CHAPTER 2 - CONCEPTS IN STRUCTURAL STEEL DESIGN

2-1

$D = 30.8$ kips, $L = 1.7$ kips, $L_r = 18.7$ kips, $S = 19.7$ kips

Combination 1: $\quad 1.4D = 1.4(30.8) = 43.12$ kips

Combination 2: $\quad 1.2D + 1.6L + 0.5S = 1.2(30.8) + 1.6(1.7) + 0.5(19.7)$

$\qquad\qquad = 49.53$ kips

Combination 3: $\quad 1.2D + 1.6S + 0.5L = 1.2(30.8) + 1.6(19.7) + 0.5(1.7)$

$\qquad\qquad = 69.33$ kips

(a) Combination 3 controls. $\qquad\qquad\qquad\qquad \underline{P_u = 69.3 \text{ kips}}$

(b) Since $P_u \leq \phi_c P_n$, $\qquad\qquad\qquad\qquad \underline{\phi_c P_n = 69.3 \text{ kips}}$

(c) $P_n = \dfrac{\phi_c P_n}{\phi_c} = \dfrac{69.33}{0.90} = 77.03$ kips $\qquad \underline{P_n = 77.0 \text{ kips}}$

(d) Combination 3 controls.

$\quad P_a = D + (L_r \text{ or } S \text{ or } R) = D + S = 30.8 + 19.7 = 50.5$ kips $\quad \underline{P_a = 50.5 \text{ kips}}$

(e) $P_a \leq \dfrac{P_n}{\Omega}$, $P_n = \Omega P_a = 1.67(50.5) = 84.34$ kips $\qquad \underline{P_n = 84.3 \text{ kips}}$

2-2

$D = 26$ kips, $L = 15$ kips, $L_r = 5$ kips, $S = 8$ kips, $R = 5$ kips, $W = 8$ kips

Combination 1: $\quad 1.4D = 1.4(26) = 36.4$ kips

Combination 2: $\quad 1.2D + 1.6L + 0.5S = 1.2(26) + 1.6(15) + 0.5(8) = 59.2$ kips

Combination 3: $\quad 1.2D + 1.6S + 0.5L = 1.2(26) + 1.6(8) + 0.5(15) = 51.5$ kips

Combination4: $\quad 1.2D + 1.0W + 0.5L + 0.5S = 1.2(26) + 1.0(8) + 0.5(15) + 0.5(8)$

$\qquad\qquad = 50.7$ kips

(a) Combination 2 controls. $\qquad\qquad\qquad\qquad \underline{P_u = 59.2 \text{ kips}}$

(b) Since $P_u \leq \phi_c P_n$, $\qquad\qquad\qquad\qquad \underline{\phi_c P_n = 59.2 \text{ kips}}$

(c) $P_n = \dfrac{\phi_c P_n}{\phi_c} = \dfrac{59.2}{0.90} = 65.78$ $\qquad\qquad\qquad\qquad$ $\underline{P_n = 65.8 \text{ kips}}$

(d) Combination 6a controls.

$\quad P_a = D + 0.75(0.6W) + 0.75L + 0.75S$

$\qquad = 26 + 0.75(0.6)(8) + 0.75(15) + 0.75(8) = 46.85 \text{ kips} \qquad \underline{P_a = 46.9 \text{ kips}}$

(e) $P_a \le \dfrac{P_n}{\Omega}$, $\ P_n = \Omega P_a = 1.67(46.85) = 78.24 \text{ kips}$ $\qquad\quad$ $\underline{P_n = 78.2 \text{ kips}}$

2-3

$D = 0.2 \text{ kips/ft}, \ L_r = 0.13 \text{ kips/ft}, \ S = 0.14 \text{ kips/ft}$

Combination 1: $\quad 1.4D = 1.4(0.2) = 0.28 \text{ kips/ft}$

Combination 2: $\quad 1.2D + 1.6L + 0.5S = 1.2(0.2) + 1.6(0) + 0.5(0.14)$

$\qquad\qquad\qquad\ = 0.31 \text{ kips/ft}$

Combination 3: $\quad 1.2D + 1.6S = 1.2(0.2) + 1.6(0.14) = 0.464 \text{ kips/ft}$

(a) Combination 3 controls. $\qquad\qquad\qquad\qquad\qquad$ $\underline{P_u = 0.464 \text{ kips/ft}}$

(b) Combination 3 controls: $P_a = D + S = 0.2 + 0.14 = 0.34 \text{ kips/ft}$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ $\underline{P_a = 0.34 \text{ kips/ft}}$

2-4

(a) LRFD

Roof:

$\quad D = 30 \text{ psf}, \ L_r = 20 \text{ psf}, \ S = 21 \text{ psf}, \ R = \dfrac{4}{12}(62.4) = 20.8 \text{ psf}$

Combination 1: $\quad 1.4D = 1.4(30) = 42.0 \text{ psf}$

Combination 2: $\quad 1.2D + 1.6L + 0.5S = 1.2(30) + 1.6(0) + 0.5(21) = 46.5 \text{ psf}$

Combination 3: $\quad 1.2D + 1.6S = 1.2(30) + 1.6(21) = 69.6 \text{ psf}$

Combination 3 controls. $\qquad\qquad\qquad\qquad\qquad$ $\underline{P_u = 69.6 \text{ psf}}$

[2-2]

Floor:

$D = 62$ psf, $L = 80$ psf

Combination 1: $1.4D = 1.4(62) = 86.8$ psf

Combination 2: $1.2D + 1.6L = 1.2(62) + 1.6(80) = 202$ psf

Combination 2 controls. $\underline{P_u = 202 \text{ psf}}$

(b) ASD

Roof:

Combination 3 controls: $D + S = 30 + 21 = 51.0$ psf $\underline{P_a = 51.0 \text{ psf}}$

Floor:

Combination 2 controls: $D + L = 62 + 80 = 142.0$ psf $\underline{P_a = 142 \text{ psf}}$

2-5

$D = 13.3$ kips, $L = 6.9$ kips, $L_r = 1.3$ kips, $S = 1.3$ kips, $W = 150.6$ kips,

$E = 161.1$ kips

(a) LRFD

Combination 1: $1.4D = 1.4(13.3) = 18.62$ kips

Combination 2: $1.2D + 1.6L + 0.5L_r = 1.2(13.3) + 1.6(6.9) + 0.5(1.3)$

$= 27.65$ kips

Combination 3: $1.2D + 1.6S + 0.5W = 1.2(13.3) + 1.6(1.3) + 0.5(150.6)$

$= 93.34$ kips

Combination 4: $1.2D + 1.0W + 0.5L + 0.5L_r$

$= 1.2(13.3) + 1.0(150.6) + 0.5(6.9) + 0.5(1.3) = 170.7$ kips

Combination 5: $1.2D \pm 1.0E + 0.5L + 0.2S$

$= 1.2(13.3) + 1.0(161.1) + 0.5(6.9) + 0.2(1.3) = 180.8$ kips

Combination 5 controls. $\underline{P_u = 181 \text{ kips}}$

[2-3]

(b) ASD

Combination 5 controls: $D \pm (0.6W \text{ or } 0.7E) = 13.3 + 0.7(161.1) = 126.1$ kips

$$\underline{P_a = 126 \text{ kips}}$$