1

Structural Design Criteria

The IRC establishes minimum structural design criteria necessary to accommodate normal loads placed on a building and, depending on a home's location, resist the forces of natural hazards such as snow, wind, earthquake, and flood. In most cases, the tried-and-true construction practices offered in the IRC incorporate these criteria, eliminating the need for an engineered design or complex calculations. For example, the code provides span tables for conventional wood framing elements such as joists, girders, headers, and rafters.

Construction must safely support all loads:

- Snow, wind, seismic, and flood loads, which vary by geographic region
- *Live loads*
- *Dead loads*
- Roof loads

Note: *The roof is designed for the roof live load (not more than 20* psf*) or the snow load, whichever is greater.*

To correctly apply the values of the tables and the prescriptive methods of construction, builders must know the structural design criteria in the planning chapter of the code. Determining the appropriate live loads is fairly straightforward. However, seismic, wind, snow, soil, or flood area values differ by geographic location. In addition, frost depth, weathering severity, ice barrier underlayment requirements, and history of termite damage vary by climate and geography. Therefore, builders often must obtain information through the maps found in the IRC or through their local building departments.

Moreover, some structural elements still may require an engineered design. For example, the sizing of wide-flange steel beams commonly used in dwelling construction is outside the scope of the IRC. Instead, accepted engineering practices will determine their sizes.

Live Loads

Minimum required live loads for floors are based on the use of the space. Guards and handrails also must be secured to safely resist forces against them (table 1.1).

Table 1.1 Minimum uniformly distributed live loads

Use	Live load (psf)	Note
Rooms other than sleeping rooms	40	
Sleeping rooms	30	
Decks and exterior balconies	40	
Stairs	40	Concentrated load of 300 lb. per 4 sq. in.
Habitable attics and attics served by fixed stairs	30	
Uninhabitable attics with limited storage	20	Access hatch or pull-down stair to storage area at least 24 in. wide × 42 in. high
Uninhabitable attics without storage	10	
Passenger vehicle garages	50	Elevated garage floors must support a concentrated load of 2,000 lb. per 20 sq. in.
Handrails and top rails of guards		Concentrated load of 200 lb. applied from any direction
Guard balusters and infill panels		Horizontally applied load of 50 lb. on an area of 1 sq. ft.

Deflection

Allowable deflection is a measurement of bending under code-prescribed loads to ensure adequate stiffness of structural framing members such as studs, joists, beams, and rafters (table 1.2). Although the prescriptive tables account for deflection in their values, builders must be familiar with deflection limits in order to choose the appropriate table for sizing a framing member. Allowable deflection is measured by dividing the span or length (L) of the member by a prescribed factor, such as 360 for floor joists (L/360). To determine allowable deflection for a certain span, convert feet to inches and divide the result

Table 1.2 Allowable deflection of structural members

Structural member	Allowable deflection
Rafters, slope > 3⁄12, no finished ceiling attached to rafters	L/180
Rafters, slope > 3⁄12, finished ceiling attached to rafters	L/240
Ceiling joist	L/240
Plastered ceilings	L/360
Floors	L/360
All other structural members	L/240

Note: Wall deflection and wind load deflections are not shown.

by 360. The following example is for a floor joist with a 16 ft. span:
L = 16 ft. × 12 in. = 192 in.
Allowable deflection = 192 in. / 360 = 0.53 in.
Allowable deflection for this floor joist is approximately ½ in.
Note: *A 16 ft. span rafter with a 4⁄12 slope and no ceiling attached has an allowable deflection of L/180, which is twice the deflection allowed for floor joists.*

Calculating Dead Loads

The prescriptive tables of the IRC detailing continuous footing sizes for conventional frame construction assume average weights of construction materials. Therefore, additional calculations typically are not required. The material and component weights (tables 1.3 and 1.4) may help builders correctly size an isolated footing, or another element not covered in the IRC tables.

Wind

The prescriptive structural provisions of the IRC are limited to those geographical regions with ultimate design wind speeds of 140 mph or less (130 mph in hurricane-prone regions) as defined in the IRC

Table 1.3 Building material weights

Materials	Weight (psf)
Plywood – ¼ in.	.8
Plywood – ½ in.	1.6
Plywood – ¾ in.	2.4
4″ Brick	35.0
Gypsum board – ½ in.	2.1
Gypsum board – ⅝ in.	2.5
Quarry tile – ½ in.	5.8
Hardwood flooring – 25⁄32 in.	4.0
Built-up roofing	6.5
Shingles, asphalt	1.7–2.8
Shingles, wood	2.0–3.0
Common dimension lumber (lb. per cu. ft.)	27–29 lb. per cu. ft.
Concrete (lb. per cu. yd.)	150 lb. per cu. ft.

wind maps. Otherwise, the code requires a design in accordance with one of the referenced standards. In addition to an engineered design that complies with the *International Building Code (IBC)*[1] and ASCE 7,[2] the IRC includes references to ICC 600, *Standard for Residential Construction in High Wind Regions*[3] and *AWC Wood Frame Construction Manual (WFCM)*.[4]

Table 1.4 Average weights of building components

Description	Weight (psf)
Roof dead load (framing, sheathing, asphalt shingles, insulation, drywall)	10
Exterior wall (2 × 4 framing, sheathing, siding, insulation, drywall)	10
Floor (joist, sheathing, carpeting, drywall)	10
Concrete wall–8 in. thick	100
10 in. thick	125
12 in. thick	150
Concrete block wall–8 in. thick	60

Wind Exposure Category

In addition to the basic wind speeds for a geographic area, ground surface irregularities affect the wind's impact on a building. The IRC classifies wind exposure into three categories:

1. Exposure B—some wind protection with trees and buildings characteristic of urban and suburban settings
2. Exposure C—open terrain with scattered obstructions
3. Exposure D—adjacent to large bodies of water, including hurricane-prone regions

Exposure categories are important design criteria for engineering purposes. For many of the prescriptive methods of wood frame construction in the IRC, wind exposure category is not a factor. However, wind exposure category must be considered when applying the provisions for wall sheathing, wood wall bracing, roof tie-down, and exterior wall and roof coverings. The following components must be *listed* and installed to resist wind loads based on the wind speed and exposure category:

- Siding
- Roof covering
- Windows
- Skylights
- Exterior doors
- Overhead doors

Hurricanes

Hurricane-prone regions are the coastal areas of the Atlantic Ocean and Gulf of Mexico where the ultimate design wind speed is greater than 115 mph. The IRC wind maps identify the portions of hurricane-prone regions that require an engineered design or a design that complies with other referenced standards. Windows and other glazing require additional protection if they are in *windborne debris*