

11.2.3 Drift Limits for Wind Loading

For lightweight metal building systems, seismic loading rarely controls the design of lateral-load-resisting framing—wind loading usually does. The model building codes are silent about lateral drift limits for wind, a fact that may reflect a lack of consensus on the matter and an understanding that such limits relate to building quality and should not be code-mandated. The guidelines are available elsewhere, however.

Since as early as 1940, a lateral deflection limit of $H/500$ has been recommended for tall buildings.⁵ The authoritative *Structural Engineering Handbook*⁶ states that the deflection index spectrum commonly used is 0.0015 to 0.0035 (which translates to a range of drift limits between $H/666$ to $H/286$). It includes a Weiskopf & Pickworth deflection-index guide that charts the index values as a function of the magnitude of wind loads and wind exposure. The handbook points out that engineering judgment must recognize economic values involved, and that a speculative office building might be constructed to a less stringent drift limit than a single-occupancy corporate or prestige building.

The *Building Structural Design Handbook*⁷ reflects that a 0.0025 drift index ($H/400$), even from a 25-year storm, “may be appropriate for a speculative office building. On the other hand, it may be completely inappropriate for a hospital, library, or any other type of high-quality building project.” It goes on to suggest that the issue may be addressed by specifying a strict limit on the drift, say $H/500$, but for the drift to be computed using a smaller design wind loading than that imposed by a 50-year storm. For example, the loading from a 10- or 25-year windstorm might be used.

A survey of structural engineers around the country by the ASCE Task Committee on Drift Control of Steel Building Structures of the ASCE Committee on Design of Steel Building Structures⁸ has found that the design practices with respect to wind drift vary considerably. Most designers, however, specify drift indexes of 0.0015 to 0.003 (corresponding to the limits of $H/666$ to $H/333$) caused by a 50-year mean wind recurrence interval for all types of structures. The most commonly used wind-drift limit for low-rise structures is, again, 0.0025 ($H/400$) caused by a 50-year wind. Incidentally, the task committee felt that wind-induced drift limits should not be codified.

A commentary to Section B1.2 of ASCE 7-98⁹ summarizes the Task Committee finding that the drift limits in common usage for building design are of the order of $H/600$ to $H/400$. ASCE 7 then states that smaller drift limits may be appropriate for brittle cladding. It suggests that an absolute drift limit may be needed, because some partitions, cladding, and glazing may be damaged by drifts more than $3/8$ in, unless special detailing is used to accommodate movement. To compute the drift, the commentary suggests using 70 percent of service wind loading computed by the procedures of ASCE 7.

11.2.4 Drift Limits in AISC Design Guide No. 3

Recognizing a dearth of serviceability criteria for metal building systems under wind loading, MBMA and AISC have published a design guide entitled *Serviceability Design Considerations for Low-Rise Buildings*.¹⁰ The guide’s eminent authors, James M. Fisher and Michael A. West, have undertaken a major effort to stimulate discussion on various serviceability topics, including drift and deflections. The guide should be read by everybody involved in structural design of low-rise buildings.

Reflecting a subjective nature of serviceability criteria, the guide’s authors base many of its recommendations on their own judgment and experience. They admit that the criteria are controversial and envision the guide as a catalyst for the debate rather than a final word in the discussion. (Some metal building manufacturers, however, seem to think exactly the opposite—that no further questions remain.)

The guide uses a 10-year mean recurrence interval wind speed loading for its drift-limit criteria, rather than a 50-year loading used for strength calculations. The rationale is that 50-year storms are rare events that have little in common with day-to-day experience of buildings. Furthermore, the consequences of serviceability failures are “noncatastrophic” and should be weighted against high up-front costs required to prevent the failures. The guide states that 10-year wind pressures can be reasonably approximated by using 75 percent of the 50-year wind pressure values.

(Some other sources have also questioned the common practice of basing wind-drift calculations on the wind loads likely to return only once in 50 years. Galambos and Ellingwood,¹¹ for example,

advocate using a reference period of 8 years, which represents the average period of one tenancy in an office building.)

For several types of walls, the guide proposes certain maximum limits on the magnitude of bare-frame lateral drift, horizontal deflection, and racking (lateral movement parallel to the wall). Reproduced below are the criteria for foundation-supported cladding; the guide also considers criteria for column- and spandrel-supported panels. In the following expressions, H stands for the wall height and L for the length of a supporting steel member.

The maximum recommended story drift for various materials is

$H/60$ to $H/100$ for metal panels

$H/100$ for precast concrete

$H/200$ for reinforced masonry (can be reduced to $H/100$ with proper detailing)

Where interior partitions are used, bare-frame story drift is limited to $H/500$.

The maximum recommended horizontal deflections of girts or wind columns supporting metal or masonry walls are

$L/120$ for metal panels

$L/240$, but not over 1.5 in, for masonry walls

A limit on racking of $H/500$ is recommended for column- and spandrel-supported curtain walls. Again, all these criteria are for a 10-year wind loading.

The limitations on lateral drift and horizontal deflections proposed by the guide are more liberal than those of other sources. Some engineers find it counterintuitive that the guide seems to offer a larger degree of protection to interior drywall partitions than to brittle exterior walls. The drift limits of the Guide are reprinted in the MBMA *Metal Building Systems Manual*.¹²

11.2.5 How Lateral Drift Is Computed

Prior to a discussion of the various criteria listed above, it is necessary to briefly examine how drift and horizontal deflections are calculated and what the numbers actually mean.

The total story drift is a sum of two components—the frame drift and the diaphragm displacement between the frames (Fig. 11.3). For a typical pre-engineered building with rigid frames spaced 20 to 30 ft apart and a horizontal-rod roof bracing, the diaphragm deflection component might be insignificant. At another extreme, in buildings where no roof bracing is present at all, and wind loading is distributed to frames by eave struts, the diaphragm deflections could be larger than the frames' drift. Unfortunately, the diaphragm deflection computations are occasionally neglected by some metal building designers.

The actual frame drift can be readily determined by most pre-engineered building software. For preliminary calculations, any general structural analysis computer program can be used. The approximate formula of Fig. 11.4 could be handy for rough checks of two-hinge frames with constant member sections. Naturally, the process is much more complex for rigid frames with tapered columns and beams, in which case computers are a must.

11.2.6 Lateral Drift from Gravity Loads

A discussion focused solely on the lateral drift resulting from wind or seismic loading misses one important point: frame sidesway can be caused not only by lateral loads but also by gravity loads. Many structural engineers used to the design of conventional buildings do not realize that a gable frame can have a substantial amount of “kicking out” at the roof level when loaded with snow or roof live load (Fig. 11.5). Lateral displacements at the frame knees from large snow loads could exceed story drifts caused by winds. The codes do not address the issue, probably because gable frames are largely endemic to metal building systems.