CIVE 3205

Example AC20

Elastic Local Buckling

$\left(\frac{b_{el}}{t} \; \& \; \frac{h}{w} > \text{limit} \right)$

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Revisions:

- Feb 26/20 – original posting.

AC20-1

Calculate the factored axial strength of a W360x64 of 350W steel. $F_y = 350$ MPa.
Use $L_x = 6000$ mm $\quad L_y = 3000$ mm $\quad K = 1.0$

W360x64:

$A = 8140 \text{ mm}^2$ $\quad b = 203$ mm $\quad t = 13.5$ mm

$r_x = 148$ mm $\quad d-2t = 320$ mm $\quad w = 7.7$ mm

$r_y = 48.1$ mm

i) local buckling

flange: $\dfrac{b_{el}}{t} = \dfrac{203}{2 \times 13.5} = 7.52$

$\text{limit} = \dfrac{200}{\sqrt{350}} = 10.7 > 7.52$ $\quad$ o.k.

web: $\dfrac{h}{w} = \dfrac{320}{7.7} = 41.6$

$\text{limit} = \dfrac{670}{\sqrt{350}} = 35.8 < 41.6$ $\quad$ N.G.

$\therefore$ use § 13.3.5 to compute reduced capacity based on effective properties.

Method (a) - compute effective cross section properties.

web: $\dfrac{h_e}{w} = \dfrac{670}{\sqrt{350}}$

$h_e = \dfrac{670}{\sqrt{350}} \times 7.7 = 275.8$ mm.

(if web had this h, it would meet the slenderness limits).

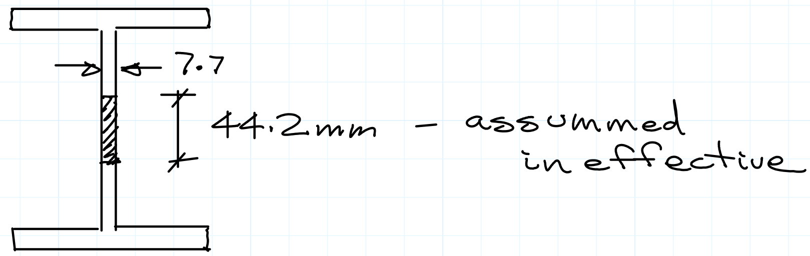
$h - h_e = 320 - 275.8 = 44.2$ mm.

calc. section properties of W360x64 with 44.2 mm of web removed from x-section.

AC20-1 (continued)

W360 x 64:

$A = 8140\ mm^2$



reduced effective area

$A_e = 8140 - 44.2 \times 7.7 = 7800\ mm^2$

Other section properties are to be of the gross x-section (see commentary for §13.3.5)

$\frac{K_x L_x}{r_x} = \frac{1.0 \times 6000}{148} = 40.54$

$\frac{K_y L_y}{r_y} = \frac{1.0 \times 3000}{48.1} = 62.37$ ← governs

$F_e = \frac{\pi^2 \times 200\,000}{62.37^2} = 507.4$

$\lambda = \sqrt{\frac{350}{507.4}} = 0.8305$

$n = 1.34$

$C_r = \phi A_e F_y \left(1 - \lambda^{2n}\right)^{-1/n}$

$= 0.9 \times 7800 \times .35 \left(1 + 0.8305^{2.68}\right)^{-1/1.34}$

$C_r = 1724\ kN$

Method (b) – compute effective $F_y = F_{ye}$

$\frac{h}{w} = \frac{670}{\sqrt{F_{ye}}}$ $\quad F_{ye} = \left(\frac{670}{h/w}\right)^2$

$= \left(\frac{670}{(320/7.7)}\right)^2$

$= 259.9\ MPa$

$F_e = \frac{\pi^2 \times 200000}{62.37^2} = 507.4$

$\lambda_e = \sqrt{\frac{259.9}{507.4}} = 0.7157$

$n = 1.34$

$C_r = 0.9 \times 8140 \times .2599 \left(1 + .7157^{2.68}\right)^{-1/1.34}$

$C_r = 1475\ kN$

AC20-1 (Continued)

Discussion: there is a significant difference between the two methods. The designer is free to use whichever method she prefers; S16-09 does not specify that the minimum should be used.

For comparison, if the strength was not reduced by the methods of §13.3.5

$$C_r = \frac{8140}{7800} \times 1724 = 1799 \text{ kN}$$

By method (a) we have a 4% reduction in strength