1 WALL BRACING: WHY IT'S NEEDED AND HOW IT WORKS

All buildings, regardless of size or location, must be designed to safely resist the structural loads anticipated during their lifetime. These loads can be divided into two categories: *vertical loads* and *lateral loads*. Wood-frame construction makes it easy for building professionals to construct strong, attractive and durable structures that resist these loads, meet building code requirements and assure good performance.

Vertical loads

Vertical loads act in the "up" or "down" direction. In most cases the "down" loads are caused by gravity. These loads are the obvious ones: the weight of the building itself (dead load), the weight of everything and everybody in the building (live load), and environmental loads, such as those from snow, wind or earthquake. The "up" loads act in an upward direction. An example of an "up" load is wind uplift.

These loads are easy to understand and typical construction practice has evolved into an efficient system that does a good job of accommodating them. Generally speaking, builders in high wind areas are as comfortable installing uplift straps as they are placing headers on cripple studs.

CHAPTER 1

Summary

Because downward loads are always present (due to gravity), any deficiencies in the vertical load path are almost immediately apparent due to structural instability. For example, a beam with support at only one end will fall down during construction.

Lateral loads

The real challenge lies not with the vertical loads, but rather with the "sideways" loads, or, as they are referred to in the design community, *lateral loads*. Lateral loads act in a direction parallel to the ground. Most often the result of wind or seismic (earthquake) forces, lateral loads can cause structures to bend and sway, collapse, or even – in cases where the structure is not well attached to the foundation – roll over.

A wood beam carrying an excessive vertical load may creak, groan, split or deflect over time, warning that repair may be necessary to prevent failure. Because the wind and seismic forces that result in lateral loads are sudden and infrequent, there are no such warning indicators of an impending failure.

In every region of the country, lateral load resistance – an essential part of which is wall bracing – has to be planned during design and built into the structure during construction. While this is especially important in regions susceptible to strong wind and seismic forces, the provisions or requirements of the International Residential Code (IRC) make lateral load resistance an important consideration in every part of the country. The IRC prescriptively requires specific building elements to resist lateral forces for all structures within its scope.

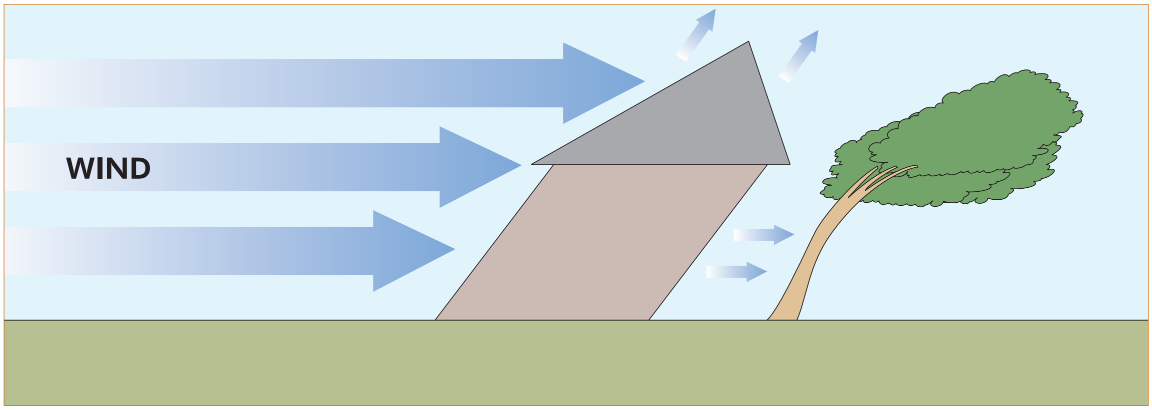
When designing a residence to meet the seismic or wind bracing requirements of the code, it is important to understand how lateral loads act on wood framing systems and how construction detailing and fasteners affect the ultimate lateral performance of the structure. Builders, designers and building officials can use the IRC wood wall bracing requirements to ensure strength, quality and safety in residential structures. Certainly, a better understanding of these requirements will ensure fewer mistakes in design and plan review, as well as in construction.

Wind forces

During a wind event, wind pushes against one wall while pulling on the opposite wall, as demonstrated in ***FIGURE 1.1***. Because the two walls receiving wind pressures – the receiving walls – push and pull the structure in the same direction as the wind, the walls on the sides of the structure – the bracing walls – must restrain the structure from moving. When the wind is in the perpendicular direction, the walls change roles: walls that previously restrained the structure now receive the wind pressures, and walls that previously received the wind pressures now must restrain the structure. Thus, all walls must be strong enough to resist the wind forces that push against the structure, regardless of whether they must act as a receiving wall or a restraining wall.

FIGURE 1.1

Wind forces acting on a structure



The 2012 IRC wall bracing provisions for wind apply only to residential structures located in areas where the basic wind speed is less than 110 miles per hour. Basic wind speeds are obtained from IRC Figure R301.2(4)A (***FIGURE 1.2***). However note that some regions of the U.S. that are subject to very high winds, as identified in IRC Figure R301.2(4)B (***FIGURE 1.3***), require the use of alternate engineering-based standards or engineered design and are not eligible for prescriptive bracing. If a specific location is defined by IRC Figure R301.2(4)B as a "wind design required" region, or the wind design speed is 110 mph or greater, the IRC wind design provisions do not apply and alternate standards or the IBC must be used. An area designated as a "special wind region" requires the designer to check with the local building official to determine the design wind speed for that location. IRC Section R301.2.1 and ***CHAPTER 2*** cover these requirements in detail.

FIGURE 1.2

Map of basic wind speeds

Adapted from IRC Figure R301.2(4)A

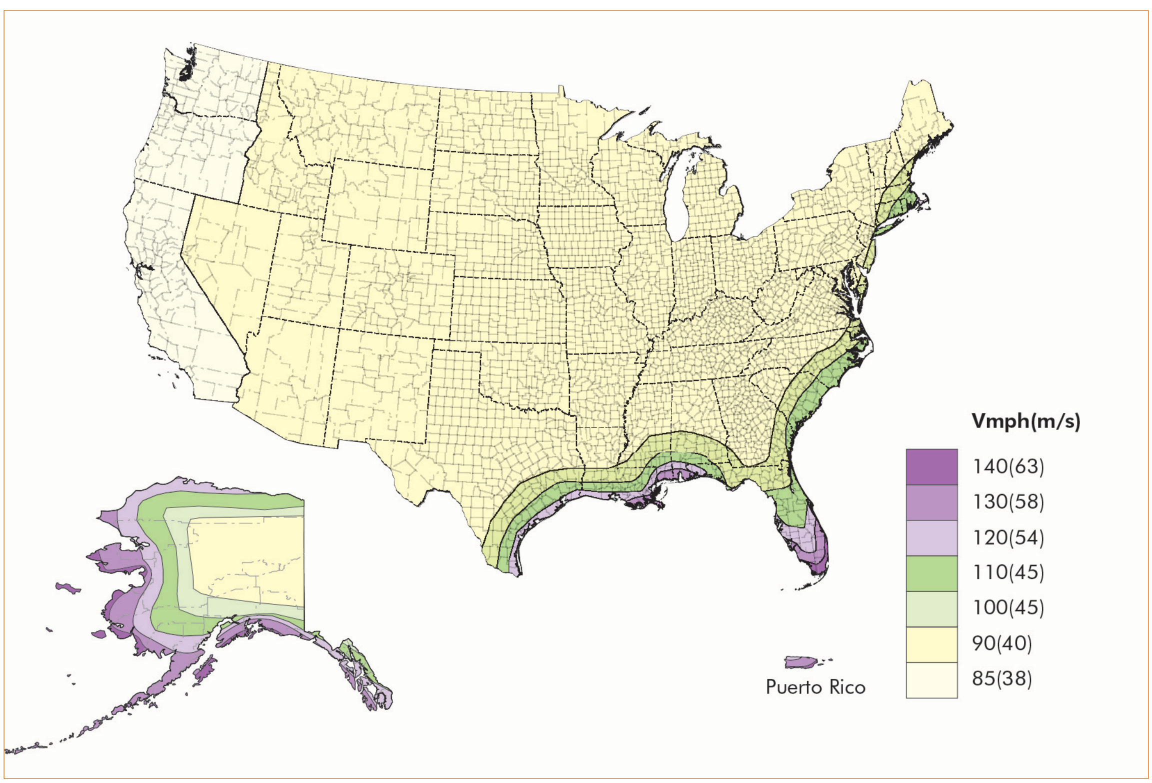
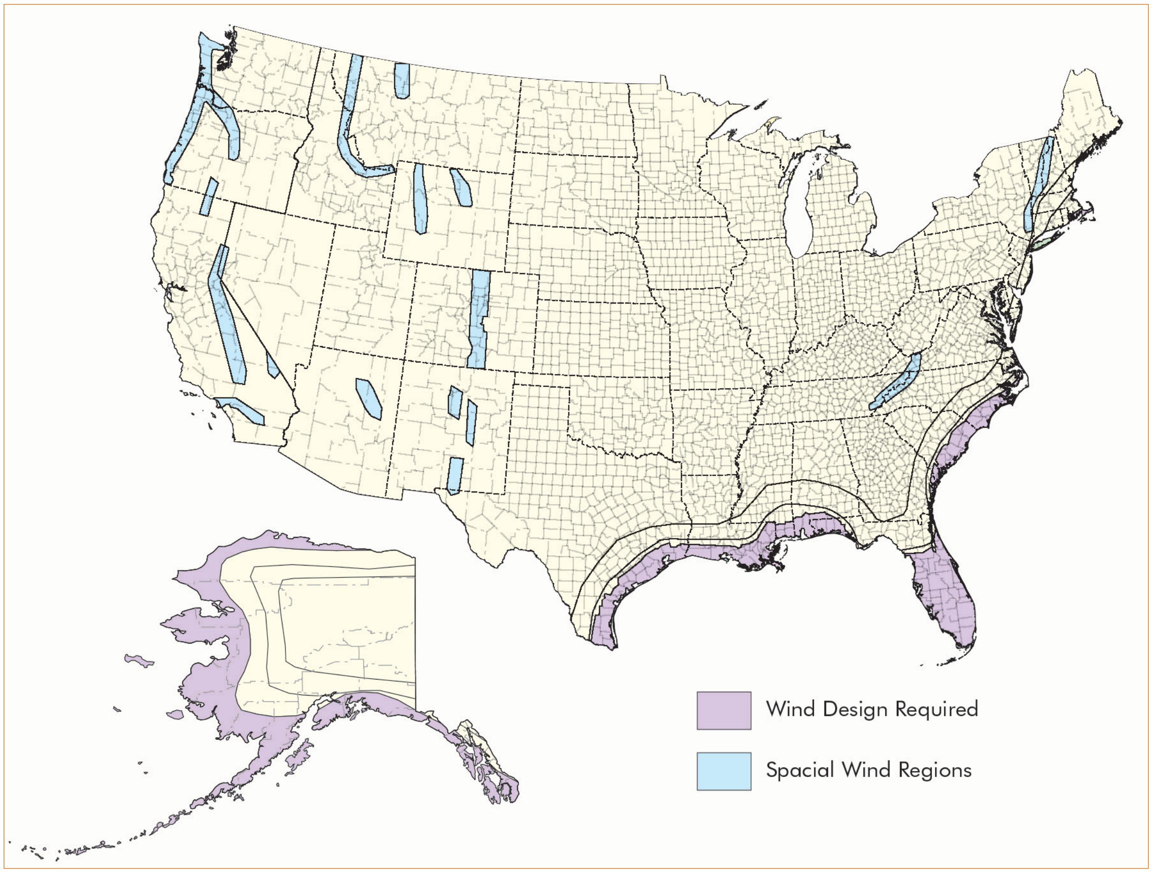


FIGURE 1.3

Map of regions that require wind design

Adapted from IRC Figure R301.2(4)B



In addition to the basic wind speed, the IRC requires identification of the building site's wind exposure category. As explained in IRC Section R301.2.1.4 and ***CHAPTER 2*** of this guide, wind exposure category is determined by evaluation of the site characteristics that affect the building's exposure to wind from any direction. The evaluation considers variations in topography, vegetation and nearby structures. Historically, the four wind exposure categories were: A, B, C and D; for engineered structures, however, the design community has merged A and B into a single exposure under Exposure B. While the IRC still lists Exposure Category A in the definition section (IRC Section 202), it is not used elsewhere in the code.

The wind bracing requirements of IRC Table R602.10.3(1) (***TABLE 3.3***) are based on Exposure Category B. For Exposure Categories C and D, bracing requirements increase up to 70 percent in accordance with the adjustment factors found in IRC Table R602.10.3(2) (***TABLE 3.4***).

The wind exposure category is also used to determine the IRC Section R301.2.1 design load performance requirements for components and cladding. The proper selection of wall sheathing products and the correct amount of products is essential to ensure the exterior wall assembly has the capacity to resist component and cladding wind pressure and suction forces when acting as the receiving wall. For example, IRC Table R602.3(3) addresses the proper selection and installation of wood structural panel sheathing based on the design wind speed and exposure category. See ***CHAPTER 2***.

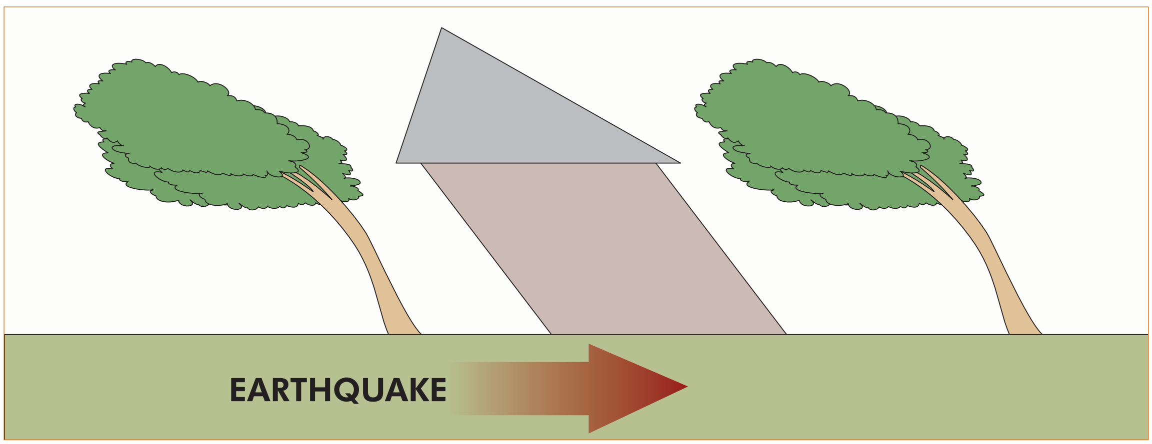
Seismic forces

Seismic forces are generated by ground motions during an earthquake event, as shown in ***FIGURE 1.4***. The ground motion causes the structure's mass to accelerate back and forth, up and down. This acceleration causes forces to develop within the structure in locations where the structure's mass is concentrated (Newton's Second Law: Force = Mass x Acceleration). Essentially, the seismic ground motion moves the foundation (*acceleration*), while inertia (*mass* of the structure) attempts to resist this motion. Instead of mass, building codes use seismic weight to determine seismic forces. The seismic weight multiplied by an acceleration expressed as a fraction of the earth's gravity produces the seismic force. Because seismic forces are directly proportional to the weight (mass) of the structure, IRC Section R301.2.2.2.1 (see ***CHAPTER 2***) imposes limits on the weights of materials used to construct the building. The seismic weight of the structure is generally concentrated at the floors and roof of the structure.

FIGURE 1.4

Earthquake forces acting on a structure

Vertical (upward) forces not shown for clarity



Similar to the wind maps discussed previously, the IRC provides an earthquake map (IRC Figure R301.2(2)) that displays the various Seismic Design Categories for regions of the country. The portion of the map showing the eastern half of the continental United States is excerpted in ***FIGURE 1.5*** of this guide.