Sdutions HW2 | Grading

5.12 4 + 3 + 3 = 10 total

5.14 5 total = 5

6.10 6 + 6 + 3 = 15 total

6.11 5 = 5 total

6.12 10 + 5 = 15 total

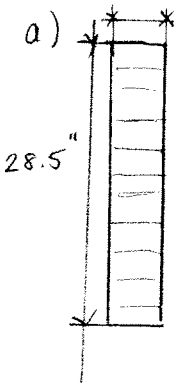
50 total for HW # 2

Points

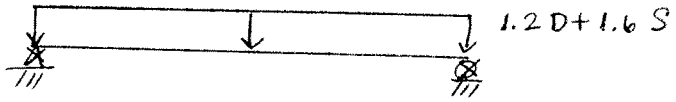
(5.12) Given: Load Combination 1.2D + 1.6S

5 1/8" by 28.5", 24F-1.8E DF, span = 32', l_u = 0.

a)



(Not to scale)



Find: S_x, I_x

(4)

Solution:

$$S_x = \frac{bd^2}{6} = \frac{(5.125")(28.5")^2}{6} = \boxed{693.8\ in^3}$$ ✓

$$I_x = \frac{bd^3}{12} = \frac{(5.125")(28.5")^3}{12} = \boxed{9886.6\ in^4}$$ ✓

Checks with Table 1C

b) Find: $F_{bx}^{+\prime}$, F_{vx}', E_x'

Solution:

$$F_{bx}^{+\prime} = 2400\ psi\ (K_F \phi \lambda)(C_M C_t \cdots C_v \text{ or } C_L)$$

$$= 2400(2.16)(0.8)(C_v \text{ or } C_L)$$

$$= 4147.2\ psi\ (C_v \text{ or } C_L)$$

(3)

$$C_v = \left(\frac{21}{L}\right)^{0.1}\left(\frac{12}{d}\right)^{0.1}\left(\frac{5.125}{b}\right)^{0.1}$$

$$= \left(\frac{21}{32}\right)^{0.1}\left(\frac{12"}{28.5"}\right)^{0.1}\left(\frac{5.125}{5.125}\right)^{0.1}$$

$$= 0.96(0.917)(1.0)$$

$$= 0.88$$

$l_u = 0$ so $C_L = 1.0$

$$\therefore F_{bx}^{+\prime} = 4147.2(0.88) = 3649.5\ psi$$

$$F_{vx}' = 265\ psi\ (K_F \phi \lambda) = 265(2.16)(0.8) = 457.9\ psi$$

$$E_x' = 1.8 \times 10^6\ psi \quad \text{since } C_t = C_M = 1.0.$$

c) MC > 16%: Table 5A Adjustment Factors { C_M = 0.8 for F_b; 0.875 for F_v; 0.833 for E

$F_{bx}^{+/} = 3649.5\ psi\ (0.8) = 2919.6\ psi$

$F_{vx}' = 457.9\ psi\ (0.875) = 400.7\ psi$

$E_x' = 1.8 \times 10^6\ psi\ (0.833) = 1,499,400\ psi$

(3)

10

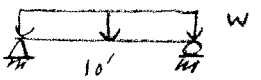
(5.14) Repeat (5.12) for 24F-V4 DF

(5)

Solution: According to Table 5A, this is the same as 24F-1.8E so the answers are the same.

5

(6.10) Given: $w_D = 200^{\#/ft}$, $w_{Lr} = 250^{\#/ft}$



$1.2D + 1.6L_r$

$\ell = 10'$, 4" x 10" nominal, SS H-F $l_u = 0$, MC ≤ 19%

deflection Limit: $\Delta_{allow\ (Live)} \leq L/360$

$\Delta_{allow\ (D+L)} \leq L/240$

Find: if member is adequate (LRFD)

Solution: $\boxed{M_n' \geq M_u,\ V_n' \geq V_u,\ \Delta_{allow} \geq \Delta_{actual}}$

1) Calculate M_u, V_u and Δ_{actual}. 4" x 10" ≡ 3 1/2" x 9 1/4"

$W_u = 1.2\,w_D + 1.6\,w_{Lr} = 1.2(0.2^{k/'}) + 1.6(0.25^{k/'}) = 0.24 + 0.4 = 0.64^{k/'}$

(6)

$M_u = \frac{w_u \ell^2}{8} = \frac{(0.64^{k/'})(10')^2}{8} = 8\ ft\text{-}k = 96\ in\text{-}k$

$V_u = \frac{w_u \ell}{2} = \frac{(0.64^{k/'})(10')}{2} = 3.2^{k}$ {We have the option of using V_u at d" from support.}

$\Delta_{actual} = \frac{5 w \ell^4}{384 E I}$; $I_x = 230.8\ in^4$ from Table 1B Supplement

$\Delta_{actual\ L} = \frac{5(0.25^{k/'})(10')^4}{384(230.8\ in^4) E_x'}$

$E_x = 1,600,000\ psi = 1600\ ksi$; Table 4.3.1: use $C_M C_t C_i$, no $K_F \phi \lambda$.

$\therefore \Delta_{actual\ L} = \frac{5(0.25^{k/'}(\frac{ft}{12"}))(120")^4}{384(230.8\ in^4)(1600\ ksi)} = \frac{216000000}{1418035 20} = 0.15"$

$\Delta_{actual\ D+L} = \frac{5(0.45^{k/'}/12")(120")^4}{384(230.8\ in^4)(1600 ksi)} = \frac{388860 00}{1418035 20} = 0.27"$

2) Calculate M_n', V_n', Δ_{allow}.

$M_n' = S_x \, F_{b_n}'$

$S_x = 49.91 \text{ in}^3$ (Table 1B Supp.)

Supp. Specs.

(Tables 4A & 4.3.1)
(Appendix N)

$F_{b_n}' = (1.400 \text{ ksi}) C_M C_t C_L C_F C_{fu} C_i C_r K_F \phi_b \lambda$
$= (1.4)(1)(1)(1)(1.2)(1)(1)(1)(2.16)(0.8)$
$= \underline{2.903 \text{ ksi}}$

$M_n' = (49.91 \text{ in}^3)(2.903 \text{ ksi}) = \underline{144.9 \text{ in-k}}$

$V_n' = \frac{2}{3} A (F_{v_n}')$ for a rectangular section

$A = 32.38 \text{ in}^2$

$F_{v_n}' = (0.150 \text{ ksi}) C_M C_t C_i K_F \phi_v \lambda$
$= (0.150)(1)(1)(1)(2.16)(0.8)$
$= \underline{0.2592 \text{ ksi}}$

(")

$V_n' = \frac{2}{3} (32.38 \text{ in}^2)(0.2592 \text{ ksi}) = \underline{5.6^k}$

$\Delta_{allow\,L} = \ell/360 = 120"/360 = \underline{0.33"}$

$\Delta_{allow\,D+L} = \ell/240 = 120"/240 = \underline{0.5"}$

6

3) Comparison:

$M_n' = 144.9 \text{ in-k} > M_u = 96 \text{ in-k}$ OK

$V_n' = 5.6^k > V_u = 3.2^k$ OK

$\Delta_{allow\,L} = 0.33" > \Delta_{actual\,L} = 0.15"$ OK

$\Delta_{allow\,D+L} = 0.5" > \Delta_{actual\,D+L} = 0.27"$

3

15 Total

(6.11) Same as before except MC > 19%.

MC affects C_M. C_M is used in the calculation of $F_{b'n}$, $F_{v'n}$ and E.

∴ The capacity values are modified.

and Δ_{actual_L} and $\Delta_{actual_{D+L}}$ are modified.

From Table 4A Supp.:

$C_M = 0.85$ for F_b but need to check $F_b C_F$: $(1400\ psi)(C_F = 1.2) = 1680\ psi > 1150\ psi$.

∴ $C_M = 0.85$ for F_b

$= 0.97$ for F_v

$= 0.9$ for E

∴ $M'_n = S_x F'_{bn} = (49.91\ in^3)(0.85)(2.903\ ksi) = \underline{123.2\ in\text{-}k}$ (5)

(C_M from before)

$V'_n = \frac{2}{3} A F'_{v_n} = \frac{2}{3}(32.38\ in^2)(0.97)(0.2592\ ksi)$

(C_M from before)

$= \underline{5.43\ k}$

$\Delta_{actual_L} = \frac{0.15''}{0.9} = 0.167'' \sim \underline{0.17''}$

$\Delta_{actual_{D+L}} = \frac{0.27''}{0.9} = \underline{0.3''}$

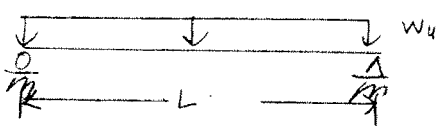
Comparison:

$M'_n = 123.2\ in\text{-}k > M_u = 96\ in\text{-}k$	OK
$V'_n = 5.43k > V_u = 3.2k$	OK
$\Delta_{allow_L} = 0.33'' > \Delta_{actual_L} = 0.17''$	OK
$\Delta_{allow_{D+L}} = 0.5'' > \Delta_{actual_{D+L}} = 0.3''$	OK

5 total

Problem 6.12 LRFD(i).

Given:



$w_D = .2^{k/ft}$, $w_{LF} = 0.25^{k/ft}$

$1.2D + 1.6L_F$

$L = 10'$, 4 x 10 nominal, Sel Str H-F

$l_u = L/2 = 5' = 60''$, MC ≤ 19%

$\Delta_L \leq L/360$

$\Delta_{(D+L)} \leq L/240$

Find: Is member adequate?

Solution: $M_n' \geq M_u$

$V_n' \geq V_u$

$\Delta_{allow} \geq \Delta_{actual}$

(Repeated → no extra points)

1) Calculate M_u, V_u and Δ_{actual} (Repeated from above)

$$M_u = \frac{w_u L^2}{8} = \frac{(0.2^{k/'}(1.2) + 0.25^{k/'}(1.6))(10')^2}{8} = \frac{(\underbrace{0.24 + 0.4}_{0.64})(10')^2}{8} = \underline{96\ in\text{-}k}$$

$$V_u = \frac{w_u L}{2} = \frac{(0.64^{k/'})(10')}{2} = \underline{3.2^k}$$

$\Delta_{actual} = \frac{5wL^4}{384EI}$) 4 x 10 is 3.5" x 9.25" with $I_x = 230.8\ in^4$ Table 1B

E = 1600 ksi Table 4A

$$\Delta_L = \frac{5(0.25^{k/}/(12^{''/}))(10' \times 12^{''/})^4}{384(1600)(230.8)}$$

$$= \frac{5(0.021^{k/''})(120)^4}{14\,1803520} = \underline{0.15''}$$

$$\Delta_{(D+L)} = \frac{5(0.45^{k/}/12^{''/})(120'')^4}{141803520} = \underline{0.274''}$$

2) Calculate M_n', V_n' and Δ_{allow}.

$M_n' = F_{bn}' S_x$. $S_x = 49.91\ in^3$ Table 1B.

$F_{bn}' = (K_F \phi \lambda)(C_M C_t C_L C_F C_{fu} C_i C_r) F_b$ p.27 Table 4.3.1 Specs.

$F_b = 1400$ psi for Sel Struct HF p. 33 NDS Supplement

$C_F = 1.2$ Table 4A Adjustment Factors p.30 NDS Supplement.

$C_t = C_{fu} = C_r = C_M = C_i = 1.0$, $K_F = 2.16/\phi$, $\lambda = 0.8$ Appendix N.

Need to calculate C_L for $l_u = 60"$ See pp. 14-15 Specs.
$l_e = ?$ Table 3.3.3 p. 14 Specs.

$l_u/d = 60"/9.25" = 6.5 < 7$, $l_e = 2.06\, l_u = 123.6"$.

$R_B = \sqrt{\frac{l_e d}{b^2}}$ (p. 15 NDS Specs.)

$= \sqrt{\frac{(123.6")(9.25")}{(3.5")^2}} = \sqrt{\frac{1143.3}{12.25}} = \sqrt{93.3} = 9.7$

(10 pt total Calcul of C_L)

$F_{bE} = \frac{1.20\, E'_{min}}{R_B^2}$

$E'_{min} = \underbrace{C_m C_t C_i C_T K_F \phi_S E_{min}}_{\text{Table 4.3.1 (Specs)}} = \overbrace{(1.5/\phi)\phi}^{\text{Appendix N}} \underbrace{E_{min}}_{\text{Table 4A}} = 1.5(580\ ksi)$

$= 870\ ksi$

$F_{bE} = \frac{1.20\,(870\ ksi)}{93.3} = 11.19\ ksi$

$F_b^* = K_F \phi \lambda (C_m C_t C_F C_i C_r)(F_b = 1{,}400\ ksi)$

$= 2.16(0.8)(1.2)1.4\ ksi$

$= 2{,}903\ ksi$

$F_{bE}/F_b^* = (11.19/2.903) = 3.85$

$1 + F_{bE}/F_b^* = 4.85$

$\frac{1 + F_{bE}/F_b^*}{1.9} = 2.55$

$C_L = \frac{1+(F_{bE}/F_b^*)}{1.9} - \sqrt{\left(\frac{1+(F_{bE}/F_b^*)}{1.9}\right)^2 - \frac{F_{bE}/F_b^*}{0.95}}$

$= 2.55 - \sqrt{(2.55)^2 - 4.05}$

$= 0.984$

$F'_{bn} = 0.984(2.903\ ksi) = 2.856\ ksi$

$M'_n = S_x F'_{bn} = 49.91\ in^3 (2.856\ ksi) = \underline{142.5\ in\text{-}k}$

$V'_n = \left(\frac{2}{3} A\right) F'_v$

$A = 32.38\ in^2$

$F_v = 0.150\ ksi$

$F'_v = F_v (C_M C_t C_i) K_F \phi \lambda$ Table 4.3.1 p. 27 Specs (repeated from 6.10)

$= 0.150(2.16)(0.8)$

$= 0.2592\ ksi$

$V'_n = \frac{2}{3}(32.38\ in^2)(0.2592\ ksi)$

$= \underline{5.6^k}$

$(\Delta_{allow})_L = L/360 = \frac{10'(12''/')}{360} = \underline{0.33''}$

$(\Delta_{allow})_{D+L} = \frac{L}{240} = \underline{0.5''}$

3) Compare

$M'_n \geq M_u$	$142.5\ in\text{-}k > 96\ in\text{-}k$	OK!
$V'_n \geq V_u$	$5.6^k > 3.2^k$	
$(\Delta_L)_{allow} \geq \Delta_L$	$0.33'' > 0.015''$	
$(\Delta_{D+L})_{allow} > \Delta_{D+L}$	$0.5'' > 0.274''$	

5 pts Check

15 pts total