CHAPTER 2 - CONCEPTS IN STRUCTURAL STEEL DESIGN

2-1

D = 9 kips, L_r = 5 kips, S = 6 kips, R = 7 kips, W = 8 kips

(a)

1: $1.4D = 1.4(9) = 12.6$ kips

3: $1.2D + 1.6 + 0.5W = 1.2(9) + 1.6(7) + 0.5(8) = 26$ kips

4: $1.2D + 1.0\text{W} = 1.2(9) + 1.0(8) = 18.8$ kips

R_u = 26 kips (combination 3)

(but the column must be checked for an uplift of 4.7 kips.)

(b) $\phi R_n = 26$ kips

(c) $R_n = \dfrac{\varphi R_n}{\varphi} = \dfrac{26}{0.90} = 28.9$ kips $R_n = 28.9$ kips

(d)

3: $D + R = 9 + 7 = 16$ kips

6. $D + 0.75(0.6W) + 0.75(R) = 9 + 0.75(0.6)(8) + 0.75(7) = 17.9$ kips

R_a = 17.9 kips (combination 6)

(but the column must be checked for an uplift of 2.6 kips)

(e) $R_n = \Omega R_a = 1.67(17.9) = 29.9$ kips $R_n = 29.9$ kips

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2-2

1: $1.4D = 1.4(9) = 12.6$ kips

3: $1.2D + 1.6S + 0.5W = 1.2(9) + 1.6(6) + 0.5(8) = 24.4$ kips

4: $1.2D + 1.0W + 0.5S = 1.2(9) + 1.0(8) + 0.5(6) = 21.8$ kips

(a) 24.4 kips (combination 3)

(b) $\phi R_n = 24.4$ kips

(c) $R_n = \dfrac{\phi R_n}{\phi} = \dfrac{24.4}{0.90} = 27.1$ kips $R_n = 27.1$ kips

(d)

3. $D + S = 9 + 6 = 15$ kips

5. $D + 0.6W = 9 + 0.6(8) = 13.8$ kips

6. $D + 0.75(0.6W) + 0.75S = 9 + 0.75(0.6)(8) + 0.75(6) = 17.1$ kips

$$17.1 \text{ kips } (\text{Combination 6})$$

(e) $R_n = \Omega R_a = 1.67(17.1) = 28.6$ kips $\qquad R_n = 28.6$ kips

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2-3

(a) Combination 1: $1.4D = 1.4(45) = 63$ ft-kips

Combination 2: $1.2D + 1.6L + 0.5L_r = 1.2(45) + 1.6(63) + 0.5(0) = 154.8$ ft-kips

$$R_u = 155 \text{ ft - kips (combination 2)}$$

(b) $R_n = \dfrac{R_u}{\phi} = \dfrac{154.8}{0.9} = 172$ ft - kips $\qquad R_n = 172$ ft - kips

(c) Combination 2: $D + L = 45 + 63 = 108$ ft-kips $\qquad R_a = 108$ ft-kips (combination 2)

(d) $R_n = \Omega R_a = 1.67(108) = 180$ ft-kip $\qquad R_n = 180$ ft-kips

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2-4

$D = 18$ kips, $L = 2$ kips

(a)

1: $1.4D = 1.4(18) = 25.2$ kips

2: $1.2D + 1.6L = 1.2(18) + 1.6(2) = 24.8$ kips

$$R_u = 25.2 \text{ kips (combination 1)}$$

(b)

2: $D + L = 18 + 2 = 20$ kips. $\qquad R_a = 20$ kips (combination 2)

2-5

$D = 21$ psf, $L_r = 12$ psf, $S = 13.5$ psf, $W = 22$ psf upward (*in this particular case, the wind load cannot be reversed, even in those cases where reversal would normally be considered*.)

Treat gravity loads as positive and wind load as negative:

(a)

1: $1.4D = 1.4(21) = 29.4$ psf

2: $1.2D + 0.5S = 1.2(21) + 0.5(13.5) = 32.0$ psf

3: $1.2D + 1.6S + 0.5W = 1.2(21) + 1.6(13.5) + 0.5(-22) = 35.8$ psf

$1.2D + 1.6S + 0.5L = 1.2(21) + 1.6(13.5) + 0.5(0) = 46.8$ psf

$R_u = 46.8$ psf (combination 3)

(Combination 5, with R_u = -3.1 psf, would also need to be considered in the design of the roof in order to prevent uplift.)

(b)

3: $D + S = 21 + 13.5 = 34.5$ psf

5: $D + 0.6W = 21 + 0.6(-22) = 7.8$ psf

6: $D + 0.75(0.6W) + 0.75S = 21 + 0.75(0.6)(-22) + 0.75(13.5) = 21.2$ psf

7: $0.6D + 0.6W = 0.6(21) + (-22) = -9.4$ psf

$R_a = 34.5$ psf (combination 3)

(Combination 7, with R_a = -9.4 psf, would also need to be considered in the design of the roof in order to prevent uplift.)