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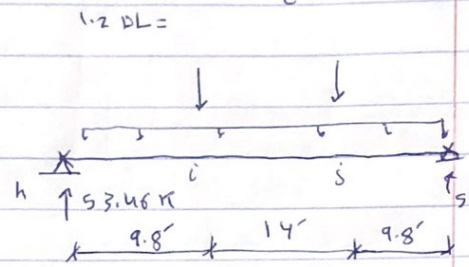
ENCE 437
Final Exam
Part 2.

Beam is W 18 X130
A 572 Gr 50

$F_y = 50$ ksi
$F_u = 65$ ksi

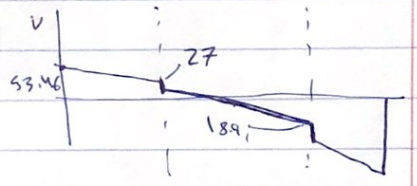


$w_u = 1.2 w_D + 1.6 w_L$
$w_u = 2.7$ k/ft

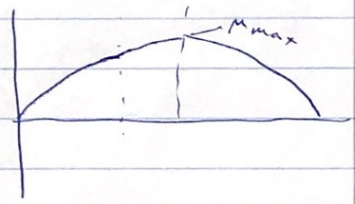
at (i): $P_u = (1.2)(2.2) + 1.6(3.4)$

at i $P_u = 8.1$ k

at j $P_u = 1.2 P_D + 1.6 P_L = 8.1$ k



$V_u = 53.46$ k



$M_{max} = \frac{53.46+27}{2}(9.8) + \frac{(7)(18.9)}{2}$

$M_u = M_{max} = 460.4$ k.ft

$L_b = 33.6'$

$L_p = 1.76\, r_y \sqrt{\frac{E}{F_y}} = (1.76)(8.03)\sqrt{\frac{29000}{50}} = 340'' = 28.4'$

$L_r = 1.95\, r_{ts} \frac{E}{(0.7)F_y} \sqrt{\frac{J_c}{S_x h_o} + \sqrt{\left(\frac{J_c}{S_x h_o}\right)^2 + 6.76\left(\frac{0.7F_y}{E}\right)^2}}$

$h_o = d - t_f = 18.1_{in}$

$\frac{J_c}{S_x h_o} = \frac{14.5}{(256)18.1} = 0.00313$

$r_{ts}^2 = \frac{\sqrt{I_y C_w}}{S_x} = \frac{\sqrt{(1275)(227001)}}{256} = 9.8$

$r_{ts} = 3.13$

$L_r = 440'' = 36.65'$

$L_p < L_b < L_r$

$$C_b = \frac{12.5\, M_m}{2.5\, M_m + 3 M_A + 4 M_B + 3 M_c} = \frac{12.5\,(460.4)}{(2.5)(460.4) + 6(320) + (4)(460.4)}$$

$M_A = M_c = 320$ K.ft $\Rightarrow C_b = 1.17$

$M_B = M_{Max}$

$L_p < L_b < L_r$: $M_n = C_b \left[M_p - (M_p - 0.7 f_y S_x) \left(\frac{L_b - L_p}{L_r - L_p} \right) \right] \leq M_p$

$\frac{L_b - L_p}{L_r - L_p} = \frac{33.6 - 28.4}{36.65 - 28.4} = 0.63$

$M_p = Z_x f_y = (290)\,50 = 14500$ K.ft

$\Rightarrow M_n = 12\,881$ K.ft $< M_p$.

$\phi M_n = 0.9 M_n = 11\,593$ K.ft $> M_u = 460.4$ K.ft

adequate for bending.

For Shear: $V_n = 0.6\, f_y\, A_w\, C_v$

$A_w = d\, t_w = (19.3)(0.67) = 12.93$ in^2

C_v

$h/t_w = 28.8$, $1.1\sqrt{\frac{k_v E}{f_y}} = 59.2 > h/t_w$

So $\Rightarrow V_n = (0.6)(50)(12.93)(1) = 387.9$ K

$\therefore C_v = 1$, $\phi_v = 1$

$\phi V_n = 387.9$ K $>> V_u = 53.46$ K

adequate for Shear.

Check for deflection

Simply support. (Service load).

$$\Delta_D = \frac{5}{384}\frac{w_D L^4}{E I_x} = \frac{5}{384}\frac{(0.62)/12\ (33.6 * 12)^4}{(29000)(2460)}$$

$\Delta_D = 0.25$ in

$\Delta_L = 0.49$ in

$$(\Delta_L)_{limit} = \frac{L}{360} = \frac{(33.6)(12)}{360} = 1.12 \text{ in} > \Delta_L$$

$$(\Delta_D)_{limit} = \frac{L}{240} = 1.68 \text{ in} > \Delta_D$$

~~adequate~~

* No LWB, LFB

Checked ✓ $\lambda_f < \lambda_r$

$\lambda_w < (\lambda_w)_r$

$\lambda_f < (\lambda_f)_r = 24$

$\lambda_w < (\lambda_w)_r = 137.3$

The beam checked is adequate