exterior walls. A reasonable serviceability wind load criteria may be taken as 0.75W or 75 percent of the nominal design wind load (Galambos and Ellingwood, 1986).

TABLE 5.5 *Recommended Allowable Deflection Limits*[1]

Element or Condition	Deflection Limit, Δ_{all} [2]	Load Condition
Rafters without attached ceiling finish	$\ell/180$	L_r or S
Rafters with attached ceiling finishes and trusses	$\ell/240$	L_r or S
Ceiling joists with attached finishes	$\ell/240$	L_{attic}
Roof girders and beams	$\ell/240$	L_r or S
Walls	$\ell/180$	W or E
Headers	$\ell/240$	(L_r or S) or L
Floors[3]	$\ell/360$	L
Floor girders and beams[4]	$\ell/360$	L

Notes:
[1]Values may be adjusted according to designer discretion with respect to potential increases or decreases in serviceability. In some cases, a modification may require local approval of a code variance. Some deflection checks may be different or not required depending on the local code requirements. The load condition includes the live or transient load only, not dead load.
[2]ℓ is the clear span in units of inches for deflection calculations.
[3]Floor vibration may be controlled by using $\ell/360$ for spans up to 15 feet and a 1/2-inch limit for spans greater than 15 feet. Wood I-joist manufacturers typically recommend $\ell/480$ as a deflection limit to provide enhanced floor performance and to control nuisance vibrations.
[4]Floor vibration may be controlled for combined girder and joist spans of greater than 20 feet by use of a $\ell/480$ to $\ell/600$ deflection limit for the girder.

Given that system effects influence the stiffness of assemblies in a manner similar to that of bending capacity (see Section 5.2.4.2), the system deflection factors of Table 5.6 are recommended. The estimated deflection based on an analysis of an element (e.g., stud or joist) is multiplied by the deflection factors to account for system effect. Typical deflection checks on floors under uniform loading can be easily overestimated by 20 percent or more. In areas where partitions add to the rigidity of the supporting floor, deflection can be overestimated by more than 50 percent (Hurst, 1965). When concentrated loads are considered on typical light-frame floors with wood structural panel subflooring, deflections can be overestimated by a factor of 2.5 to 3 due to the neglect of the load distribution to adjacent framing members and partial composite action (Tucker and Fridley, 1999). Similar results have been found for sheathed wall assemblies (NAHBRF, 1974). When adhesives attach wood structural panels to wood framing, even greater reductions in deflection are realized due to increased composite action (Gillespie et al., 1978; Pellicane and Anthony, 1996). However, if a simple deflection limit such as $\ell/360$ is construed to control floor vibration in addition to the serviceability of finishes, the use of system deflection factors of Table 5.6 is not recommended for floor system design. In this case, a more accurate estimate of actual deflection may result in a floor with increased tendency to vibrate or bounce.

TABLE 5.6 System Deflection Adjustment Factors[1]

Framing System	Multiply single member deflection estimate by:
Light-wood-frame floor system with minimum 2x8 joists, minimum 3/4-inch-thick sheathing,[2] and standard fastening	0.85–Uniform load 0.4–Concentrated load
Light-wood-frame floor system as above, but with glued and nailed sheathing	0.75–Uniform load 0.35–Concentrated load
Light-wood-frame wall system with 2x4 or 2x6 studs with minimum 3/8-inch-thick sheathing on one side and 1 /2-inch-thick gypsum board on the other; both facings applied with standard fastening[3]	0.7–2x4 0.8–2x6

Notes:
[1]System deflection factors are not recommended when evaluating floor member deflection limits of Table 5.5 with the implied purpose of controlling floor vibration.
[2]Two sheathing layers may be used to make up a minimum thickness of 3/4-inch.
[3]The factors may be adjusted according to fastener diameter in accordance with footnote 5 of Table 5.4. If fastening is doubled (i.e., spacing halved), the factors may be divided by 1.4 (Polensek, 1975).

Floor Vibration

The NDS does not specifically address floor vibration because it is a serviceability rather than a safety issue. In addition, what is considered an “acceptable” amount of floor vibration is highly subjective. Accordingly, reliable design information on controlling floor vibration to meet a specific level of “acceptance” is not readily available; therefore, some rules of thumb are provided below for the designer wishing to limit vibration beyond that implied by the traditional use of an $\ell/360$ deflection limit (FHA, 1958; Woeste and Dolan, 1998).

- For floor joist spans less than 15 feet, a deflection limit of $\ell/360$ considering design live loads only may be used, where ℓ is the clear span of the joist in inches.
- For floor joist clear spans greater than 15 feet, the maximum deflection should be limited to 0.5 inches.
- For wood I-joists, the manufacturer’s tables that limit deflection to $\ell/480$ should be used for spans greater than 15 feet, where ℓ is the clear span of the member in inches.
- When calculating deflection based on the above rules of thumb, the designer should use a 40 psf live load for all rooms whether or not they are considered sleeping rooms.
- As an additional recommendation, glue and mechanically fasten the floor sheathing to the floor joists to enhance the floor system’s strength and stiffness.

Floor deflections are typically limited to $\ell/360$ in the span tables published in current building codes using a standard deflection check without consideration of system effects. For clear spans greater than 15 feet, this deflection limit has caused nuisance vibrations that are unacceptable to some building occupants or owners. Floor vibration is also aggravated when the floor is supported on a bending member (e.g., girder) rather than on a rigid bearing wall. It may be