

Example (LRFD Steel Design, Third Edition by William T. Segui, page 23-24.)

A column (compression member) in the upper story of a building is subject to the following loads:

Dead load: 109 kips compression
 Floor live load: 46 kips compression
 Roof live load: 19 kips compression
 Snow: 20 kips compression

- Determine the controlling load combination and the corresponding factored load.
- If the resistance factor, ϕ , is 0.85, what is the required *nominal* strength?

Solution Even though a load may not be acting directly on a member, it can still cause a load effect in the member. This is true of both snow and roof live load in this example. Although this building is subjected to wind, the resulting forces on the structure are resisted by members other than this particular column.

- The controlling load combination is the one that produces the largest factored load. We evaluate each expression that involves dead load, D , live load resulting from equipment and occupancy, L , roof live load, L_r , and snow, S .

Combination 1: $1.4D = 1.4(109) = 152.6$ kips

Combination 2: $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$. Because S is larger than L_r and $R = 0$, we need to evaluate this combination only once, using S .

$$1.2D + 1.6L + 0.5S = 1.2(109) + 1.6(46) + 0.5(20) = 214.4 \text{ kips}$$

Combination 3: $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (0.5L \text{ or } 0.8W)$. In this combination, we use S instead of L_r , and both R and W are zero.

$$1.2D + 1.6S + 0.5L = 1.2(109) + 1.6(20) + 0.5(46) = 185.8 \text{ kips}$$

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- Combination 4: $1.2D + 1.6W + 0.5L + 0.5(L_r \text{ or } S \text{ or } R)$. This expression reduces to $1.2D + 0.5L + 0.5S$, and by inspection, we can see that it produces a smaller result than combination 3.
- Combination 5: $1.2D \pm 1.0E + 0.5L + 0.2S$. As $E = 0$, this expression reduces to $1.2D + 0.5L + 0.2S$, which produces a smaller result than combination 4.
- Combination 6: $0.9D \pm (1.6W \text{ or } 1.0E)$. This expression reduces to $0.9D$, which is smaller than any of the other combinations.

Answer Combination 2 controls, and the factored load is 214 kips.

- b. If the factored load obtained in part (a) is substituted into the fundamental LRFD relationship, Equation 2.3, we obtain

$$\Sigma \lambda_i Q_i \leq \phi R_n$$

$$214.4 \leq 0.85 R_n$$

$$R_n \geq 252.2 \text{ kips}$$