AMERICAN WOOD COUNCIL

Updating Code Conforming Wood Designs

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BCD420-A Updating Code Conforming Wood Designs

Description:
This article provides and overview of the 2015 Code Conforming Wood Design (CCWD) document, which summarizes the most common requirements for wood construction for buildings, according to the 2015 International Building Code (IBC). CCWD was produced in partnership with the International Code Council (ICC). The purpose of this article is to explore code provisions for larger wood buildings allowed under the 2015 IBC.

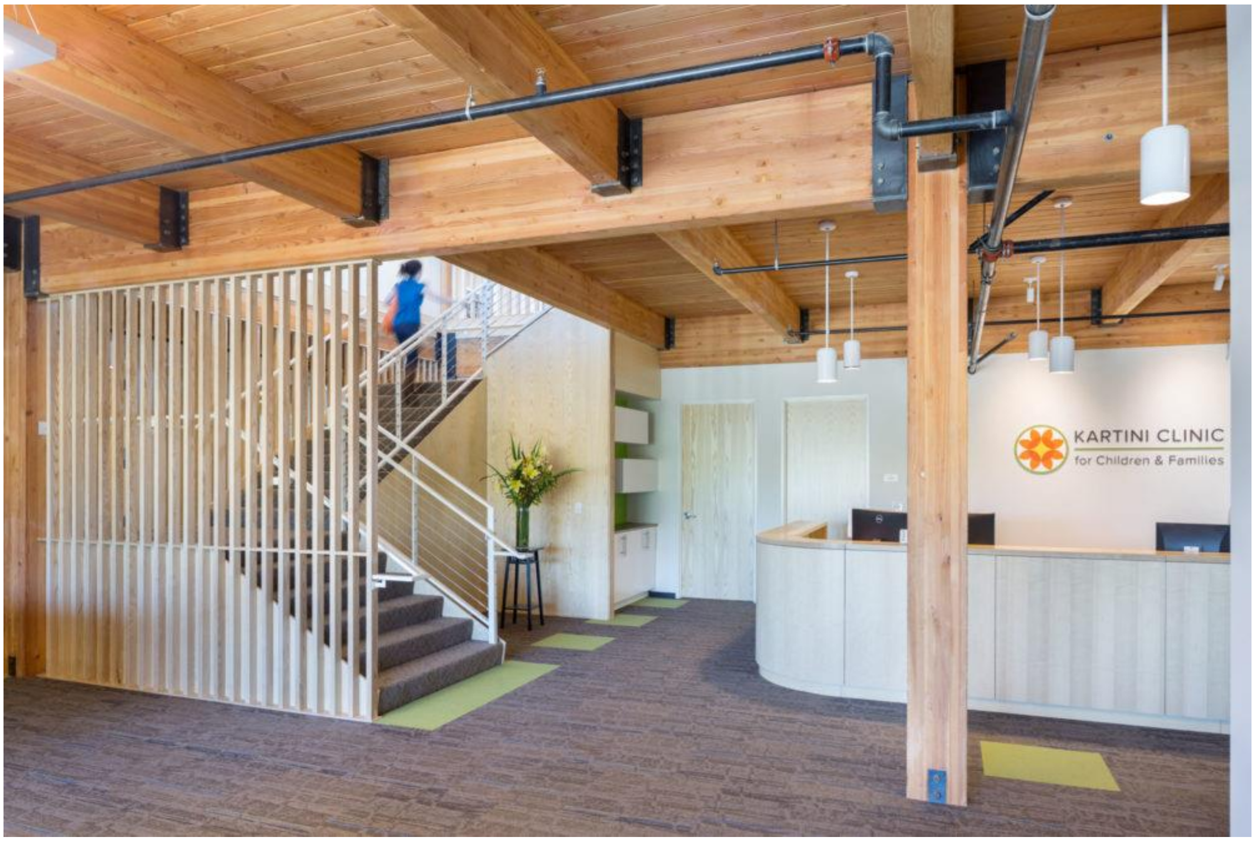
Learning Outcomes:
On completion of this course, participants will be able to:

1. Identify the Types of Construction in the IBC which allow wood construction
2. Determine how to calculate maximum building height and area
3 Describe the methods of establishing fire resistance
4. Understand the safety precautions needed during construction

To receive credit, you are required to read the entire article and pass the test. Go to http://www.awc.org/education/ecourses for complete text and to take the test for free.

Updating Code Conforming Wood Designs

August 29, 2016



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by Kenneth E. Bland, PE

Designing large buildings with wood offers distinct design options typically not found in other structural materials, along with advantages in economics, energy efficiency, and other sustainability factors. However, building codes and standards are often perceived as too complex for designers and builders, so many provisions that allow for wood use in construction are seldom realized.

The American Wood Council (AWC) has developed a document to demonstrate that modern building codes allow large, multi-story wood buildings in many common occupancy uses, with nothing more than a basic understanding of key code provisions required. Produced in partnership with the International Code Council (ICC), the 2015 *Code Conforming Wood Design* (*CCWD*) summarizes the most common requirements for wood construction in commercial buildings according to the 2015 *International Building Code* (*IBC*).

CCWD contains helpful information for building designers and engineers pertaining to allowable building size according to both occupancy and construction type, and provides examples of how the code regulates the use of wood in commercial construction. It also includes information from several key standards relating to design of wood structures recognized by the *IBC*. Specifically, the *IBC* references key 2015 AWC publications such as the *National Design Specification for Wood Construction* (*NDS*), the *Special Design Provisions for Wind and Seismic*, and the *Wood Frame Construction Manual* (*WFCM*), among others. These American National Standards Institute (ANSI)-approved standards represent a consensus on how a wood product or assembly is to be designed or installed to achieve the specified level of performance.

One North's West Building, which was completed last year, pushes the expectations of commercial construction through use of wood.

Types of wood construction

In addition to its use in traditional structural applications such as roof, floor, and wall framing, wood may be used in a variety of other structural and architectural components of a building, including:

- foundations;
- doors and windows;
- exterior and interior finishes;
- trim;
- siding;
- roofing; and
- decking.

The purpose of this article is to explore code allowances for large wood buildings, but *CCWD* also provides a full rundown of building features that can be constructed of wood and how the code addresses them with references to specific code sections.

With a few exceptions, the code limits any wood frame structural assemblies to Types III, IV, and V construction as defined by *IBC.* Construction type classifications establish allowable building area and height limits as prescribed in the building code.

Type III construction is popular for multi-family residential buildings such as apartment and condominium complexes. The code explicitly permits the use of fire-retardant-treated-wood in exterior walls of two-hour rating or less in combination with noncombustible exterior wall coverings. Type III construction is also commonly used for non-residential use group buildings, particularly in urban areas where masonry exterior walls are desired. There are two sub-classifications within Type III; Type IIIA one-hour fire-resistance rated floors and roof, and Type IIIB un-rated floors and roof. Type III construction will most often be platform construction, similar to that of Type V construction, below.

The Radiator is one-third of the Portland, Oregon, office park known as One North. It was designed by Path Architecture, along with general contractor (and developer) Kaiser Group, Munzig Structural Engineering, and PAE Consulting Engineers (for mechanical work). Glued-laminated timber (glulam) was an important part of its design, both from functional and aesthetic perspectives.

Type IV construction—historically called 'heavy timber construction'—is being reinvigorated and has gained a lot of momentum in recent years. Building and fire officials have long understood the enhanced fire performance characteristics of Type IV structures; building designers are now considering the effects of new technologies and the associated benefits of its use. In fact, the 2015 *IBC* is the first edition to recognize new mass timber products such as cross-laminated timber (CLT). Due to the structural capabilities of mass timber, wood design is better able to take advantage of the greater building height and area permitted by *IBC*. As a result, interest in, and advocacy for, mass timber technologies in tall wood buildings—those exceeding prescriptive height limits and requiring special permission—is steadily growing because of the aesthetic, environmental, economic, and cost-related wood benefits. Heavy timber is recognized to have inherent fire-resistant properties due to its mass. When accompanied by additional protection from gypsum wallboard or other membranes, it can achieve high fire resistance ratings while also limiting the effects of the additional fire load created by the massive wood.

Type V construction permits the use of wood or other approved materials for structural elements, and is further identified as Type VA (one-hour fire-resistance rated) and Type VB (no fire-resistance rating required). Often, Type VA is practical since a one-hour rating is relatively cost-effective to achieve for roof, floor, and wall assemblies. Additionally, there are no special restrictions on materials used in exterior walls, as with Types III and IV construction. Type VB, on the other hand, offers the most flexibility for commercial wood frame structures since there are no fire-resistance ratings required for the structural frame—however, there may be fire-resistance ratings required for certain building areas such as means of egress.

Other than meeting fire-resistance requirements, there is no limitation on the use of concrete or steel if chosen for portions of a Type III, IV, or V building. Adding noncombustible elements to a Type V or any other combustible construction type is permitted as long as it does not exceed the building size limit for that construction type. In some instances, alterations and additions, either horizontally or vertically, can still be accomplished with wood.

Determining maximum building height and area

Notable features provided in the 2015 *CCWD*, updated from the 2012 and 2009 versions, are the convenient tables to help determine maximum building size for eight common occupancy groups using newly formatted height and area tables of the 2015 *IBC*. Users will recognize allowable areas for sprinklered and unsprinklered are both provided in the building area tables in the back of the *CCWD*. Occupancies discussed include:

- Group A–Assembly;

- Group B–Business;
- Group E–Educational;
- Group F–Factory/Industrial;
- Group I–Institutional;
- Group M–Mercantile;
- Group R–Residential; and
- Group S–Storage.

One should note Group H (Hazardous Occupancies) and Group U (Utility and Miscellaneous Occupancies) may be built using wood construction, but are beyond *CCWD*'s scope. Section 510 of the code also contains special provisions for buildings sometimes referred to as 'podium' construction.

Using a special horizontal fire-resistance rated separation, two different construction types can be used in a single building. This is typically used to place wood-frame construction over a concrete parking structure, with the required three-hour-rated horizontal separation between the occupancies. Code changes in recent years have added more flexibility by widening the number of use groups in either the upper or lower building, and by permitting multiple stories of concrete construction below a wood frame structure above. These occupancy sections also contain special provisions for protection of exits.

Table 4 – Group B NFPA 13-Compliant Sprinklered Buildings – Maximum floor area per story [a, b, c]

# of stories	% frontage	Maximum floor area per story (sq. ft.)				
		IIIA	IIIB	IV	VA	VB
1	0-25	114,000	76,000	144,000	72,000	36,000
	50	121,120	80,750	153,000	76,500	38,250
	100	135,370	90,250	171,000	85,500	42,750
	100 (60')[d]	UL	UL	UL	UL	UL
2	0-25	85,500	57,000	108,000	54,000	27,000
	50	92,620	61,750	117,000	58,500	29,250
	100	106,870	71,250	135,000	67,500	33,750
	100 (60')[d]	UL	UL	UL	UL	UL
3	0-25	85,500	57,000	108,000	54,000	27,000
	50	92,620	61,750	117,000	58,500	29,250
	100	106,870	71,250	135,000	67,500	33,750
4	0-25	64,120	42,750	81,000	40,500	NP
	50	69,460	46,310	87,750	43,870	NP
	100	80,150	53,430	101,250	50,620	NP
5	0-25	51,300	NP	64,800	NP	NP
	50	55,570	NP	70,200	NP	NP
	100	64,120	NP	81,000	NP	NP
6	0-25	42,750	NP	54,000	NP	NP
	50	46,310	NP	58,500	NP	NP
	100	53,430	NP	67,500	NP	NP

Figure 1: Maximum floor area per story for business occupancies – this comes from Table 4 found in the 2015 Code Conforming Wood Design (CCWD).
Image courtesy the American Wood Council

General building height and area allowances are outlined in *IBC* Chapter 5. For easy reference, *CCWD* shows excerpts from the *IBC* tables for height, number of stories, and per story area (Figure 1). Generally speaking, the maximum height and area of a building depends on its construction type classification (*e.g.* Type III, IV, V, etc.), its occupancy classification (*e.g.* Use Group B, A, R, etc.), and presence of an automatic sprinkler system. When a building is equipped throughout with an automatic sprinkler complying with National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*, the permissible floor area per story can be increased by 300 percent for one-story buildings or 200 percent for multistory buildings. The building height can also be increased by 6 m (20 ft) and one story. Other considerations may include access to the building's perimeter, as well as intended use of the space around the building.

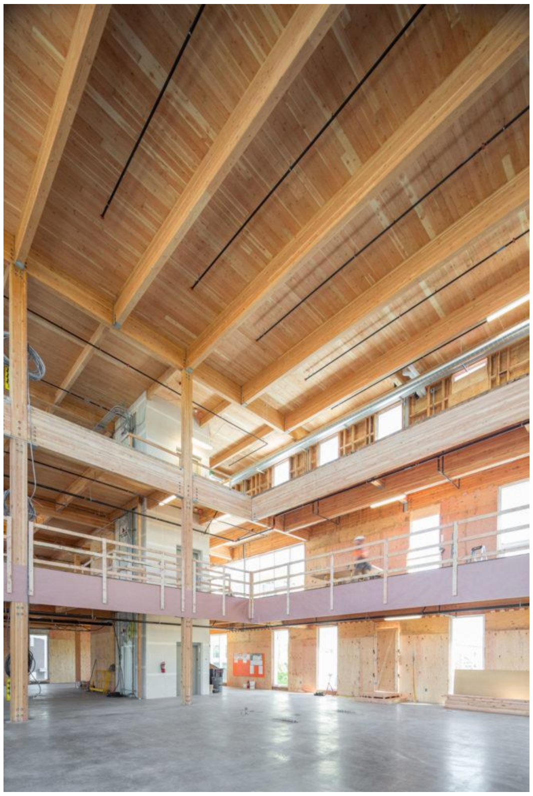
Establishing fire-resistance
CCWD users are also introduced to analytical methods for establishing fire-resistance of wood assemblies and heavy timber. Table 601 in the *IBC* establishes the required fire-resistance of building elements—primarily the structural frame, walls, floors, and roofs—based on the building construction type. Hourly fire-resistance ratings gradually increase as buildings become larger and taller. The rating is established based on how rapidly the strength or stiffness of the member or assembly is affected by the fire and whether hot gases are able to pass through the assembly.

Testing building assemblies and elements according to ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials,* or the corresponding UL standard, and using tested assemblies or elements in design, is the common path for establishing fire-resistance in building design. However, most fire testing, inspecting, and certification bodies are increasingly looking to alternatives for establishing fire-resistance listed in the code (*IBC* Section 703.3). For instance, Chapter 16 of AWC's *NDS* outlines methods for calculating fire-resistance of exposed timber and engineered wood products such as:

- glued-laminated timber (glulam);
- structural composite lumber (SCL); and
- CLT.

AWC Technical Report (TR) 10, *Calculating the Fire-Resistance of Exposed Wood Members*, gives background and examples for this method. The Component Additive Method (CAM) for wood frame assemblies, developed decades ago by the National Research Council of Canada (NRC), has additionally become well-established in the code and is widely used today (see AWC Design for Code Acceptance [DCA] 4).

The building code also permits fire protection engineering analyses based on test results for various assemblies and protected elements. This option can be used to establish fire-resistance without the need for new testing. However, new testing is still essential to the continued advancement of fire research in wood construction. (AWC has previously sponsored tests for heavy timber elements protected with gypsum membranes, and results were published in a 2009 white paper, "Fire Resistance of Wood Members with Directly Applied Protection" by Robert H. White, a research wood scientist for the U.S. Department of Agriculture (USDA) Forest Service.)



One North: East was modeled to perform 50 percent more efficiently than an average office building. It, along with One North: West was designed by a project team that included Holst Architecture, with R&H Construction Co. (general contractor), Froelich Engineers (structural), and McKinstry (mechanical/electrical/plumbing). The developer team comprised Karuna Properties II, Nels Gabbert LLC, and Owen Gabbert LLC.

Safety precautions during the construction process

In order to help mitigate and reduce the devastating financial and safety impacts of construction fires, the *CCWD* highlights important safety precautions for fire that should be implemented in all buildings under construction. These include provisions for:

- fire extinguishers;
- standpipes;
- fire safety planning and fire service access; and
- sprinkler system commissioning.

More detailed requirements stated in the *IBC* can also be found in the *International Fire Code* (*IFC*).

Further, AWC recently partnered with FireforceOne, a consulting firm led by retired California State Fire Marshal Ronny J. Coleman, to develop a set of best practice manuals, training videos, and a dedicated website to educate and inform developers, designers, and local building and fire departments on how to prevent fires, reduce losses, and help ensure overall fire safety at large construction sites. (The materials are available for design professionals to download at ConstructionFireSafetyPractices.com[1].)

Tying it all together

The end goal of AWC's *Code Conforming Wood Design* is to make the regulatory acceptance of wood construction as easy as possible for designers and builders, and to address common misconceptions about size limits for commercial wood buildings. As codes continue to evolve and become more complex, resources of this nature are increasingly helpful to understand the many provisions that allow for wood use in construction without compromising safety.

AWC strongly encourages designers and builders to review the 2015 *CCWD*, along with other technical resources referenced in this article, for the latest information on codes and standards for wood construction. (The full copy can be downloaded by visiting www.awc.org[2].)

Kenneth E. Bland, PE, joined the American Wood Council (AWC) in 1988, and serves as the vice president of codes and regulations. Prior to joining AWC, he served in building code administration and enforcement. He is a member of the Society of Fire Protection Engineers (SFPE), is the past chair of the International Code Council's (ICC's) Industry Advisory Committee, and serves on a number of standards development committees in various capacities. Bland holds a bachelor's degree in architectural engineering in structures from Pennsylvania State University, a master's of science in fire protection engineering from Worcester Polytechnic Institute, and is a licensed professional engineer. He can be reached via e-mail at kbland@awc.org[3].

Endnotes:

1. ConstructionFireSafetyPractices.com: http://ConstructionFireSafetyPractices.com
2. www.awc.org: http://www.awc.org
3. kbland@awc.org: mailto:kbland@awc.org

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