad \text{OK}$$

web is class 2 (or better)

\therefore Section is class 3

Bending:

$$M_r = \phi S_x F_y$$

$$= 0.9 \times 1520 \times 10^3 \text{ mm}^3 \times 350 \frac{\text{N}}{\text{mm}^2} \times 10^{-6} \frac{\text{kN-m}}{\text{N-mm}}$$

$$= 479 \text{ kN-m} > 432 \quad \text{O.K.}$$

Shear:

$$\frac{h}{w} = 56.4$$

$$\frac{1014}{\sqrt{350}} = 54.2 < 56.4$$

$$\frac{1435}{\sqrt{350}} = 76.7 > 56.$$

$$F_s = \frac{670 \sqrt{350}}{56.4} = 222 \text{ MPa}$$

$$V_f = 0.9 \times 524 \times 8.9 \times 222 \times 10^{-3}$$

$$= 932 \text{ kN} >> 144 \quad \text{OK.}$$

W530 x 72 also OK.

Use W530 x 72

Note: I tried both sections just to illustrate class 2 & class 3 computations. In reality - you would only try one of them - probably the lightest - but the W530 x 74 gives extra strength & stiffness at little cost.