

# POST-FRAME BUILDINGS

## and the International Building Code

BY TIMOTHY R. ROYER, PE

Building codes in various forms have been around for a very long time. One of them, the Code of Hammurabi, was written in approximately 1775 B.C. near what is now the city of Baghdad. This code included 282 laws, and six of them were related to building construction. In addition to establishing a fee for construction, this code delineated penalties for collapse of a building or faulty construction. One of those, number 229, detailed the penalty this way: “If a builder build[s] a house for someone, and does not construct it properly, and the house which he built fall[s] in and kill[s] its owner, then that builder shall be put to death” (Avalon Project, 2008). Fortunately, today’s codes are less harsh in their penalties and more detailed in their description of required design and construction techniques that prevent harm to both occupants and builders.

The building code is a legal document that helps to ensure public health and welfare by specifying a minimum level of protection from injury, fire and natural environmental forces. Building codes reduce the risk of personal physical injury by specifying minimum requirements for design procedures and giving specifications for material quality, fire protection, stairways and handrails, and means of egress, along with many other requirements that ensure public safety. Currently, the International Building Code has been adopted in all 50 states as well as by federal government agencies, a number of U.S. territories and some other countries (International

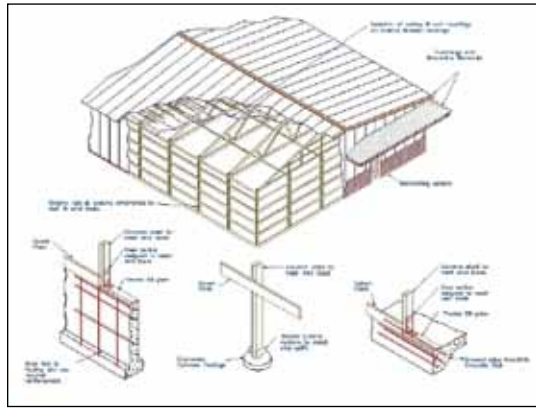


Figure 1. Typical post-frame building components

Code Council, 2015a). The IBC is a performance-based code that establishes the minimum performance level for building materials, components and systems. Engineers and architects have the latitude to design any building as long as it meets the performance-based requirements of the building code. The International Residential Code for One- and Two-Family Dwellings (ICC, 2015b) is a prescriptive code that includes sizes, types and description of materials required for specific applications. It is important to note that post-frame building design is not included in the prescriptive requirements of the IRC, and designs must comply with the performance code requirements of the IBC. However, several municipal, county and state governing bodies have developed prescriptive specifications that may allow post-frame buildings to be erected in accordance with a pre-engineered design.

Post-frame buildings are efficient structures with primary framing sys-

tems composed of wood roof trusses or rafters connected to vertical timber columns or side-wall posts. The secondary members, such as roof purlins, wall girts, and exterior cladding, transfer vertical and horizontal forces to the primary framing system.

Figure 1 shows the common components of a post-frame building. A properly designed post-frame building will meet all requirements of the IBC (American

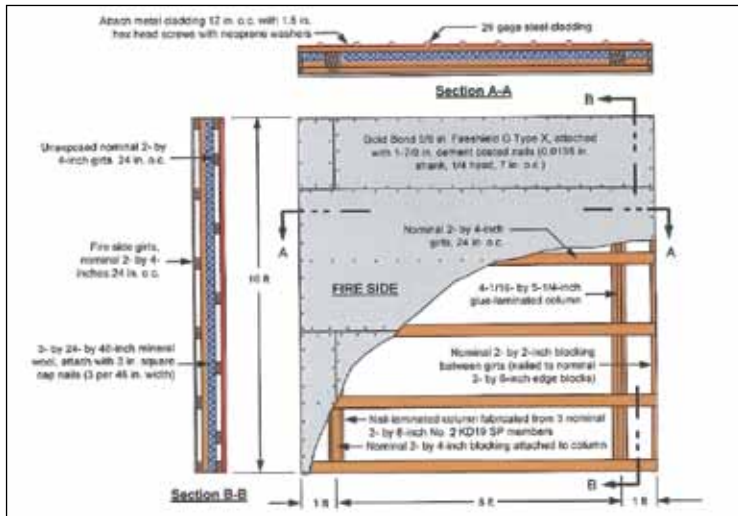
Wood Council, 2013).

This article introduces post-frame building designers to some of the requirements of the IBC and thus helps them confirm that their post-frame building designs are code compliant. The IBC includes sections on construction type, allowable heights and area, fire-resistant construction, fire protection systems, means of egress, accessibility, interior finish, interior environment and construction material. The IBC gives extremely limited coverage of structural design with wood, steel, concrete and other materials because most of this material is adopted by reference in chapter 35 of the IBC. Several reference documents that specifically apply to post-frame construction are listed under American Society of Agricultural and Biological Engineers in chapter 35. These standards are ASAE EP 484.2 *Diaphragm Design of Metal-Clad Post-Frame Rectangular Buildings*, ASAE EP 486.1 *Shallow-Post Foundation Design* and ASAE EP 559 *Design Requirements*

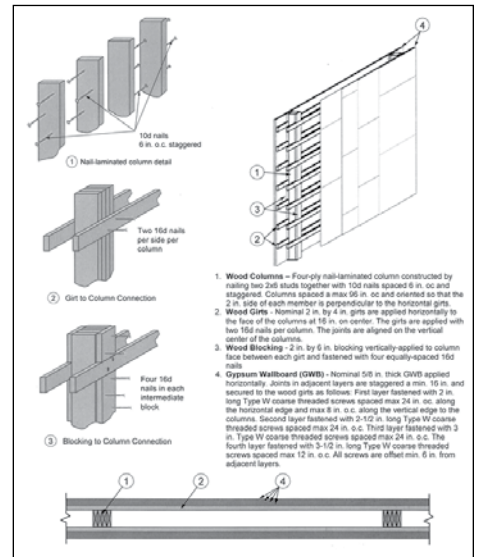
**Table 1.** International Building Code Occupancy Classifications

Group	Group Designation	Description
<b>Assembly</b>	A-1	Assembly uses, usually with fixed seating, intended for the production and viewing of the performing arts or motion pictures
	A-2	Assembly uses intended for food and/or drink consumption
	A-3	Assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A
	A-4	Assembly uses intended for viewing of indoor sporting events and activities with spectator seating
	A-5	Assembly uses intended for participation in or viewing of outdoor activities
<b>Business</b>	B	The use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts.
<b>Educational</b>	E	The use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade and child care facilities.
<b>Factory</b>	F-1	Factory industrial uses that are not classified as F-2 (Factory industrial low hazard)
	F-2	Factory industrial uses that involve the fabrication or manufacturing of noncombustible materials that during finishing, packing or processing do not involve a significant fire hazard
<b>High Hazards</b>	H-1	Buildings and structures containing materials that pose a detonation hazard
	H-2	Buildings and structures containing materials that pose a deflagration hazard or a hazard from accelerated burning
	H-3	Buildings and structures containing materials that readily support combustion or that pose a physical hazard
	H-4	Buildings and structures that contain materials that are health hazards
	H-5	Semiconductor fabrication facilities and comparable research and development areas in which hazardous production materials are used.
<b>Institutional</b>	I-1	Buildings, structures or parts thereof housing more than 16 persons, on a 24-hour basis, who, because of age, mental disability or other reasons, live in a supervised residential environment that provides personal care services. The occupants are capable of responding to an emergency situation without physical assistance from staff.
	I-2	Buildings and structures used for medical, surgical, psychiatric, nursing or custodial care on a 24-hour basis for more than five persons who are not capable of self-preservation.
	I-3	Buildings and structures that are inhabited by more than five persons who are under restraint or security. An I-3 facility is occupied by persons who are generally incapable of self-preservation because of security measures not under the occupants' control.
	I-4	Buildings and structures occupied by persons of any age who receive custodial care for less than 24 hours by individuals other than parents or guardians, relatives by blood, marriage or adoption, and in a place other than the home of the person cared for
<b>Mercantile</b>	M	Buildings and structures or a portion thereof used for the display and sale of merchandise, which involve stocks of goods, wares or merchandise incidental to such purposes and accessible to the public
<b>Residential</b>	R-1	Residential occupancies containing sleeping units where the occupants are primarily transient in nature
	R-2	Residential occupancies containing sleeping units or more than two dwelling units where the occupants are primarily permanent in nature
	R-3	Residential occupancies where the occupants are primarily permanent in nature and not classified as Group R-1, R-2, R-4, or I.
	R-4	Buildings arranged for occupancy as residential care/assisted living facilities including more than five but not more than 16 occupants, excluding staff
<b>Storage</b>	S-1	Buildings occupied for storage uses that are not classified as Group S-2
	S-2	Buildings used for the storage of noncombustible materials such as products on wood pallets, in paper cartons with or without single thickness divisions or in paper wrappings. Such products are permitted to have a negligible amount of plastic trim, such as knobs, handles or film wrapping.
<b>Utility and Miscellaneous</b>	U	Buildings and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidental to their occupancy.

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**Figure 2.** Construction details for an exterior wall that obtained a one-hour rating during a January 1990 test conducted for the National Frame Builders Association (now the National Frame Building Association) by Warnock Hersey International, Inc. Details of the test are available upon request to [info@nfba.org](mailto:info@nfba.org). (Illustration from *Post-Frame Building Design Manual* [Bohnhoff, 2015, Figure 2-3]. Copyright 2015 by National Frame Building Association. Used with permission.)



**Figure 3.** Post-frame fire wall with a 3.5 hour bearing-wall resistance rating. UL Design No. V304 (UL, 2012).

and Bending Properties for Mechanically Laminated Columns. By referencing these documents in chapter 35, the IBC is including each document in the code just as if it was printed in the code book.

The IBC classifies building construction types into five categories, Types 1 through 5. Typically, as wood frame buildings, post-frame construction is classified as Type 5. Type 5A has a fire rating of one-hour or greater, while Type 5B has a fire rating of zero, as listed in Table 601 in the IBC. By using special construction with fire-retardant-treated material, post-frame structures could be classified as Type 3 or 4, but typically post-frame buildings are designed as Type 5.

The combination of construction type and occupancy group limits a building's maximum allowable building height and area. These limits are compiled in IBC Table 503. The IBC defines 26 occupancy groups in 10 main categories (see Table 1). To properly design a post-frame building, one must make an accurate determination of use and occupancy. From IBC Table 503, it is clear that a Type 5 post-frame structure can be designed for any occupancy group. Special attention should be given to the building area modifications that are permissible according to IBC Section 506. This includes an open

frontage increase and an automatic sprinkler system increase. Some buildings are permitted to be unlimited in area, as described in IBC Section 507.

Chapter 6 of the IBC provides a detailed description of construction types. It is important to note that construction types 5A and 5B differ primarily in the fire rating of the exterior walls, bearing walls and roof and floor construction. Type 5B requires no rating for any of these elements. Type 5A requires a one-hour rating for the bearing walls, primarily structural frame, floor, and roof construction. The National Frame Building Association funded research that resulted in an approved one-hour, one-directional wall assembly (Figure 2) and two-directional one-, two-, and three-hour post-frame wall assemblies (Figure 3). The two-directional wall assemblies are listed under UL Design No. V304, BXUV. V304. A one-hour roof ceiling assembly may be constructed with a roof truss in accordance with Item 21-1.1 of IBC Table 721.1(3).

Other systems are available from the Structural Building Components Association, and proprietary systems are available from the manufacturers of truss metal connector plates. A compendium of all new fire-rated truss assemblies is available from SBCA. Many one-hour assemblies for roofs built

from dimensional lumber or engineered wood are available. Many of these can be found in the AWC's Design for Code Acceptance 3, *Fire-Rated Wood-Frame Wall and Floor/Ceiling Assemblies* (AWC, 2010).

A large building that exceeds the allowable areas as described in IBC Table 503 may need to be divided into several fire areas by fire walls or fire barriers. IBC Section 706 describes the construction of fire walls, and IBC Table 706.4 describes fire resistance ratings as they apply to specific occupancy groups. Note that for Type 5 construction, fire walls are permitted to have a two-hour fire resistance rating, according to footnote a of IBC Table 706.4. The advantage of using a post-frame-constructed fire wall includes ease of construction when compared to other types of fire walls. One requirement of IBC Section 706.2 is that "a firewall shall have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall for the duration of the time indicated." The post-frame fire wall is a structurally independent system with a post-frame foundation system supporting the columns. Other advantages include the minimal cost of a post-frame fire wall when compared to a masonry fire wall, which would

require an independent foundation system and the involvement of additional contractor trades in the project.

Other critical fire wall and fire barrier considerations are the fire separation distance between the exterior wall and property lines and/or other buildings and the separation of mixed occupancies. IBC Table 602 describes the fire resistive rating requirements for exterior walls based on fire separation distance, and IBC Table 508.4 lists the required separation of mixed occupancies. Post-frame fire-rated assemblies may be used for both of these applications as described in the code.

IBC Section 1203.2 describes attic spaces and venting. Large post-frame buildings with a ceiling have a large attic space and require either vent space at both eaves and at the ridge or some sort of mechanical venting sized appropriately for that attic space. Also, IBC Section 718.4 requires draft stopping every 3,000 sq. ft., continuous from ceiling to roof line, along with maintenance of the ventilation requirements.

Chapter 13 of the IBC refers the designer to the International Energy Conservation Code (ICC, 2012). The IECC has specific requirements for residential and commercial construction with minimum insulation values based on climate zones. One of the benefits of post-frame construction is that it allows for economical superinsulated buildings. Attic spaces may be easily insulated with R-40 or higher material. Because of their unique construction, post-frame walls may be easily insulated to R-30 (**Figure 4**).

Several other IBC sections that have specific application to post-frame construction are found in chapter 14, “Exterior Walls,” and chapter 15, “Roof Assemblies and Rooftop Structures.” IBC Table 1405.2, “Minimum Thickness of Weather Coverings,” and IBC Section 1405.11, “Metal Veneers,” describe the minimum thickness of siding materials. Although prepainted corrugated steel siding is the most common siding material used in post-frame construction, materials such as exterior plywood, wood siding and brick veneers are also



**Figure 4.** Fiberglass blanket insulation sandwiched between interior and exterior girts of a post-frame building

used. IBC Section 1507.4, “Metal Roof Panels,” provides the minimum code requirements for metal roof panels. Roofing and siding specifications are critical in post-frame building design, not only for watertight buildings but also for detailed structural design. This is true because many post-frame building designs rely on in-plane shear strength and stiffness of walls, roofs and ceilings to resist horizontal loads applied to the building.

Many technical articles concerning post-frame structural design have appeared in *Frame Building News*. Chapters 16, 18, and 23 of the IBC contain requirements for structural design, soils and foundations, and wood, respectively. As mentioned, ASABE-published standards EP 484.2, EP 486.1 and EP 559 are referred to in chapter 35 of the IBC and cover the design of post-frame diaphragms, shallow-post foundations and mechanically laminated columns. The best resource for post-frame design is the second edition of the *Post-Frame Building Design Manual* published by the National Frame Building Association (Bohnhoff, 2015). **FBN**

*Timothy R. Royer is president of Timber Tech Engineering, Inc., Denver, Pennsylvania. He can be reached at trr@timbertecheng.com.*

## REFERENCES

- American Wood Council. (2010). *Design for Code Acceptance 3. Fire-Rated Wood-Frame Wall and Floor/Ceiling Assemblies*. Leesburg, Va.: American Wood Council.
- American Wood Council. (2013). *Design for Code Acceptance 5. Post-Frame Buildings*. Leesburg, Va.: American Wood Council.
- The Avalon Project (Yale Law School). (2008). *The Code of Hammurabi* (trans. L. W. King). Retrieved from <http://avalon.law.yale.edu/ancient/hamframe.asp>
- Bohnhoff, D. (2015). *Post-Frame Building Design Manual*, Second Edition. Chicago, IL: National Frame Building Association.
- International Code Council. (2012). *International Energy Conservation Code*. Country Club Hills, Ill.: International Code Council.
- International Code Council. (2015a). *International Building Code*. Country Club Hills, Ill.: International Code Council.
- International Code Council. (2015b). *International Residential Code for One- and Two-Family Dwellings*. Country Club Hills, Ill.: International Code Council.
- UL. (2012). Design No. V304, BXUV.V304. Fire resistance ratings—ANSI/UL 263. Online certifications directory. Retrieved from <http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.htm>