11. FOR THE LOADING SHOWN, CONSIDER THE APPROPRIATE LIVE, DEAD, AND WIND COMBINATIONS

ASSUME THAT THE GRAVITY LOADS ARE THE NO-TRANSLATION EFFECTS AND THE WIND LOAD IS THE TRANSLATION EFFECT.

a) LRFD – CONSIDER $1.2D + 0.5L + 1.6W$

UPPER STORY

$P_{nt} = 1.2(21.6) + 0.5(24) = 37.9$ K

$P_{lt} = 1.6(0.9) = 1.44$ K

$M_{nt_{TOP}} = 1.2(61.7) + 0.5(68.5) = 108$ FT-K

$M_{lt_{TOP}} = 1.6(11.4) = 18.2$ FT-K

$M_{nt_{BOT}} = 1.2(49.3) + 0.5(54.8) = 86.6$ FT-K

$M_{lt_{BOT}} = 1.6(6.0) = 9.60$ FT-K

LOWER STORY

$P_{nt} = 1.2(43.2) + 0.5(48) = 75.8$ K

$P_{lt} = 1.6(3.24) = 5.18$ K

$M_{nt_{TOP}} = 1.2(24.7) + 0.5(27.5) = 43.4$ FT-K

$M_{lt_{TOP}} = 1.6(21.5) = 34.4$ FT-K

$M_{nt_{BOT}} = 1.2(12.4) + 0.5(13.8) = 21.8$ FT-K

$M_{lt_{BOT}} = 1.6(30.7) = 49.1$ FT-K

11 (continued)

1.2D + 0.5L + 1.6W BOTTOM COLUMN

$P_{nt} = 1.2(43.2) + 0.5(48) = 75.8\ K$

$P_{lt} = 1.6(3.24) = 5.18\ K$

$M_{nt\ top} = 1.2(24.7) + 0.5(27.5) = 43.4\ ft\text{-}K$

$M_{lt\ top} = 1.6(21.5) = 34.4\ ft\text{-}K$

$M_{nt\ bot} = 1.2(12.4) + 0.5(13.8) = 21.8\ ft\text{-}K$

$M_{lt\ bot} = 1.6(30.7) = 49.1\ ft\text{-}K$

DETERMINE EFFECTIVE LENGTH FACTORS FROM ALIGNMENT CHART. ASSUME ALL ASSUMPTIONS ARE SATISFIED

TOP STORY

W14x53 $I_x = 541\ in^4$

W18x65 $I_x = 1070\ in^4$

$$G_{top} = \frac{541/12}{1070/24} = 1.01$$

$$G_{bot} = \frac{2(541/12)}{1070/24} = 2.02$$

$K_x =$

11 (continued)

DETERMINE EFFECTIVE LENGTH FACTORS FROM ALIGNMENT CHART. ASSUME CHART ASSUMPTIONS ARE SATISFIED

W14x53, $I_x = 541$ in.^{4} W18x65, $I_x = 1070$ in.^{4}

Top Column

$$G_T = \frac{\frac{541}{12}}{\frac{1070}{24}} = 0.885$$

$$G_B = \frac{\frac{2(541)}{12}}{\frac{1070}{24}} = 1.77$$

$K_x = 1.4$

Bottom Column

$G_T = 1.77$

$G_B = 1.0$ Commentary pg 241

$K_x = 1.4$

DETERMINE COLUMN AVAILABLE STRENGTH, W14x53

$$\frac{KL_x}{r_x/r_y} = \frac{1.4(12)}{3.07} = 5.47 \text{ ft} > K_y L = 1.0(12) = 12.0 \text{ ft}$$

$\therefore \phi P_n = 465$ k

$L_b = 12$ ft $\therefore \phi M_n = 285$ ft-kips

From Table 6-1

$p = 2.15 \times 10^{-3}$ $b_x = 3.12 \times 10^{-3}$

11. (Continued)

Determine amplification factors

Upper Story

B_1; $C_m = 0.6 - 0.4\left(\frac{86.6}{108}\right) = 0.279$

$$P_{e_1} = \frac{\pi^2 E (541)}{(12(12))^2} = 7470$$

$$B_1 = \frac{0.279}{1 - \frac{(37.9 + 1.44)}{7470}} = 0.28 < 1.0 \quad \therefore B_1 = 1.0$$

B_2; $\Sigma P_{e_2} = R_m \frac{\Sigma H L}{\Delta_H} = 0.85 \frac{(2.9)(12)(12)}{12(12)/300} = 739^k$

$$B_2 = \frac{1}{1 - \frac{2(37.9)}{739}} = 1.11$$

Amplified P & M

$P_r = 37.9 + 1.11(1.44) = 39.5^k$ $M_r = 1.0(108) + 1.11(18.2) = 128^k$

Lower Story

B_1; $C_m = 0.6 - 0.4\left(\frac{21.8}{43.4}\right) = 0.40$

$$P_{e_1} = 7470$$

$$B_1 = \frac{0.40}{1 - \frac{(75.8 + 5.18)}{7470}} = 0.404 < 1.0 \quad \therefore B_1 = 1.0$$

11 (CONTINUED)

B_2 j

$$\Sigma P_{e_2} = R_m \frac{\Sigma HL}{D_H} = 0.85 \frac{(2.9+5.8)(12)(12)}{\frac{12(12)}{30}} = 2220^{K}$$

$$B_2 = \frac{1}{1 - \frac{2(75.8)}{2220}} = 1.07$$

Amplified P & M

$$P_r = 75.8 + 1.07(5.18) = 81.3\ K$$

$$M_{r_{top}} = 1.0(43.4) + 1.07(34.4) = 80.2\ ft\text{-}K \ *$$

$$M_{r_{bot}} = 1.0(21.8) + 1.07(49.1) = 74.3\ ft\text{-}K$$

CHECK upper story

$$\rho P_r = 2.15 \times 10^{-3}(39.5) = 0.0849 < 0.2 \quad \therefore \text{use H1-1b}$$

$$\frac{1}{2}(0.0849) + \frac{9}{8}(3.12 \times 10^{-3})(128) = 0.492 < 1.0 \quad \therefore \text{ok}$$

Check Lower story

$$\rho P_r = 2.15 \times 10^{-3}(81.3) = 0.175 < 0.2 \quad \therefore \text{use H1-1b}$$

$$\frac{1}{2}(0.175) + \frac{9}{8}(3.12 \times 10^{-3})(80.2) = 0.369 < 1.0 \quad \therefore \text{ok}$$

Thus, these columns are acceptable by LRFD