CIVE 3205

Steel 1

Partial Solution

BCPS-10

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Revisions:

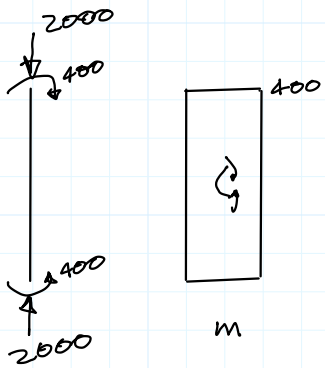
- Mar 27/20 : original posting

W310 x 158: ASTM A992 steel (Table 6-8)

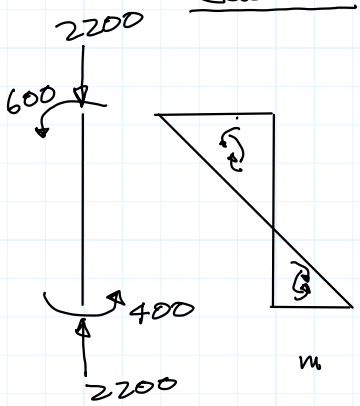
$A = 20100\ mm^2$
$I_x = 386 \times 10^6\ mm^4$
$r_x = 139$
$Z_x = 2670 \times 10^3\ mm^3$
$I_y = 125 \times 10^6\ mm^4$
$r_y = 78.9$
$J = 3770 \times 10^3\ mm^4$
$C_w = 2840 \times 10^9\ mm^6$

$d = 327\ mm$
$b = 310\ mm$
$t = 25.1\ mm$
$w = 15.5\ mm$
$d - 2t = 277\ mm$

Case 1



Case 2



Section Class (See Table 4-7, p4-105)

$\phi C_y = 6241$

$C_f / \phi C_y = 0.3205$

flange - class 1
web - class 1

class 1

$C_f / \phi C_y = 0.3525$

flange - class 1
web - class 1

class 1

a) cross section

$C_r = 6241\ kN$
$M_r = 829.0\ kN\text{-}m$

$\alpha = -\frac{400}{400} = -1$
$\omega_1 = 1.0$

$C_e = \frac{\pi^2 \times 200000 \times 386 \times 10^6}{4600^2}$

$C_e = 36010\ kN$

$C_r = 6241\ kN$
$M_r = 829.0\ kN\text{-}m$

$\alpha = +\frac{400}{600} = +0.667$
$\omega_1 = 0.333 \geq 0.4$
$\omega_1 = 0.4$

$C_e = 36010\ kN$

$$U_{1x} = \frac{1.0}{1 - \frac{2000}{36010}} = 1.059$$

use $U_{1x} = 1.059$

$$\frac{2000}{6241} + \frac{.85 \times 1.059 \times 400}{829.0}$$

$= 0.7548 < 1$ OK

$$U_{1x} = \frac{0.4}{1 - \frac{2200}{36010}} = 0.4260$$

use $U_{1x} = 1.0$

$$\frac{2200}{6241} + \frac{.85 \times 1 \times 600}{829.0} = 0.9677$$

< 1 O.K.

b) overall member strength

for C_r, use $K = 1$, $L = 4600$

$r = r_y = 78.9$

$C_r = 4604$ kN

$M_r = 829.0$ kN-m

$U_{1x} = 1.059$

$$\frac{2000}{4604} + \frac{0.85 \times 1.059 \times 400}{829.0}$$

$= 0.8687 < 1$ OK

$C_r = 4604$ kN

$M_r = 829.0$ kN-m

$U_{1x} = 0.4260$

$$\frac{2200}{4604} + \frac{0.85 \times 0.4260 \times 600}{829.0}$$

$= 0.7399 < 1$ OK

c) lateral torsional buckling strength

for C_r use weak axis.

$K = 1$ because pinned beams frame in.

$\therefore C_r = 4604$ kN

$C_r = 4604$ kN

for M_r: (§ 13.6)

$x = -1$

$\omega_2 = 1.0$

$L = 4600$

$M_{rx} = 829.0$

$U_{1x} = 1.059$

$$\frac{2000}{4604} + \frac{0.85 \times 1.059 \times 400}{829}$$

$= 0.87 < 1$ OK

$x = +0.6667$

$\omega_2 = 2.58 > 2.5$

use $\omega_2 = 2.5$

$L = 4600$

$M_{rx} = 829.0$

$U_{1x} = 1.0$

$$\frac{2200}{4604} + \frac{0.85 \times 1.0 \times 600}{829}$$

$= 1.09 \not< 1$ NG

also: $\frac{M_{fx}}{M_{rx}} \leq 1$

$\frac{400}{829} \leq 1$ OK

$\frac{600}{829} < 1$ OK

W310x158 is not adequate w.r.t. lateral torsional buckling in load case 2