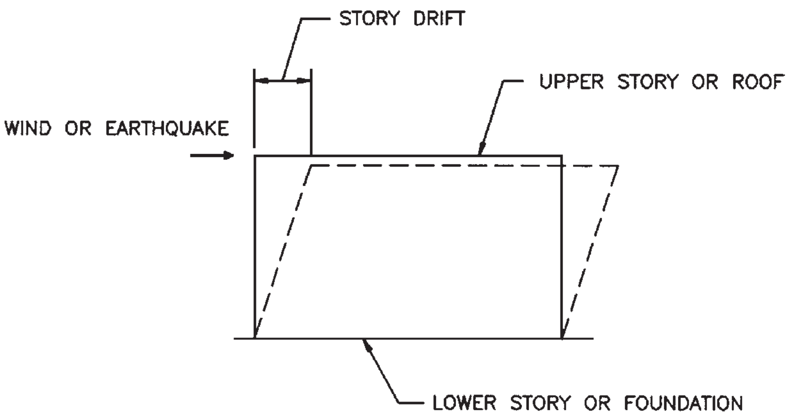

FIGURE 11.1 Story drift caused by lateral loads.

FIGURE 11.2 In this common design, a masonry front office abuts a pure metal building system in the back, raising concern about appropriate lateral drift criteria.

11.2 LATERAL DRIFT AND HORIZONTAL WALL DISPLACEMENT

11.2.1 Should It Be Mandated by Codes?

Lateral drift and deflection limits are commonly expressed in terms relative to the story, or wall, height (*H*), such as a story drift of *H*/400. Another frequently used term is *deflection* or *drift index,* an inversion of the drift limit; e.g., for a drift limit of *H*/400 the deflection index is 0.0025.

The drift limits signify the solidity and sturdiness of the building. A sturdy building costs more to build than a flimsy one but may bring a higher resale value. Two buildings designed for the same structural loads but used for different occupancies could have different stiffness requirements. For example, a high-tech research lab or a hospital would probably impose much stricter limits on allowable building movement than a typical office would. Many designers feel that horizontal deflection and drift criteria relate to quality of building construction and should not be code-mandated.

Still, the codes may specify a maximum drift threshold for the sake of preserving structural integrity of buildings and their brittle components. Indeed, excessive lateral displacements may lead to unanticipated overload of building columns due to *P*-delta effect; large movements could also damage exterior cladding and interior finishes.

For this reason, the codes are more concerned with controlling building sway caused by violent earthquakes than by strong hurricanes. Severe seismic shaking affects both structural and nonstructural elements of the building, while wind forces affect primarily the exterior envelope. The magnitude of seismic movements often exceeds those induced by wind. A building that has experienced an earthquake may sustain more *interior* damage than one hit by a hurricane, which directly affects its usability. A case in point: After the 1995 Kobe earthquake, some buildings seemed relatively undamaged from the outside but were still unusable because of buckled partitions and jammed doors caused by violent movements. The drift limits relating to seismic loading are much more lenient than those relating to wind.

11.2.2 Provisions of Model Codes for Drift Limits from Seismic Loads

The drift criteria listed below are found in the code sections dealing with seismic loads. The *International Building Code,*[1] intended eventually to supplant the three traditional model codes, lists the seismic drift limits in Table 1604.3. The allowable story drifts depend on the building construction and seismic use group. For buildings without masonry walls, the drift index ranges from $0.020h_{sx}$ for seismic use group I to $0.010\ h_{sx}$ for seismic use group III, where h_{sx} is the story height below level *x*. A more lenient set of drift indexes, ranging from $0.025h_{sx}$ for seismic use group I to $0.015\ h_{sx}$ for seismic use group III is allowed for buildings less than four stories tall without masonry walls, "with interior walls, partitions, ceilings, and exterior wall systems that have been designed to accommodate the story drifts." As noted below, such accommodation may require an uncommon level of detailing and coordination among the trades and design teams.

The 1997 *Uniform Building Code,*[2] Section 1630.10, requires that story drifts be computed using the maximum inelastic response displacement Δ_M. The code limits the calculated story drift to $0.025h$ (where h is story height) for buildings with a fundamental period of less than 0.7 s and to $0.020h$ for other buildings.

The code makes two important exceptions to this rule. The first one states that the limit can be exceeded if it can be shown "that greater drift can be tolerated by both structural . . . and nonstructural elements that could affect life safety."

The second exception specifically exempts from *any* drift limitations single-story steel-framed buildings used for factory, manufacturing, storage, business workshop, and some other occupancies. To qualify for this exemption, a building cannot have any frame-attached equipment, unless it is detailed to accommodate the drift. To avoid damage from large frame movements, the code further requires that the walls laterally braced by the steel frame be designed to accommodate the drift. This goal is to be achieved by a deformation compatibility analysis and by meeting certain prescribed requirements for wall anchorage and connections.

The 1999 *BOCA National Building Code*[3] and the *Standard Building Code*[4] contain similar, but not identical, seismic-drift provisions. Note that seismic loading in the earlier code editions was typically expressed in terms of service loads, but the latest codes treat it as a factored load.

It is clear that, under seismic loading, none of the model codes seeks to impose any flexibility limitations on metal building systems with metal-only cladding. Such conditions occur mostly in industrial and warehouse buildings. For other structures, the drift limit under seismic loading may be spelled out in the governing building code. In any case, seismic loading and its drift limits rarely govern the design of pre-engineered buildings.