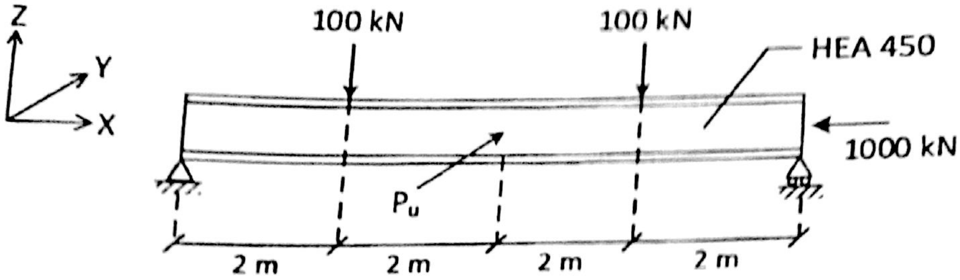
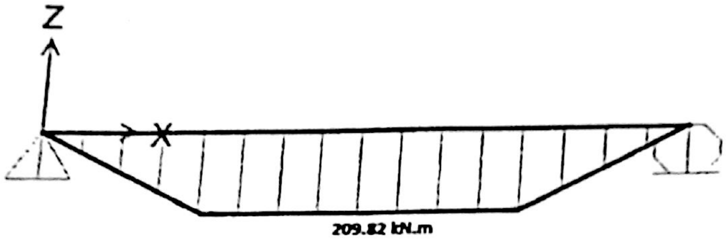
3. Determine the value of the point load, P_u, in the Y direction for the given structure. Use S275 (F_y (σ_y)= 275 MPa, F_u (σ_u)= 430 MPa) steel and LRFD. The moment diagram for the moments in Y direction is also given below. The units of the moments are in kN.m. You can assume that the second order moments in Z direction are 24% larger than the first order moments. The beam is laterally supported only at the supports. The support conditions in the weak axis are both pin supports.



Moments in Y-direction (in kN.m)



Determining P_c : $k = 1$, $L = 8000\,mm$

$r_y = 72.9\ mm$

$$\lambda = \frac{kL}{r} = \frac{1 * 8000}{72.9} = 109.739, \quad \lambda_p = 4.71\sqrt{\frac{2\times10^5}{275}} = 127$$

$\lambda < \lambda_p$ } inelastic buckling

$$\sigma_e = \frac{\pi^2 E}{\lambda^2} = \frac{\pi^2 \times 2\times10^5}{109.739^2} = 163.91\ MPa$$

$$\sigma_{cr} = \left[0.658^{\frac{275}{163.91}}\right] \times 275 = 1\cancel{3}6.26\ MPa$$

$A_g = 17800\ mm^2$

$$P_n = \sigma_{cr} A_g = 136.26 \times \frac{17800}{1000} = 2425.385 \Rightarrow \overset{0.9}{\phi} P_n = 2182.85\ kN$$

$\phi P_n = P_c = 2182.85\ kN$, $P_r = 1000\,kN$

Determining M_{cx} : LTB $Z_x = 3216\times10^3$ $I_y = 9465\times10^4$ $r_y = 72.9\,mm$

$S_x = 2896\times10^3$ $J = 243.8\times10^4$ $C_w = 4148\times10^{?}$

$L_b = 8\,m = 8000\,mm$ $h_0 = d - t_f = 419\,mm$ $Z_y = 965.5\times10^3$

$$L_p = 1.76 \times 72.9\sqrt{\frac{2\times10^5}{275}} = 3460.1\ mm \quad ; \quad r_{ts}^2 = \frac{\sqrt{9465\times10^4 \times 4148\times10^3}}{2896\times10^3}$$

$r_{ts} = 82.716\ mm$

$$L_r = 1.95 \times 82.716\,\frac{E}{0.7\sigma_y}\sqrt{\frac{Jc}{S_x h_0} + \sqrt{\left(\frac{Jc}{S_x h_0}\right)^2 + 6.76\left(\frac{0.7\sigma_y}{E}\right)^2}} = 12105.82\ m$$

$L_p < L_b < L_r$ } inelastic