Wood Uses in
Educational Buildings

Introduction

Wood construction offers distinct design options typically not found in a single structural material. It is inexpensive, readily available, easy to work with, strong and adaptable. The economic, environmental and energy efficiency advantages account for more buildings being constructed of wood than any other structural material.

The intent of this document is to summarize allowable wood use in buildings in accordance with the International Code Council (ICC) 2012 *International Building Code®* (IBC®). Emphasis will be placed on the design flexibilities permitted for wood in commercial construction. This is not meant to be a replacement for the IBC and does not encompass all of the design options in the IBC. The IBC should always be consulted for applicable specific requirements related to designs and site conditions.

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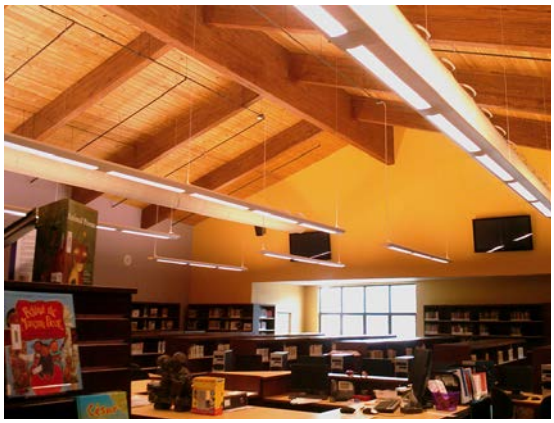

About the American Wood Council

The American Wood Council (AWC) is the voice of North American traditional and engineered wood products. AWC develops state-of-the-art engineering data, technology, and standards on structural wood products for use by design professionals, building officials, and wood products manufacturers to assure the safe and efficient design and use of wood structural components. AWC also provides technical, legal, and economic information on wood design, green building, and manufacturing environmental regulations advocating for balanced government policies that sustain the wood products industry.

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About the International Code Council

The International Code Council is a member-focused association. It is dedicated to developing model codes and standards used in the design, build and compliance process to construct safe, sustainable, affordable and resilient structures. Most U.S. communities and many global markets choose the International Codes. ICC Evaluation Service (ICC-ES) is the industry leader in performing technical evaluations for code compliance fostering safe and sustainable design and construction.

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1. General Information

Use and Occupancy Classification

Building code requirements are dependent on the appropriate classification of the building or structure for its design purpose or current occupancy. The IBC lists Education Group E occupancies in Section 305. Group "E" includes any buildings or portions of a structure used to educate six or more people through 12th grade. Buildings or portions of a structure used for supervision, personal care or education of more than five children at least $2^1/_2$ years old are also Group E structures.

Figure 1: Elementary School

Referenced Code and Standards

The IBC is developed by the International Code Council. Industry and professional standards are referenced in the IBC to clarify specific code requirements. Chapter 35 of the IBC provides a list of the standards referenced, the agency that wrote the standard, the title of the standard, and its effective date.

Standards represent consensus on how a material, product or assembly is to be designed, manufactured, tested or installed so it achieves a specified level of performance. Several key standards relating to the design of wood structures are utilized by the IBC. Specifically, the 2012 IBC references the American Forest & Paper Association (AF&PA), a legacy organization of the American Wood Council (AWC), *2012 National Design Specification® (NDS-12®) for Wood Construction with 2012 Supplement* and the AF&PA/AWC SDPWS-08, *2008 Special Design Provisions for Wind and Seismic*. The NDS details structural and fire design methods in the use of lumber, timber, prefabricated wood i-joists, structural composite lumber and wood structural panels, using either Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD). The SDPWS addresses materials, design and construction of wood members, fasteners and assemblies used to resist wind and seismic forces.

Section 8, Resources of this document provides information on how to obtain these standards and other related materials.

2. Type of Construction

Chapter 6 of the IBC defines types of construction, with wood frame construction typically found in Types V, IV and III. Additionally, the IBC has specific applications that permit the use of wood in construction Types I and II. These circumstances will be addressed in Sections 5 and 6 of this document.

Type V Construction

Figure 2: Type V Construction

Type V construction permits the use of wood or other approved materials for structural elements, including structural frame members, bearing walls, floor and roof construction, as well as nonbearing elements such as exterior walls and interior partitions. Type V construction is further defined as Type VA (all interior and exterior load-bearing walls, floors, roofs and all structural members are designed or protected to provide a minimum 1-hour fire-resistance rating) and Type VB (no fire-resistance rating is required).

Type IV Construction

Figure 3: Type IV Construction

Type IV construction (Heavy Timber, HT) has exterior walls made of noncombustible materials or fire-retardant-treated wood (FRTW) and interior building elements made of solid or laminated wood without concealed spaces. Columns supporting roof and ceiling loads must be a minimum nominal dimension of 6 inches by 8 inches and 8 inches by 8 inches if supporting floor loads. Floor beams and girders must be a minimum nominal dimension of 6 inches by 10 inches and roof beams and girders must be a minimum nominal dimension of 4 inches by 6 inches. Flooring must be a minimum nominal 3-inch thickness covered with 1-inch nominal dimension tongue-and-groove flooring and roof decking must be a minimum nominal 2-inch thickness or $1^{1}/_{8}$-inch-thick wood structural panels. Partitions must be 1-hour fire-resistance-rated construction or a minimum two layers of 1-inch nominal board or laminated construction 4 inches thick.

Type III Construction

Figure 4: Type III Construction

Type III construction requires exterior walls to be noncombustible material or FRTW having a minimum 2-hour fire-resistance rating. All of the other building elements are permitted to be wood or other approved materials. Type IIIA construction needs to provide a minimum 1-hour fire-resistance rating for all building elements and Type IIIB construction does not require any fire-resistance rating other than the exterior load-bearing wall.

Type I and II Construction

Type I and II construction requires building elements constructed of noncombustible materials. Sections 5 and 6 of this document outline circumstances where wood is permitted in Type I and II buildings.

Figure 5: Type I Construction

3. Allowable Heights and Areas for Type V, IV and III Construction

When the first edition (2000) of the IBC was published, wood buildings were allowed to have areas and heights commensurate with the largest buildings permitted for each construction type under at least one of the regional legacy codes. Since then, allowable building sizes have not changed significantly, although the number of buildings that qualify for unlimited area under the special provisions of Section 507 has expanded. In addition, special allowances for various building features such as sprinklers or the use of FRTW continue to be added. As a result, size thresholds for wood structures are more often determined by structural considerations than by code limitations. This may not be the case in the future. Upcoming editions of the IBC will recognize new mass timber products such as cross-laminated timber (CLT) and other advanced engineered wood products. Because of the structural capabilities of mass timber, wood design will be better able to take advantage of the generous building sizes permitted by the IBC—greater building heights, commercial loads, and long clear spans will be less likely to preclude it. This means the full environmental, economic, and aesthetic benefits of designing in wood will be available for more buildings.

General building height and area allowances are given in Chapter 5 of the IBC. Height and per-story area limitations are shown in the Table 503 excerpt (Figure 6) and are based on occupancy and type of construction. These area and height limitations are unmodified and can be significantly increased based on certain provisions of the code that will be explained in this section.

Group E	Type of Construction				
	Type III		Type IV	Type V	
	A	B	HT	A	B
Height (ft)	65	55	65	50	40
Stories (S)					
Area (A)					
S	3	2	3	1	1
A	23,500	14,500	25,500	18,500	9,500

Figure 6: Table 503 Excerpt

The height and area of a structure may be increased depending on the building location on the lot, the presence of automatic sprinkler systems or using some of the design options recognized

in Chapter 5 of the IBC. Upper limits for the size of certain occupancies without sprinklers are placed in Chapter 9. These increases and limits are discussed in detail in this section.

Equation 5-1 establishes the maximum allowable area per floor based on the Chapter 5 modifications.

$$A_a = \{A_t + [A_t \times I_f] + [A_t \times I_s]\} \quad \textbf{(Equation 5-1)}$$

where:

A_a = Allowable building area per story (square feet).

A_t = Tabular building area per story in accordance with Table 503 (square feet).

I_f = Area increase factor due to frontage as calculated in accordance with Section 506.2.

I_s = Area increase factor due to sprinkler protection as calculated in accordance with Section 506.3.

Allowable Increases for Frontage

Buildings adjacent to an open space adjoining a public way, with the exterior wall a minimum of 20 feet from the far side of the public way for more than 25 percent of the building perimeter, may increase the allowable floor area from Table 503 using Equation 5-2.

$$I_f = [F / P - 0.25]\, W / 30 \quad \textbf{(Equation 5-2)}$$

where:

I_f = Area increase due to frontage.

F = Building perimeter that fronts on a public way or open space having 20 feet open minimum width (feet).

P = Perimeter of entire building (feet).

W = Width of public way or open space (feet) in accordance with Section 506.2.1. (A weighted average may be used when W varies along the perimeter.) W is the open space width plus the width of the public way.

Frontage widths (W) greater than 30 feet will only receive credit for a value of 30 feet in accordance with Section 506.2.1. The maximum increase that can be obtained for frontage would occur when 100 percent of the perimeter has frontage of 30 feet or more and would result in a 75-percent floor area increase.

Weighted Average

Section 506.2.1 allows use of a weighted average to calculate the frontage width around a building. Figure 7 illustrates use of the weighted average equation.

> Note: this equation is only used when one or more of the open space widths are between 20 and 30 feet in length. If additional open space widths are greater than 30 feet, reduce the width to 30 feet before calculating a weighted average.

$$\text{Weighted average } W = (L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 \ldots) / F \quad \textbf{(Equation 5-3)}$$

where:

L_n = Length of a portion of the exterior perimeter wall

w_n = Width of open space associated with that portion of the exterior perimeter wall

F = Building perimeter that fronts on a public way or open space having a width of 20 feet or more

Length of Walls:

L_1, L_2, L_3 and L_4 = 200 ft

Frontage Width:

w_1 = 22 ft w_3 = 55 ft

w_2 = 45 ft w_4 = 50 ft

For w_2, w_3 and w_4, use the maximum 30-foot width in the weighted average equation.

F = 200 x 4 = 800 ft

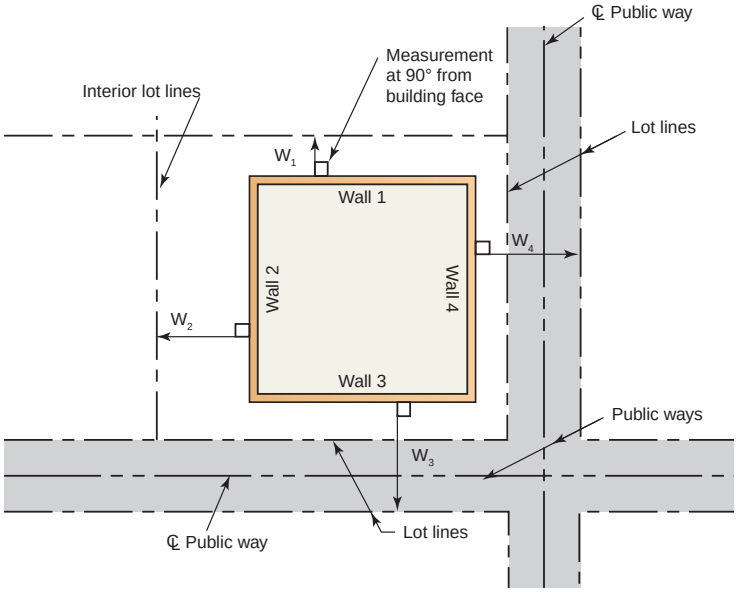


Figure 7: Open Space Width

$$W = \frac{(L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4)}{F}$$

$$W = \frac{(200 \times 22 + 200 \times 30 + 200 \times 30 + 200 \times 30)}{800} = 28 \text{ ft}$$

Frontage Increase Calculation

The frontage calculation determines the additional allowable increase in area per story due to open space around the building. Figure 8 illustrates the frontage increase concept for a three-story middle school of Type IIIA construction.

Given:

- Three-story middle school
- Type IIIA construction
- Street width of 22 feet

Determine:

- Area limitation

Solution:

Length of Walls:

L_1 = 125 ft L_3 = 125 ft

L_2 = 250 ft L_4 = 250 ft

Frontage Width:

(Note: Public way width is 22 ft)

w_1 = 15 ft w_3 = 10 + 22 = 32 ft

w_2 = 25 ft w_4 = 30 + 22 = 52 ft

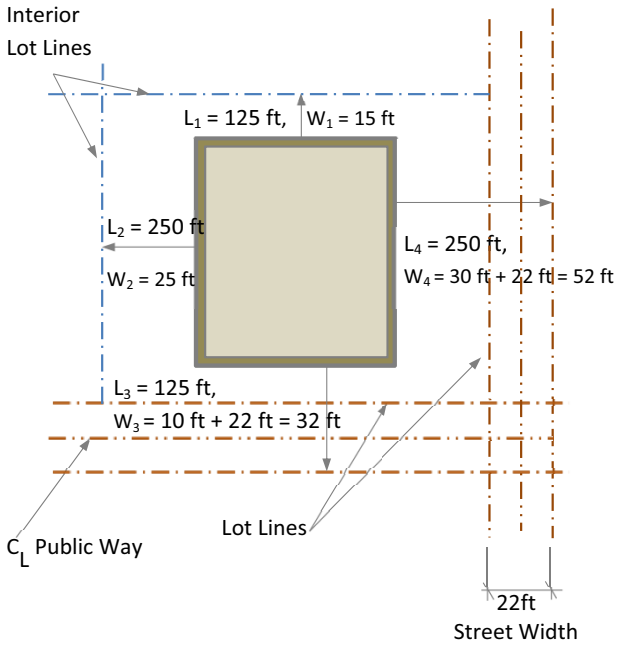


Figure 8: Frontage Increase Calculation

For w_1, the open space width is less than 20 ft; this side of the building is not included in the frontage calculations. For w_3 and w_4, use w=30 ft (maximum) in the weighted average in accordance with Section 506.2.1.

Frontage Length:

$F = L_2 + L_3 + L_4 = 250 + 125 + 250 = 625$ ft

$$W = \frac{(L_1 \times w_1 + L_2 \times w_2 + L_3 \times w_3 + L_4 \times w_4)}{F}$$ **(Equation 5-3)**

$$W = \frac{(0 + 250 \times 25 + 125 \times 30 + 250 \times 30)}{625} = 28 \text{ ft}$$

A_t = 23,500 sq ft

$I_f = (F / P - 0.25) \times W / 30$ **(Equation 5-2)**

$I_f = [(625 / 750) - 0.25] \times 28 / 30 = 0.54$

$A_a = \{A_t + [A_t \times I_f] + [A \times I_s]\}$ **(Equation 5-1)**

A_a = 23,500 + (23,500 x 0.54) + (23,500 x 0) = 36,190 sq ft per story maximum

A_a = 36,190 x 3 stories = 108,570 sq ft for total maximum building area

Actual = 31,250 sq ft per story, 93,750 sq ft total ✓ **OK**

Note that this example assumes a nonsprinklered building; however, if the Group E occupancy has a fire area exceeding 12,000 sq. ft. or has educational spaces below the lowest level of exit discharge serving that portion of the building, sprinklers would be required per Section 903.2.3, as explained in the next section.

Allowable Increases for Automatic Sprinkler Systems

When a building is equipped throughout with an NFPA 13-compliant automatic sprinkler system, the allowable floor area is permitted to be increased by 300 percent for a one-story building and 200 percent for a multistory building.

In addition to the area increase, Section 504.2 also permits the Table 503 building heights to be increased by 20 feet and the number of stories above grade plane to be increased by one story. Figure 9 illustrates the combined effect of frontage and automatic sprinkler systems on the allowable area calculation.

Given: Single-story Type VB grade school

Provided with automatic sprinkler system throughout and located on lot as shown.

Determine: Maximum allowable building area

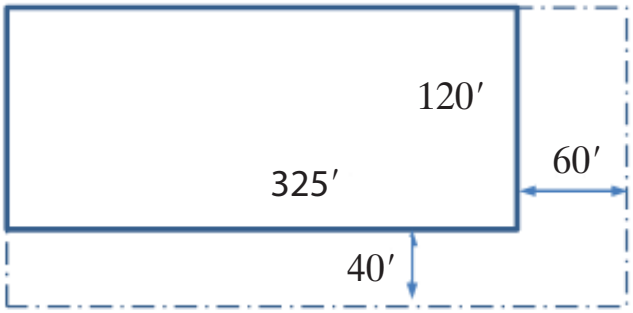


Figure 9: Allowable Building Area Calculation

Solution:

A_t = 9,500 (Table 503)

Frontage Increase (Section 506.2)

$I_f = (F / P - 0.25) \times W / 30$

$I_f = [(445 / 890) – 0.25] \times 30 / 30 = 0.25$ (where $W > 30$, use 30)

Note: The weighted average calculation was not needed in this example.

Sprinkler Increase (Section 506.3)

I_s = 3 (300% increase)

Total Allowable area (Section 506.1)

$A_a = A_t + (A_t \times I_f) + (A_t \times I_s)$

A_a = 9,500 + (9,500 x 0.25) + (9,500 x 3) = 40,375 square feet

Actual area = 325 x 120 = 39,000 square feet ✓ OK

Area Limits for Nonsprinklered Buildings in Chapter 9

Many occupancies, including Group E, have floor area limits allowed by Chapter 5 that are greater than those permitted in Chapter 9 for nonsprinklered buildings. The same thresholds apply to all construction types, not just wood. The allowable area per story can exceed allowable fire areas and a sprinkler system may be required.

If sprinklers are provided, allowable area increases for both sprinklers and open frontage may be taken. Alternatively, fire areas may be kept below sprinkler thresholds by compartmentalizing floor areas with fire-resistance-rated construction in accordance with the definition for “Fire area” and the requirements of Chapter 7. The requirement for sprinklers can also be triggered by height above grade.

According to Section 903.2.3, sprinkers are required when a Group E fire area exceeds 12,000 sq. ft. In addition sprinklers are required in every portion of Group E occupancies below the level

of exit discharge, except when every classroom throughout the building has at least one exterior exit door at ground level.

Sprinklers offer a substantial increase to life safety, which is well documented and merits the consideration of designers for that reason alone. But their advantages can also be economic. The code offers considerable trade-offs for providing sprinklers, including:

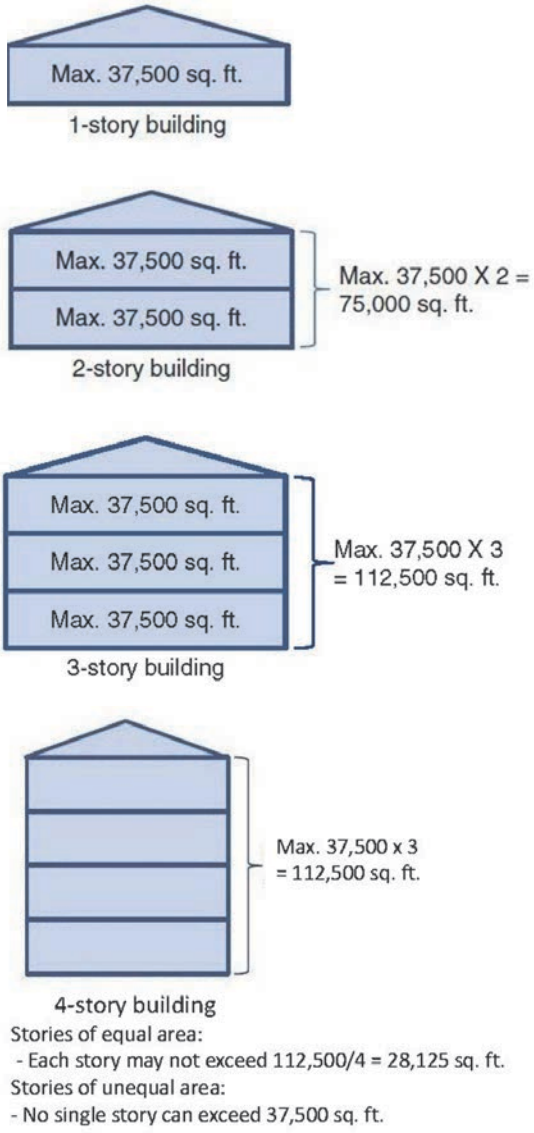
- Reductions in corridor ratings and corridor opening protection,
- Flexibility in means of egress (travel distance to exits, number and separation of exits, common path of travel),
- Reductions in dwelling unit separations,
- Alternate to emergency escape openings,
- Alternate to certain fire and smoke damper requirements, and
- Interior finish flexibility.

For these reasons, the addition of sprinklers should always be considered in the overall cost analysis for any project.

Tables 1 and 2 at the end of this document illustrate the allowable area and height increases permitted for Educational occupancy (E). Table 1 lists nonsprinklered allowable building area per story. Table 2 lists sprinklered allowable building area per story.

Total Building Area Limit

Single Occupancy



A single occupancy building with three or more stories above grade has a total building area of the allowable building area per story (A_a) multiplied by three in accordance with Section 506.4.1. Therefore, buildings with four or more stories of the same floor area will have smaller maximum areas per floor than a three-story building of the same type of construction and occupancy. For two-story buildings, the total building area is the maximum allowable building area multiplied by two. The maximum area of any story above grade cannot exceed the allowable building area per story. A single basement is not included in total allowable building area in accordance with Section 506.4.

The actual building area for all stories in the building added together must be less than the total allowable building area.

3 and 3+ Story Building

Total Allowable Building Area

$A_t = 3 \times A_a$

2-Story Building

Total Allowable Building Area

$A_t = 2 \times A_a$

where:

A_t = allowable building area.

A_a = allowable building area per story.

Figure 10: Maximum Building

Mixed Occupancy

Mixed occupancy buildings are permitted a total allowable building area calculated in accordance with Section 506.5. But, a single-story basement does not need to be included in the total allowable building area, when the basement does not exceed the area permitted for a single story.

More than one occupancy in a single building can be accommodated by using the allowable area of the most restrictive occupancy (referred to as "nonseparated occupancies" in accordance with Section 508.3). Alternatively, the occupancies can be regulated as "separated occupancies" (Section 508.4) to allow somewhat larger floor areas. This methodology will often mandate separation of the occupancies by fire barriers and/or horizontal assemblies. The code also accommo-

dates limited area spaces that are accessory to the function of the main occupancy, if the restrictions of Section 508.2 are followed. See Section 506.5 for additional limits for single- and multistory mixed occupancy buildings. Note that "incidental uses" (as opposed to accessory uses) are covered in Section 509 of the code and always require separation in accordance with Table 509.

Unlimited Area Buildings

Unlimited area Group E buildings are permitted by Section 507.10, provided they are no more than one story above grade plane; of Type IIIA or IV construction; equipped throughout with an NFPA 13-compliant automatic sprinkler system; each classroom has two means of egress, with one means of egress a direct exit to the outside of the building complying with Section 1020 and the building is surrounded on all sides by public ways or yards not less than 60 feet wide.

Allowable Increases with Fire Walls

A fire wall is a fire-resistance-rated wall with protected openings that restricts the spread of fire and extends continuously from the foundation to or through the roof. Fire walls built in compliance with Section 706 create separate buildings for the purpose of area limitations and other code-required features. Fire walls separating Group E occupancies require a 3-hour minimum fire-resistance rating (2-hour minimum for Type V construction). Each portion of a building separated by a fire wall is evaluated individually for allowable heights and areas based upon the type of construction. Fire walls in Type V construction may be wood framed; in other construction types they must be of noncombustible materials in accordance with Section 706.3.

4. Establishing Fire Resistance

Table 601 of the IBC establishes the required fire resistance of building elements (primarily the structural frame, walls, floors and roofs) due to the construction type of the building (e.g., Type IIIA, Type IIIB, Type IV, etc). Required ratings are given in hours. The exception is Type IV, where the wood structural elements are assumed to have inherent fire resistance due to their required minimum dimensions (no fire-resistance rating is required except for exterior walls).

Fire resistance describes the rate at which a building material degrades due to a fire. Resistance is based on how fast a material will burn, how rapidly the strength of the member or assembly is affected by the fire and whether the member or assembly can maintain its design strength. Fire resistance of wood members and assemblies may be established by any one of five means listed in Section 703.3. The most common methods are indicated below.

Tested Assemblies

Tested assemblies include wood assemblies that have been tested to the ASTM E 119 or UL 263 standard. Using one of these standards, an assembly is typically assigned a 1- or 2-hour fire rating depending upon its performance in the fire test(s). Designers choose listed assemblies from various fire-resistance publications or directories, such as the UL *Fire Resistance Directory* or the Gypsum Association *Fire Resistance Design Manual*.

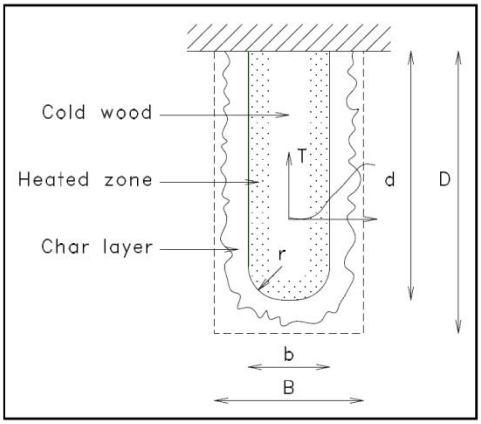


Figure 11: Heavy Timber Member Exposed to Fire

Prescriptive Assemblies

The fire resistance of certain wood assemblies is prescribed in Section 721 based on testing using ASTM E 119 or UL 263. Section 703.3 permits the use of other sources, as well. Often used is the AWC publication AWC DCA 3, *Fire Rated Wood Floor and Wall Assemblies*, which is available for free download at www.awc.org/codes/dcaindex.html.

Calculated Fire Resistance

The fire resistance of exposed wood members may be calculated using the provisions of Chapter 16 of the *National Design Specification*® (NDS®) (see Section 722.1). AWC's Technical Report No. 10 (TR10), *Calculating the Fire Resistance of Exposed Wood Members,* contains full details of the NDS method as well as design examples, and is available for free download at www.awc.org/publications/TR/index.html. Although Section 722.6.3 contains an acceptable calculation method as well, it is limited to 1-hour fire resistance. This method will be deleted in the upcoming editions of the IBC and replaced by a reference to the NDS Chapter 16 method which has broader application and leaves less room for design error.

The fire resistance of wood frame assemblies also may be calculated using the provisions of Section 722.6, which is based on the known fire resistance of many tested assemblies. The information in AWC publication AWC DCA 4, *Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Endurance*, was the basis for these code provisions. It is available for free download at www.awc.org/codes/dcaindex.html.

5. Wood Use in "Noncombustible" Construction

Type I and II construction typically requires the use of noncombustible materials. Section 603 specifies 25 applications where combustible materials are permitted without reclassifying the building to a different type of construction. For example, wood blocking is permitted for handrails, millwork, cabinets and window and door frames. Furring or nailing strips used in connection with "set-out" construction are also permitted. Show windows, wooden bulkheads below the window and nailing and furring strips are also permitted to be wood if the window is not more than 15 feet above grade.

Fire-Retardant-Treated Wood

There are many additional applications for fire-retardant-treated wood (FRTW) in Type I and II construction. FRTW is permitted in nonbearing partitions where the fire-resistance rating does not exceed 2 hours, and may be used in nonbearing exterior walls that do not require a fire-resistance rating. Roof construction, including structural framework, permits FRTW, except for Type IA construction of three stories or more where the lowest roof member is less than 20 feet measured vertically from the upper floor.

As mentioned above, FRTW may also be used in exterior walls of Type III and IV construction, which are required to be noncombustible. Because of this, certain code provisions that assume noncombustible exterior walls have become difficult to interpret. But usually a practical solution to these code questions can be achieved by working closely with the code official. For instance, the addition of solid FRTW wood blocking of a certain thickness in floor cavities that intersect with the exterior wall in Type III construction is an appropriate precaution to maintain the fire resistance and material integrity of the exterior wall.

Heavy Timber Members

Heavy timber (HT) construction is permitted in roof construction as an alternative to 1-hour or less fire-resistance-rated noncombustible construction. This would allow HT use in all roof construction except Type IA construction. HT columns and arches are permitted on the exterior of walls if the fire separation distance is 20 feet or more.

Figure 12: Heavy Timber Construction

6. Wood Features

Wood may be used as an architectural or structural component of a building. It is renewable and biodegradable, using less energy to manufacture than steel, concrete, aluminum or plastic. Wood use in foundations, doors, windows, exterior and interior finishes, trim and roofing contributes to the aesthetics of the building in an economical and efficient manner.

Wood Foundations

Wood foundations for buildings are permitted when designed and installed in accordance with the AF&PA/AWC *Permanent Wood Foundation Design Specification* (PWF). Insulated wood foundation systems conserve energy and easily accommodate installation of wiring, plumbing, ductwork and interior finishes. Savings in labor, time and material costs may be achieved when these systems are used.

Wood Walls and Partitions

Wood stud framing is permitted for all load-bearing and nonload-bearing interior walls and partitions in Type III and V construction. Type IV construction permits wood stud framed partitions of 1-hour fire-resistance-rated construction (Section 602.4.6) or solid wood formed by at least two layers of 1-inch matched boards, or 4-inch-thick laminated construction.

Wood Interior Finish

In general wood materials may be used as interior finish in Education (E) occupancies. Table 803.9 places minimum performance classifications on finish materials based on their location in the building. The material performance classification is determined by testing in accordance with the ASTM E 84 or UL 723 standard and results in a classification as Class A (flame spread index 0-25); Class B (26-75) or Class C (76-200). All classifications must have a smoke-developed index between 0-450 (Section 803.1.1).

Figure 13: Wood Interior Finish
(Photo Courtesy of Barbara J Sales)

Exit enclosures and exit passageways in Group E occupancies require Class A materials if in a nonsprinklered building and Class B if it is sprinklered. (Note: Buildings less than three stories above grade plane permit the reduction of the exit enclosure and exit passageway classifications to Class B and Class C, respectively.) Exit enclosures and exit passageways are permitted to use Class C wainscotting or paneling in the grade lobby for not more than 1,000 square feet of applied surface when applied to a noncombustible base. Corridors require Class B (nonsprinklered) and Class C (sprinklered) materials while rooms and enclosed spaces, whether sprinklered or not, allow Class C materials.

Most wood species qualify as Class C, while some, such as cedar, west coast hemlock, Idaho white pine, redwood, and spruce, can qualify as Class B. Wood boards and panels may meet Class A criteria when pressure treated with a fire-retardant chemical. Flame spread information according to wood species is provided in AWC DCA 1, Flame Spread Performance of Wood Products, which is available for free download at www.awc.org/codes/dcaindex.html.

Traditional wood floor covering is exempt from interior floor finish requirements. Exposed portions of Type IV structural members are also exempt from the interior finish requirements in accordance with Section 803.3.

Wood Interior Trim

Baseboards, chair rails, picture molding, handrails, guards, windows and doors are permitted to be wood or wood-based materials. Trim is required to meet a Class C classification and combustible trim, excluding handrails and guards, cannot exceed 10 percent of the wall or ceiling area to which it is attached (Section 806.5).

Figure 14: Wood Trim

Wood Doors and Windows

Figure 15: Wood Windows

Wood doors and windows are often the optimum choice for buildings due to their aesthetics, energy efficiency and functionality. Exterior openings are generally required to be protected as an opening protective assembly when the exterior wall is within given distances of a lot line. Table 602 determines when the exterior walls are required to be fire-resistance rated due to their location on the lot and Table 705.8 defines the allowable percentages of protected and unprotected openings allowed in those walls.

For Group E occupancies, unlimited amounts of unprotected openings are permitted when the exterior walls are 30 feet or more from the lot line, 10 feet or more if Type IIB or VB construction. No unprotected openings are permitted in the exterior wall within 5 feet of the lot line for nonsprinklered buildings and no openings are permitted if the wall is closer than 3 feet from the lot line.

Bay and oriel windows must conform to the type of construction required for the building; however, FRTW is permitted for these windows in buildings not more than three stories above grade plane and of construction Types I, II, III and IV (Section 1406.4).

Interior wood door assemblies are required to be fire-protection rated when the wall assembly they are in requires a fire-resistance rating and opening protection, such as door assemblies in exit enclosures or exit access corridor walls. The minimum required fire-protection rating of the fire door assembly is given in Table 716.5 and ranges from 20 minutes up to 3 hours based upon the required fire-resistance rating and type of wall assembly.

Wood Siding

Figure 16: Wood Siding

Wood siding products come in a variety of sizes, shapes and textures, ranging from wood shingles and shakes to boards and wood structural panels. Each material brings different characteristics in look and performance. The IBC addresses the minimum expectations of these products in Chapter 14 as exterior wall components and Chapter 23 as a wood building material.

Wood shingles as a weather covering are required to be a minimum $^{3}/_{8}$-inch thick and wood siding without sheathing is required to be $^{1}/_{2}$-inch thick. According to Table 1405.2, wood siding less than $^{1}/_{2}$-inch thick requires bracing for support in accordance with Table 2304.6.

Wood Veneer

Wood veneer is permitted on buildings of Type I, II, III or IV construction and allowed up to 40 feet above grade, 60 feet if FRTW is used, provided the veneer is 1-inch nominal thickness, $^{7}/_{16}$-inch exterior hardboard siding or $^{3}/_{8}$-inch exterior-type wood structural panels or particleboard. Open or spaced veneers without concealed spaces are not permitted to project more than 24 inches from the building wall (Section 1405.5).

Figure 17: Wood Veneer
Photo Courtesy of Jeremy Bittermann

Wood Balconies, Open Exterior Exit Stairs and Ramps

Exterior balconies may be of Type IV construction or of wood construction that provides a fire-resistance rating equal to the floor rating required by Table 601. The aggregate length of the balcony is limited to 50 percent of the building perimeter. Type I or II structures not more than three stories above grade plane are permitted to have FRTW in the balcony as long as the balcony is not a required exit. Type III, IV and V buildings may have Type V construction of the balcony without requiring a fire-resistance rating if the balcony is sprinkler protected. In this case, the length limitation of the balcony is eliminated (Section 1406.3).

Figure 18: Wood Balcony

Open exterior exit stairs and ramps may be constructed of wood when the building is of Type IV and V construction in accordance with Sections 1009.9 and 1010.8. The IBC limits their use to buildings that do not exceed six stories above grade and do not have occupied floor levels 75 feet or more above the lowest level of vehicular access by the fire department in accordance with Section 1026.2.

Wood Roof Coverings

Roof assemblies and coverings are divided into classifications in accordance with testing by the ASTM E 108 or UL 790 standard. FRTW roof coverings are also tested in accordance with the ASTM D 2898 standard. Table 1505.1 requires a minimum Class B roof covering for all types of construction except Types IIB, IIIB and VB. These construction types require minimum Class C materials and if the buildings are not more than two stories above grade plane, have no more than 6,000 square feet of roof area and 10 feet minimum of distance to

Figure 19: Wood Shakes

the lot lines on all sides of the roof, they are permitted to use No. 1 cedar or redwood shakes and No. 1 shingles (Table 1505.1).

Fire-retardant-treated wood (FRTW) shingles and shakes can qualify for Class A, B or C classification. Wood shingles and wood shake installation requirements are found in Sections 1507.8 and 1507.9 with a comparison in Table 1507.8.

Wood Projection Limitations

Regardless of the material used or the construction type, Section 705.2 places limits on the proximity of projections to the line used to calculate fire separation distance (typically the lot line). According to Table 705.2, in no case may a projection come within 24 inches of a lot line. When the fire separation distance (FSD) from the exterior wall is 5 feet or greater, projections cannot come within 40 inches of the lot line; when the FSD is less than 2 feet, projections are prohibited altogether.

In Type III, IV, and V construction, projections of any material are permitted subject to the limitation of Section 705.2.3. That section says that combustible projections located where openings are not permitted, where protection of some openings is required, or when located within five feet of the lot line (or other line used to determine the fire separation distance) must be one of the following:

- Minimum 1-hour fire-resistance-rated construction;
- Type IV construction; or
- FRTW

Note that the exception in Section 705.2.3 allows projections in Groups R-3 and U occupancies to be of typical Type VB construction (protection in the form of rated construction, Type IV construction, or FRTW is not required) when the fire separation distance is greater than or equal to 5 feet.

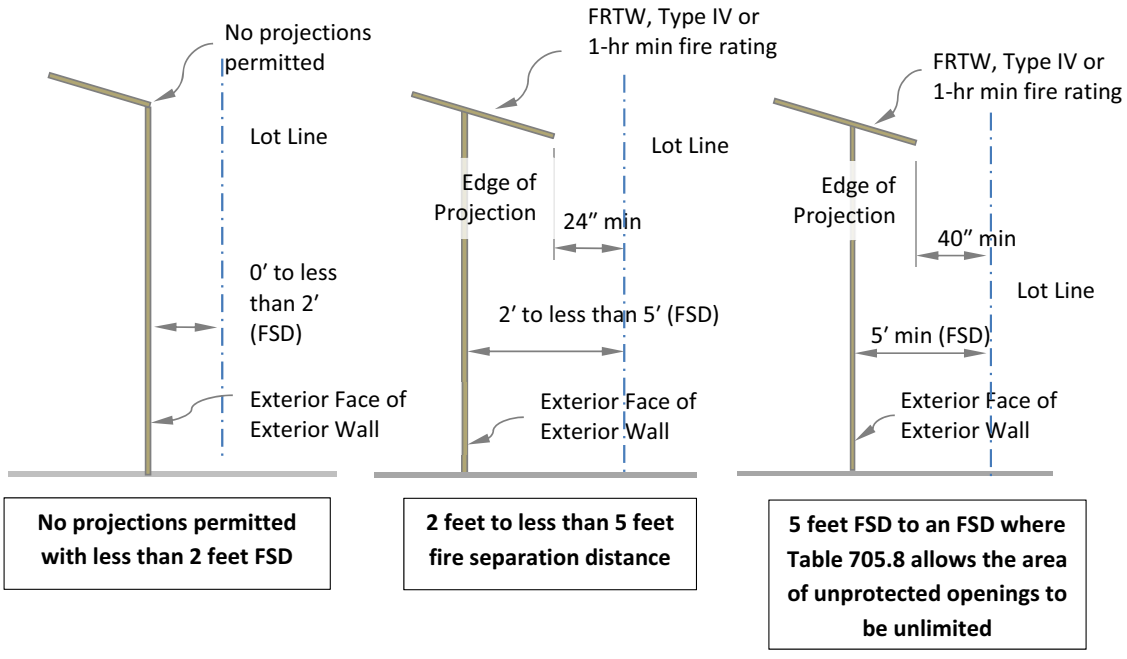


Figure 20: Wood Projection Limitations for other than Group R-3 and U

Wood Rooftop Structures

Wood penthouses are limited by the construction classification permitted for the building. FRTW is permitted for use on buildings of Type I construction two stories or less above grade plane and in Type II construction when the exterior of the penthouse is 5 feet or more from the lot lines in accordance with Section 1509. A 1-hour fire-resistance rating is required when the exterior wall of the penthouse is less than 20 feet from the lot line.

Type III, IV and VA construction permit penthouses to be Type IV construction or FRTW if 20 feet or more from the lot line.

Wood penthouses used to enclose tanks or elevators must not exceed 28 feet in height above the roof. If enclosing other uses, their height is limited to 18 feet maximum.

Wood unroofed mechanical equipment screens, fences or enclosures limited to 4 feet in height are permitted.

Wood towers, spires, domes and cupolas are permitted on buildings of Type III, IV and V provided that they do not exceed 85 feet in height above grade plane or 200 square feet in area. The IBC places further limitations on these structures in Section 1509.5.

Wood in Locations Subject to Decay or Termites

Wood that is located where it will be exposed to weather, moisture or termites is required to be naturally durable wood species or preservative-treated wood using water-borne preservatives, in accordance with AWPA U1. Naturally durable decay-resistant wood species are heartwood of redwood, cedar, black locust and black walnut. Naturally durable termite-resistant wood species are heartwood of redwood, Alaska yellow-cedar, eastern red cedar and heartwood and sapwood of all western red cedars (Sections 202 and 2304.11).

7. Precautions During Construction

Chapter 33 provides minimum safety precautions for fire during construction for all buildings. The section includes provisions for fire extinguishers, standpipes, means of egress and sprinkler system commissioning. The *International Fire Code®* (IFC®) also contains detailed requirements for fire precautions during construction.

Fire Extinguishers

During construction, one portable fire extinguisher must be placed at each stairway on all floor levels with combustible materials, in each storage or construction shed and where special hazards exist in accordance with Section 3309.

Maintaining Means of Egress

During construction, when a building height reaches 50 feet or four stories, a minimum of one temporary lighted stairway must be provided unless a permanent stairway is available for use at all times in accordance with Section 3310.

Standpipes

A minimum of one standpipe must be available during construction for fire department use. The standpipe must be installed before the construction is 40 feet above fire department access. The standpipe is placed adjacent to usable stairs and has fire department hose connections. The

standpipe is extended during construction to within one floor of the highest point of construction having flooring in accordance with Section 3311. During demolition, a standpipe is maintained in working condition. The standpipe may be demolished floor by floor as demolition proceeds.

Sprinkler System Commissioning

The sprinkler system must be tested and approved before the certificate of occupancy is awarded in accordance with Section 3312.

Additional requirements in the *International Fire Code®*

Additional requirements for fire safety during construction are contained in the IFC, as follows:

- Temporary heating equipment must be listed and labeled; installation and maintenance of the equipment must be in accordance with the listing (IFC 3303).
- Smoking is prohibited except in approved areas with posted signage (IFC 3304).
- A fire watch must be maintained with qualified personnel if required by the fire code official (IFC 3304).
- Welding operations must follow the provisions of IFC Chapter 35. Electrical wiring must follow the provisions of NFPA 70 (IFC 3304).
- The owner must designate a fire prevention superintendent responsible for the fire prevention program during construction. Requirements for the program are listed in IFC Section 3308.
- An accessible emergency phone must be provided in an approved location at the construction site. The construction site street address and fire department emergency phone number must be posted by the phone (IFC 3309).
- Fire-fighting vehicle access must be provided within 100 feet of temporary or permanent fire department connections. (IFC 3310).
- An approved water supply for fire protection must be available when combustible material is at the construction site (IFC 3312).
- Requirements for safeguards during roofing operations are listed in IFC Section 3317.

8. Resources

For additional assistance and information, contact the American Wood Council (AWC) at (202) 463-4713 or info@awc.org. For additional assistance and information from the International Code Council (ICC), seewww.iccsafe.org

American Wood Council Standards

These standards and related code publications, design aids, technical reports and guides for wood design and construction can be purchased and, in some cases, downloaded for free at www.awc.org.

2012 NDS®	*2012 National Design Specification®* (NDS®) *for Wood Construction with 2012 Supplement*
SDPWS-2008	*2008 Special Design Provisions for Wind and Seismic*
2012 WFCM	*2012 Wood Frame Construction Manual for One- and Two-family Dwellings*
2007 PWF	*2007 ANSI/AF&PA Permanent Wood Foundation Design Specification*
	2012 ANSI/AF&PA Span Tables for Joists and Rafters
WCD No. 4-2003	*2003 ANSI/AF&PA Wood Construction Data—Plank and Beam Framing for Residential Buildings*

Other Associations Publishing Referenced Standards

Standards from additional organizations are referenced in this publication. The following table lists the standard, its title and the site from which the standard is available.

Standard-Edition	Title	Website
AAMA/WDMA/CSA 101/I.S.2/A440-11	*North American Fenestration Standard/Specifications for Windows, Doors and Skylights*	aamanet.org wdma.com
APA PDS—04	*Panel Design Specification*	apawood.org
ASCE 7-10	*Minimum Design Loads for Buildings and Other Structures*	asce.org
ASTM D 2898-04	*Test Methods for Accelerated Weathering of Fire-retardant-treated Wood and Wood-based Products*	astm.org
ASTM E 84-09	*Test Methods for Surface Burning Characteristics of Building Materials*	
ASTM E 108-07a	*Test Methods for Fire Tests of Roof Coverings*	
ASTM E 119-08a	*Test Methods for Fire Tests of Building Construction and Materials*	
AWPA C1-03	*All Timber Products-Preservative Treatment by Pressure Processes*	awpa.com
AWPA M4-08	*Standard for the Care of Preservative-treated Wood Products*	
AWPA U1-11	*USE CATEGORY SYSTEM: User Specification for Treated Wood Except Section 6, Commodity Specification H*	
2012 IBC	*2012 International Building Code*	iccsafe.org
2012 IRC	*2012 International Residential Code*	
ICC 600-08	*Standard for Residential Construction in High Wind Regions*	
NFPA 13-10	*Installation of Sprinkler Systems*	nfpa.org
NFPA 13D-10	*Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes*	
NFPA 13R-10	*Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height*	
NFPA 70-11	*National Electrical Code*	
UL 263-03	*Standard for Fire Tests of Building Construction and Materials, with revisions through October 2007*	ul.com
UL 723-08	*Standard for Test for Surface Burning Characteristics of Building Materials*	
UL 790-04	*Standard Test Methods for Fire Tests of Roof Coverings*	

This publication was developed by the International Code Council in cooperation with the American Wood Council. While every effort was made to insure accuracy of the information it contains, neither organization assumes responsibility for particular designs or plans prepared from this document.

9. Building Area Tables

The tables are organized by sprinkler status and contain the maximum number of stories and maximum allowable area per floor for Types IIIA and IIIB, IV, VA and VB construction.

Table 1 – Group E Nonsprinklered 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	23,500	14,500	25,500	18,500	9,500
	50	29,370	18,120	31,870	23,120	11,870
	100	41,120	25,370	44,620	32,370	16,620
2	0-25	23,500	14,500	25,500	NP	NP
	50	29,370	18,120	31,870	NP	NP
	100	41,120	25,370	44,620	NP	NP
3	0-25	23,500	NP	25,500	NP	NP
	50	29,370	NP	31,870	NP	NP
	100	41,120	NP	44,620	NP	NP

NP = Not Permitted

a. Frontage based on open space widths of 30 feet or more.
b. Interpolation permitted.
c. Sprinklers must be provided for Group E occupancies when the fire area exceeds 12,000 square feet in accordance with Section 903.2.3, or by reason of other specific conditions in that section. In lieu of sprinklers, compartmentalization of the floor area into fire areas not more than 12,000 square feet can be provided with fire-resistance-rated construction in accordance with Chapter 7.

Table 2 – Group E 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	94,000	58,000	102,000	74,000	38,000
	50	99,870	61,620	108,370	78,620	40,370
	100	111,620[e]	68,870	121,120[e]	87,870	45,120
2, 3[d]	0-25	70,500	43,500	76,500	55,500	28,500
	50	76,370	47,120	82,870	60,120	30,870
	100	88,120	54,370	95,620	69,370	35,620
4	0-25	52,870	NP	57,370	NP	NP
	50	57,280	NP	62,150	NP	NP
	100	66,090	NP	71,710	NP	NP

NP = Not Permitted

a. The maximum floor area for four stories above grade plane was determined by dividing the maximum total allowable building area by the number of stories in accordance with Section 506.4. The floor area of each story is assumed to be equal in size to the other stories.
b. Frontage based on open space widths of 30 feet or more.
c. Interpolation permitted.
d. Type VA and VB construction do not permit three stories above grade plane.
e. Single-story Group E buildings may be of unlimited area when meeting the requirements of Section 507.10.

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