Chapter C2
COMBINATIONS OF LOADS

C2.1 GENERAL

Loads in this standard are intended for use with design specifications for conventional structural materials, including steel, concrete, masonry, and timber. Some of these specifications are based on allowable stress design, while others employ strength (or limit states) design. In the case of allowable stress design, design specifications define allowable stresses that may not be exceeded by load effects due to unfactored loads, that is, allowable stresses contain a factor of safety. In strength design, design specifications provide load factors and, in some instances, resistance factors. Load factors given herein were developed using a first-order probabilistic analysis and a broad survey of the reliabilities inherent in contemporary design practice (Ellingwood et al. (1982), Galambos et al. (1982)). It is intended that these load factors be used by all material-based design specifications that adopt a strength design philosophy in conjunction with nominal resistances and resistance factors developed by individual material-specification-writing groups. Ellingwood et al. (1982) also provide guidelines for materials-specification-writing groups to aid them in developing resistance factors that are compatible, in terms of inherent reliability, with load factors and statistical information specific to each structural material.

The requirement to use either allowable stress design (ASD) or load and resistance factor design (LRFD) dates back to the introduction of load combinations for strength design (LRFD) in the 1982 edition of the Standard. An indiscriminate mix of the LRFD and ASD methods may lead to unpredictable structural system performance because the reliability analyses and code calibrations leading to the LRFD load combinations were based on member rather than system limit states. However, designers of cold-formed steel and open web steel joists often design (or specify) these products using ASD and, at the same time, design the structural steel in the rest of the building or other structure using LRFD. The *AISC Code of Standard Practice for Steel Buildings and Bridges* (2005) indicates that cold-formed products and steel joists are not considered as structural steel. Foundations are also commonly designed using ASD, although strength design is used for the remainder of the structure. Using different design standards for these types of elements has not been shown to be a problem. This requirement is intended to permit current industry practice while, at the same time, not permitting LRFD and ASD to be mixed indiscriminately in the design of a structural frame.

C2.2 SYMBOLS AND NOTATION

Self-straining forces can be caused by differential settlement foundations, creep in concrete members, shrinkage in members after placement, expansion of shrinkage-compensating concrete, and changes in temperature of members during the service life of the structure. In some cases, these forces may be a significant design consideration. In concrete or masonry structures, the reduction in stiffness that occurs upon cracking may relieve these self-straining forces, and the assessment of loads should consider this reduced stiffness.

Some permanent loads, such as landscaping loads on plaza areas, may be more appropriately considered as live loads for purposes of design.

C2.3 COMBINING FACTORED LOADS USING STRENGTH DESIGN

C2.3.1 Applicability

Load factors and load combinations given in this section apply to limit states or strength design criteria (referred to as “load and resistance factor design” by the steel and wood industries), and they should not be used with allowable stress design specifications.

C2.3.2 Basic Combinations

Unfactored loads to be used with these load factors are the nominal loads of this standard. Load factors are from Ellingwood et al. (1982), with the exception of the factor 1.0 for *E,* which is based on the more recent NEHRP research on seismic-resistant design (FEMA 2004). The basic idea of the load combination analysis is that in addition to dead load, which is considered to be permanent, one of the variable loads takes on its maximum lifetime value while the other variable loads assume “arbitrary point-in-time” values, the latter being loads that would be measured at any instant of time (Turkstra