

CHAPTER 2 - CONCEPTS IN STRUCTURAL STEEL DESIGN

2-1

$$D = 30.8 \text{ kips}, L = 1.7 \text{ kips}, L_r = 18.7 \text{ kips}, S = 19.7 \text{ kips}$$

$$\text{Combination 1: } 1.4D = 1.4(30.8) = 43.12 \text{ kips}$$

$$\begin{aligned} \text{Combination 2: } 1.2D + 1.6L + 0.5S &= 1.2(30.8) + 1.6(1.7) + 0.5(19.7) \\ &= 49.53 \text{ kips} \end{aligned}$$

$$\begin{aligned} \text{Combination 3: } 1.2D + 1.6S + 0.5L &= 1.2(30.8) + 1.6(19.7) + 0.5(1.7) \\ &= 69.33 \text{ kips} \end{aligned}$$

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

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

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

$$(d) \text{ Combination 3 controls.}$$

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

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

2-2

$$D = 26 \text{ kips}, L = 15 \text{ kips}, L_r = 5 \text{ kips}, S = 8 \text{ kips}, R = 5 \text{ kips}, W = 8 \text{ kips}$$

$$\text{Combination 1: } 1.4D = 1.4(26) = 36.4 \text{ kips}$$

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

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

$$\begin{aligned} \text{Combination 4: } 1.2D + 1.0W + 0.5L + 0.5S &= 1.2(26) + 1.0(8) + 0.5(15) + 0.5(8) \\ &= 50.7 \text{ kips} \end{aligned}$$

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

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

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

(d) Combination 6a controls.

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

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

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

2-3

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

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

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

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

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

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

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

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

2-4

(a) LRFD

Roof:

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

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

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

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

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

Floor:

$$D = 62 \text{ psf}, L = 80 \text{ psf}$$

$$\text{Combination 1: } 1.4D = 1.4(62) = 86.8 \text{ psf}$$

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

Combination 2 controls.

$$\underline{P_u = 202 \text{ psf}}$$

(b) ASD

Roof:

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

$$\underline{P_a = 51.0 \text{ psf}}$$

Floor:

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

$$\underline{P_a = 142 \text{ psf}}$$

2-5

$$D = 13.3 \text{ kips}, L = 6.9 \text{ kips}, L_r = 1.3 \text{ kips}, S = 1.3 \text{ kips}, W = 150.6 \text{ kips},$$

$$E = 161.1 \text{ kips}$$

(a) LRFD

$$\text{Combination 1: } 1.4D = 1.4(13.3) = 18.62 \text{ kips}$$

$$\begin{aligned} \text{Combination 2: } 1.2D + 1.6L + 0.5L_r &= 1.2(13.3) + 1.6(6.9) + 0.5(1.3) \\ &= 27.65 \text{ kips} \end{aligned}$$

$$\begin{aligned} \text{Combination 3: } 1.2D + 1.6S + 0.5W &= 1.2(13.3) + 1.6(1.3) + 0.5(150.6) \\ &= 93.34 \text{ kips} \end{aligned}$$

$$\begin{aligned} \text{Combination 4: } 1.2D + 1.0W + 0.5L + 0.5L_r \\ &= 1.2(13.3) + 1.0(150.6) + 0.5(6.9) + 0.5(1.3) = 170.7 \text{ kips} \end{aligned}$$

$$\begin{aligned} \text{Combination 5: } 1.2D \pm 1.0E + 0.5L + 0.2S \\ &= 1.2(13.3) + 1.0(161.1) + 0.5(6.9) + 0.2(1.3) = 180.8 \text{ kips} \end{aligned}$$

Combination 5 controls.

$$\underline{P_u = 181 \text{ kips}}$$

(b) ASD

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

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