Combination 5: $1.2D + 1.0E + L + 0.2S$
Combination 6: $0.9D + 1.0W$
Combination 7: $0.9D + 1.0E$

where

D = dead load
L = live load due to occupancy
L_r = roof live load
S = snow load
R = rain or ice load*
W = wind load
E = earthquake (seismic load)

In combinations 3, 4, and 5, the load factor on L can be reduced to 0.5 if L is no greater than 100 pounds per square foot, except for garages or places of public assembly. In combinations with wind or earthquake loads, you should use a direction that produces the worst effects.

The ASCE 7 basic load combinations are also given in Part 2 of the AISC *Steel Construction Manual* (AISC 2011a), which will be discussed in Section 2.6 of this chapter. They are presented in a slightly different form as follows:

Combination 1: $1.4D$
Combination 2: $1.2D + 1.6L + 0.5(L_r \text{ or } S \text{ or } R)$
Combination 3: $1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (0.5L \text{ or } 0.5W)$
Combination 4: $1.2D + 1.0W + 0.5L + 0.5(L_r \text{ or } S \text{ or } R)$
Combination 5: $1.2D \pm 1.0E + 0.5L + 0.2S$
Combinations 6 and 7: $0.9D \pm (1.0W \text{ or } 1.0E)$

Here, the load factor on L in combinations 3, 4, and 5 is given as 0.5, which should be increased to 1.0 if L is greater than 100 pounds per square foot or for garages or places of public assembly. ASCE 7 combinations 6 and 7 arise from the expression shown by considering combination 6 to use $1.0W$ and combination 7 to use $1.0E$. In other words,

Combination 6: $0.9D \pm 1.0W$
Combination 7: $0.9D \pm 1.0E$

Combinations 6 and 7 account for the possibility of dead load and wind or earthquake load counteracting each other; for example, the net load effect could be the difference between $0.9D$ and $1.0W$ or between $0.9D$ and $1.0E$. (Wind or earthquake load may tend to overturn a structure, but the dead load will have a stabilizing effect.)

As previously mentioned, the load factor for a particular load effect is not the same in all load combinations. For example, in combination 2 the load factor for the live load L is 1.6, whereas in combination 3, it is 0.5. The reason is that the live load

*This load does not include *ponding,* a phenomenon that we discuss in Chapter 5.

is being taken as the dominant effect in combination 2, and one of the three effects, L_r, S, or R, will be dominant in combination 3. In each combination, one of the effects is considered to be at its •lifetime maximumŽvalue and the others at their •arbitrary point in timeŽvalues.

The resistance factor ϕ for each type of resistance is given by AISC in the Specification chapter dealing with that resistance, but in most cases, one of two values will be used: 0.90 for limit sates involving yielding or compression buckling and 0.75 for limit states involving rupture (fracture).

2.4 SAFETY FACTORS AND LOAD COMBINATIONS FOR ASD

For allowable strength design, the relationship between loads and strength (Equation 2.1) can be expressed as

$$R_a \leq \frac{R_n}{\Omega} \tag{2.7}$$

where

R_a = required strength
R_n = nominal strength (same as for LRFD)
Ω = safety factor
R_n/Ω = allowable strength

The required strength R_a is the sum of the service loads or load effects. As with LRFD, specific combinations of loads must be considered. Load combinations for ASD are also given in ASCE 7. These combinations, as presented in the AISC *Steel Construction Manual* (AISC 2011a), are

Combination 1:	D
Combination 2:	$D + L$
Combination 3:	$D + (L_r \text{ or } S \text{ or } R)$
Combination 4:	$D + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$
Combination 5:	$D \pm (0.6W \text{ or } 0.7E)$
Combination 6a:	$D + 0.75L + 0.75(0.6W) + 0.75(L_r \text{ or } S \text{ or } R)$
Combination 6b:	$D + 0.75L \pm 0.75(0.7E) + 0.75S$
Combinations 7 and 8:	$0.6D \pm (0.6W \text{ or } 0.7E)$

The factors shown in these combinations are not load factors. The 0.75 factor in some of the combinations accounts for the unlikelihood that all loads in the combination will be at their lifetime maximum values simultaneously. The 0.7 factor applied to the seismic load effect E is used because ASCE 7 uses a strength approach (i.e., LRFD) for computing seismic loads, and the factor is an attempt to equalize the effect for ASD.

Corresponding to the two most common values of resistance factors in LRFD are the following values of the safety factor Ω in ASD: For limit states involving yielding