

International Building Code: More Options with Greater Opportunity for Wood-Frame Design

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Introduction

The 2006 *International Building Code (IBC)* is being readied for publication early in 2006. It will continue to give architects, engineers and designers more options and much greater freedom in designing wood-frame construction, especially non-residential construction. Most of the opportunities created with the initial development of the *IBC* (2000 edition) are included in this next edition. Of course, adoption by various states and local jurisdictions might be several years away. However, insofar as the opportunities extant in

the 2000 edition are also found in the upcoming 2006 edition, a quick *IBC* brush-up course may be helpful.

A Quick Refresher Course

Wood Design & Building published a background article on the *IBC* in the Autumn 1997 issue. Here are some highlights:

- The *IBC* consolidates the three regional model building codes in the United States. The three legacy model code

groups – Building Officials and Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress, International (SBCCI) – established the International Code Council (ICC) in 1994 to develop a single, correlated, family of codes. The *IBC* is the final code to be published, following the energy conservation, fuel gas, mechanical, plumbing, private sewage disposal, property maintenance, zoning, and fire codes. It is issued simultaneously with the *International Residential Code (IRC)*.

- The *IBC* replaces the model regional codes and is being offered across the United States and in those foreign countries utilizing one of the existing model codes. Like any model code, it will not go into effect, however, until it is adopted by states and local jurisdictions, with inevitable modifications.

What is its Impact?

The existence of such a broad-based consensus code has led jurisdictions which never developed a code before to do so. Pennsylvania has adopted the *2003 IBC* as its very first comprehensive state wide building code. New Hampshire has created a statewide code based on the *IBC*. Louisiana has just announced adoption of *IBC* as a statewide code. New York and Florida have converted more locally based codes to the *IBC*. Even California expects to adopt the *IBC* (it's a long process in California). All states with a statewide building code have adopted the *IBC*. Nearly every state in the union uses an I-code within the state. Illinois is investigating the creation of a statewide code with the *IBC* as the model should such an action occur.

What Has Not Changed?

The code format used in the *IBC* will be familiar to design professionals. Chapter 23 of the *2000 International Building Code* governs use, design, construction, and quality of wood members and their fasteners. Aside from prescriptive conventional construction provisions, Chapter 23 relies in large part on design tools developed by the American Forest & Paper Association (AF&PA) as well as those from American In-

stitute of Timber Construction (AITC), APA–The Engineered Wood Association (APA), and National Frame Builders Association (NFBA). It includes many familiar requirements for wood construction that are common to all three existing model codes.

Height and Area Changes

Increased allowable building height and area (H&A) provisions under the *IBC* have the greatest potential impact on wood construction. **Figure 1** shows the potential increase in non-residential wood-frame construction under the *IBC*. The H&A provisions were developed by comparing the three legacy model code requirements for the most similar use group and type of construction.

The *IBC* drafting committee reviewed fire records from the United States Fire Administration and from National Fire Protection Association. The fire record did not support moving to more restrictive area limits. It also did not support changes in Types of Construction. The largest value was then chosen for each entry in the *IBC* so that no existing building would suddenly be non-conforming.

The committee then took the area increase provisions from the Board for the Coordination of Model Codes

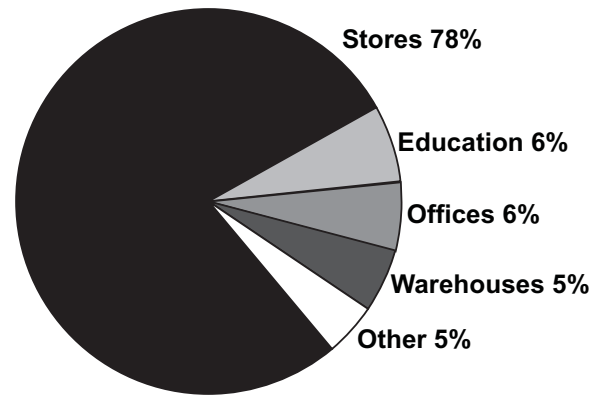


Figure 1. — Percentages of new opportunity under *IBC* provisions for designing wood-frame non-residential buildings. Stores show dramatic new potential for designers.

Case Study – Los Angeles Apartments Above Mercantile with a 2-story Parking Garage



This large apartment complex is also constructed in a fashion similar to *IBC* Type III construction. It has Type I parking beneath and uses open yard and sprinkler increases to realize the necessary story size for cost efficiency.

This building in Los Angeles, California was built under the *1997 Uniform Building Code (UBC)*. The building illustrates the *IBC* section 508.2, which permits building story count to begin above a 3-hour separation for parking below and Group R above. The height is measured from the grade plane. In this example, *UBC* area separation assemblies are used to gain floor area. This can also be accomplished using the fire walls in the *IBC*.

(BCMC) report. With a few modifications, such as the open yard ratio [W/30] limits, the result is the following formula:

$$A_a = A_t + \left[\frac{A_t I_f}{100} \right] + \left[\frac{A_t I_s}{100} \right]$$

where:

- A_a = allowable area per floor (sq. ft.)
- A_t = tabular area per floor (sq. ft.)
[IBC Table 503 values]
- I_f = area increase due to frontage (percent)
- I_s = area increase due to sprinkler protection (percent)

$$I_f = 100 \left[\left(\frac{F}{P} \right) - 0.25 \right] \frac{W}{30}$$

P = perimeter of the entire building (ft.)

W = width of public way or open space

F = building perimeter which faces open space
a minimum of 20 ft. in width (ft.)

(The ratio W/30 is permitted to be 2 for A-1, A-4, B, F, M, and S; 1 for all other use groups).

Other IBC Impacts

- Definitions of some use groups and types of construction have been changed. These changes generally introduce

Example of a Wood-Frame Nursery Sales Building – Height and Area Calculations

Calculating Increased Height and Area for Nursery Sales Building

The shaded area partially surrounding the building is 28 feet wide and extends 190 feet in the back, is 30 feet wide and extends the full width on the right and full length of the front. The building is 225 feet by 65 feet. The property lines are not restrictive in the example.

Occupancy Classification: M (Mercantile)

Nursery Sales

Construction Type: 5B

Area: $20,000 \text{ ft}^2 - 5,400 \text{ ft}^2 = 14,600 \text{ ft}^2$

Unsprinklered

Steps to determine increase:

1. Determine perimeter to frontage ratio:

$$I_f = 100 \left[\left(\frac{F}{P} \right) - 0.25 \right] \frac{W}{30}$$

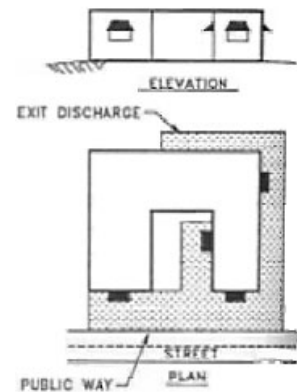
$$I_f = 100 \left[\left(\frac{190 + 65 + 225}{225 + 225 + 65 + 65} \right) - 0.25 \right] \frac{28}{30}$$

$$I_f = 100 \left[\left(\frac{480}{580} \right) - 0.25 \right] \frac{28}{30}$$

$$I_f = 100 [0.83 - 0.25] 0.93$$

$$I_f = 100 [0.58] 0.93$$

$$I_f = 54$$



$$A_a = A_t + \left[\frac{A_t I_f}{100} \right] + \left[\frac{A_t I_s}{100} \right]$$

$$A_a = 9000 \text{ ft}^2 + \left[\frac{9000 \text{ ft}^2 * 54}{100} \right] + \left[\frac{9000 \text{ ft}^2 * 0}{100} \right]$$

$$A_a = 9000 \text{ ft}^2 + \left[\frac{486000 \text{ ft}^2}{100} \right] + \left[\frac{0 \text{ ft}^2}{100} \right]$$

$$A_a = 9000 \text{ ft}^2 + 4860 \text{ ft}^2 + 0 \text{ ft}^2$$

$$A_a = 13860 \text{ ft}^2$$

2. Determine total allowable area:

Solutions to Non-conforming Designed Area

Since the total allowable area is $13,860 \text{ ft}^2$, the proposed building area of $14,600 \text{ ft}^2$ is larger than the allowable area. A quick solution is readily apparent:

1. widen the open space for its entire distance to 30 feet and lengthen the 30-foot-wide perimeter to the entire building length in the rear (the frontage ratio becomes 64 and the new allowable area is $14,760 \text{ ft}^2$, which is permitted); or
2. sprinkler the building; I_s becomes 300 percent and the allowable area becomes $27,000 \text{ ft}^2$ with no open perimeter increase whatsoever.

Tabular allowable height and area from Table 503 is one story and 9000 ft^2

more conditions that permit wood-frame construction. One of the changes impacting wood construction is the definition of Type III construction. The definition, borrowed from the Legacy *Uniform Building Code*, is:

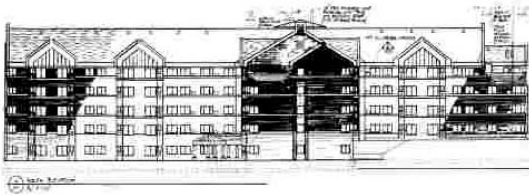
602.3 Type III. Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by this code. Fire retardant treated wood framing complying with Section 2303.2 shall be permitted within exterior wall assemblies of a 2-hour rating or less.

- The *IBC* permits sprinklered buildings with NFPA 13 systems to contain one additional story and be increased in height 20 feet. Residential buildings with NFPA 13R systems may be increased one story and 20 feet in height and are not subject to the total building area limit of a three-story building (13R is only appropriate up to four stories above grade plane).

Use Group Separation

Another feature of the *IBC* is use or area separation requirements. In the *IBC*, a rated wall in accordance with Table 602 can be used to separate a building into two smaller areas, neither of which exceeds threshold values that require installation of sprinklers. This is not considered a fire wall separating buildings. It is a fire separation assembly, separating the building into fire areas – new to many code users. In addition, the *IBC* allows fire walls of combustible material in buildings of Type V construction. This permits the structure to be divided into separate buildings, each subject to its own height and area limits. In a parallel development, NFPA 221, the standard for fire walls and fire barrier walls, has, in its latest edition, a provision for a 2-hour fire resistance rated fire wall built using two contiguous 1 hour fire resistance rated assemblies. Many wood-frame assemblies are capable of achieving the 1-hour rating. It opens many new opportunities for design using wood-frame construction.

Case Study – Copperfield Hill



Copperfield Hill is the first five-story wood-frame building built in Minneapolis, Minnesota. This type of construction is routine in the Western United States. The building is a 165,000 square foot self-contained retirement community which provides apartment-style living spaces and common areas, including a kitchen and dinner facility, music room, library, card and game rooms, a craft shop, and an art center. The project was completed in 1987. The budget for the project was \$9.5 million, which included the cost of land and \$4.7 million for construction. Wood-frame was chosen based primarily on cost compared to steel-frame. Bids for steel-frame came in at more than 75 percent higher than the wood-frame. The ease of wood construction allowed the building to be framed in slightly more than 5 months.

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The building was designed under the *Uniform Building Code (UBC)*. The *UBC* required exterior walls to be constructed of non-combustible materials. This is similar to the Type III construction found in the *2003 IBC*. The architect divided Copperfield Hill's living area into six "buildings" by the use of fire walls (the *UBC* referred to these assemblies as fire separation walls). To minimize shrinkage, the project architect selected open web parallel-chord trusses for most floor joist members. Other than shrinkage consideration, this type of truss provides easy access for routing plumbing, mechanical, and electrical systems. Solid-sawn lumber joists and wood I-joists were also used, but to a lesser extent.

Steel was used to form the large open central atrium and to support the code-required noncombustible metal pan stairs. For aesthetics and to meet the code requirement for non-combustible exterior wall assemblies, a brick facing was chosen. For framing within the exterior walls, the architects specified fire retardant-treated (FRT) lumber covered by Type X gypsum wallboard on the interior. The *IBC* provides for using FRT in exterior walls but the noncombustible cladding requirement was not also carried over. Although the exterior brick walls reach a 50-foot height in some places, they were constructed without the use of relieving angles. However, numerous vertical expansion joints and flexible brick ties were used to minimize cracking.

Wind was the main lateral force design consideration. No uplift problems were encountered in the design. To carry the high gravity loads on the lower floors, 3 by 4 lumber at 16 inches on-center was typically used for the interior wall studs, and 2 by 6 lumber at 16 inches on-center was used for exterior wall studs. Hem-Fir Stud grade was specified for stud lumber.

Unlimited Areas

- Under the *IBC*, depending on the building's use, wood buildings of unlimited area are permitted when 60-foot spatial separation to the property line is provided and the building is sprinklered and constructed as Type III. Furthermore, buildings of use groups which might otherwise be permitted to be unlimited in area but which lack a full 60-foot-wide open perimeter can gain increased area for widths from 30-foot separation up to 60-foot separation ($W/30 \leq 2$). Also, buildings with as little as 20-foot fire separation will enjoy credit for open perimeter.

Larger Single-Story Buildings

- The *IBC* allows the area for single-story buildings that are sprinklered to be increased to 300 percent of the tabular area.

Fire Resistance Ratings

- The *IBC* permits asymmetric testing for fire resistance rating (testing from the inside only) where the distance to the property line is at least 5 feet. This creates new possibilities in the West and parts of the Mid-West for both exterior cladding and interior finish work.

- The *IBC* has a table of prescriptive fire resistance rated assemblies. Table 720 now contains I-joist assemblies and nominal 2x exterior wall assemblies rated at 100 percent load capacity.
- If sprinklering is not used for H&A increases, it is permitted to reduce fire resistive requirements by one hour for all construction elements except exterior walls.

The Bottom Line

Learning the provisions of the *IBC* may be a challenge for designers, builders, and building officials. New code text, appendices, and definitions will change the environment in which wood-frame buildings are selected, designed, and built. But the *IBC* will more than compensate design professionals by giving them more powerful tools with wider applications for designing with wood. They will have more options and the convenience of a single code. This is an idea whose time has come.

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