Therefore, an adjustment to certain tabulated values is appropriate for sizes other than those tested; however, the tabulated values for Southern Yellow Pine have already been adjusted for size and do not require application of C_F. Table 5.2 indicates the tabulated values that should be adjusted to account for size differences. The adjustment applies when visually graded lumber is 2 to 4 inches thick or when a minimum 5-inch-thick rectangular bending member exceeds 12 inches in depth. Refer to NDS-S for the appropriate size adjustment factor.

5.2.4.5 Column Stability Factor (C_P)

Tabulated compression design values in the NDS-S are based on the assumption that a compression member is continuously supported along its length to prevent lateral displacement in both the weak and strong axes. When a compression member is subject to continuous lateral support in at least two orthogonal directions, Euler buckling cannot occur. However, many compression members (e.g., interior columns or wall framing) do not have continuous lateral support in two directions.

The column stability factor, C_P adjusts the tabulated compression stresses to account for the possibility of column buckling. For rectangular or non-symmetric columns, C_p must be determined for both the weak- and strong-axis bracing conditions. C_p is based on end-fixity, effective length of the member between lateral braces, and the cross-sectional dimensions of the member that affect the slenderness ratio used in calculating the critical buckling stress. Given that the Euler buckling effect is associated only with axial loads, the C_P factor applies to the allowable compressive stress parallel to grain, F_c, as shown in Table 5.2. Refer to the NDS for the equations used to calculate the column stability factor.

5.2.4.6 Beam Stability Factor (C_L)

The tabulated bending design values, F_b, given in the NDS-S are applicable to bending members that are either braced against lateral-torsional buckling (i.e., twisting) or stable without bracing (i.e., depth is no greater than the breadth of the member). Most bending members in residential construction are laterally supported on the compression edge by some type of sheathing product. The beam stability factor does, however, apply to conditions such as ceiling joists supporting unfinished attic space. When a member does not meet the lateral support requirements of NDS•3.3.3 or the stability requirements of NDS•4.4.1, the designer should modify the tabulated bending design values by using the beam stability factor, C_L, to account for the possibility of lateral-torsional buckling. For glued laminated timber bending members, the volume factor (C_V) and beam stability factor (C_L) are not applied simultaneously; thus, the lesser of these factors applies. Refer to the NDS•3.3.3 for the equations used to calculate C_L.

5.3 Structural Evaluation

As with any structural design, the designer should perform several checks with respect to various design factors. This section provides an overview of checks specified in the NDS and specifies several design concerns that are not addressed by the NDS. In general, the two categories of structural design concerns are:

Structural Safety (strength)

- Bending and lateral stability
- Horizontal Shear
- Bearing
- Combined bending and axial loading
- Compression and column stability
- Tension

Structural Serviceability

- Deflection due to bending
- Floor vibration
- Shrinkage

The remainder of this chapter applies these design checks to examples of different structural systems and elements in a home. In addition, given that the intent of this guide is to provide supplemental instruction for the use of the NDS in the efficient design of wood-framed homes, the reader is referred to the NDS for symbol definitions, as well as other guidance.

5.3.1 Structural Safety Checks

Bending (Flexural) Capacity

The following equations from the NDS determine if a member has sufficient bending strength. Notches in bending members should be avoided, but small notches are permissible; refer to NDS•3.2.3. Similarly, the diameter of holes in bending members should not exceed one-third the member's depth and should be located along the center line of the member. Greater flexural capacity may be obtained by increasing member depth, decreasing the clear span or spacing of the member, or selecting a grade and species of lumber with a higher allowable bending stress. Engineered wood products or alternative materials may also be considered.

[NDS•3.3]

$f_b \leq F'_b$ basic design check for bending stress

$F'_b = F_b$ x (applicable adjustment factors per Section 5.2.4)

$f_b = \frac{Mc}{I} = \frac{M}{S}$ extreme fiber bending stress due to bending moment from transverse load

$S = \frac{I}{c} = \frac{bd^2}{6}$ section modulus of rectangular member

$I = \frac{bd^3}{12}$ moment of inertia of rectangular member

$c = \frac{1}{2}d$ distance from extreme fiber to neutral axis