



# Research Report

## Lumber Use in Type III-A Buildings

SRR No. 1602-03

Structural Building Components Association (SBCA)

July 8, 2016

### SBCA is an APPROVED SOURCE

This research report is based on practical scientific research (literature review, testing, analysis, etc.). This research report complies with the following sections of the building code:

- [IBC Section 104.11.1](#) and [Section 1703.4.2](#) – "**Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved sources*."
- [IBC Section 202](#) – "**APPROVED SOURCE.** An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses."

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## **Introduction:**

Per the *IBC* the majority of buildings will fall into one of the five different classifications, I, II, III, IV, or V depending on the type of construction used to build the structure.<sup>1</sup> Each type of construction, except IV, has an A and B designation based on the fire-resistance rating required for different building elements. This report will focus on Type III-A building construction<sup>2</sup>.

## **Key Definitions:**

### **TYPE III CONSTRUCTION:**

Building construction type where the exterior walls are required to be of noncombustible materials and all other components of the building including interior walls, roof and floors are may be combustible.

[IBC 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.

### **FIRE-RETARDANT-TREATED WOOD (FRTW):**

Wood products that, when impregnated with chemicals by a pressure process or other means during manufacture, exhibit reduced surface-burning characteristics and resist propagation of fire. ([2015 IBC Section 2302](#) Treated Wood)

### **FIRE-RESISTANCE RATING:**

The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests prescribed in [2015 IBC Section 2302](#)

### **COMBUSTIBLE:**

Readily ignitable and free-burning materials.

### **NONCOMBUSTIBLE:**

Nonflammable material that must pass the testing criteria from Section 8 of ASTM E 136. The commentary X1.2 of ASTM E 136 gives more background information.

### **EXTERIOR WALLS:**

Outer most walls that enclose the structure and support more than just its own dead weight.

## **Background:**

Many factors go into classifying buildings. Each type will have different allowable height, allowable number of stories and allowable area limitations as shown in the [IBC Tables 504.3](#), [504.4](#) and [506.2](#). Each type of construction also has their own level of fire resistance. From type I to type V, type I will be the most fire-resistant and V will be the least fire-resistant. The level of fire resistance is based on the materials used to build the building. The five different classifications are divided into two different groups of combustible and noncombustible depending on the materials used. The noncombustible group consists of type I and type II. The combustible group consists of construction types III, IV and V.<sup>3</sup> Some examples of noncombustible materials are concrete, brick, masonry, ceramic tiles, metals (except aluminum), magnesium, glass, mineral wool, rock wool and more. An example of a combustible material when speaking of building construction is untreated wood.<sup>4</sup>

The five types will also be subdivided into 2 different groups, group A (protected) and group B (unprotected), depending on the required fire-resistant rating for the building's interior structural members. Typically group A buildings require the interior to have a one-hour fire-resistance rating whereas group B does not require it. Although this is true most of the time, there are still exceptions when groups A and B may be required to have a fire-resistance rating greater than one hour as shown in the *IBC* Table 601 ([Figure 1](#)) and Table 602 ([Figure 2](#)).

The five different classifications exist due to their different limitations and regulations. Some buildings may consist of two different construction types but the building will be classified as the lowest of the two types present. No matter what, a

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<sup>1</sup> [2015 IBC Section 601](#)

<sup>2</sup> Korel Home, Korel Home Designs, <http://www.korel.com/construction-type.asp> Accessed: 25 February 2016.

<sup>3</sup> [2015 IBC Section 601](#)

<sup>4</sup> [www.ncdoi.com](http://www.ncdoi.com), NCDOT OSFM Evaluation Services, [http://www.ncdoi.com/OSFM/Engineering\\_and\\_Codes/Documents/whitepaper\\_2012/2012%20Non-Combustible%20Material\\_.pdf](http://www.ncdoi.com/OSFM/Engineering_and_Codes/Documents/whitepaper_2012/2012%20Non-Combustible%20Material_.pdf) Accessed: 25 February 2016.

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building only fits the classification when it is within the limitations and meets all the requirements of that particular construction type<sup>3</sup>.

<b>TABLE 601 FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)</b>									
BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame <sup>f</sup> (see Section 202)	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	HT	1	0
Bearing walls									
Exterior <sup>e, f</sup>	3	2	1	0	2	2	2	1	0
Interior	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 602								
Exterior									
Nonbearing walls and partitions									
Interior <sup>d</sup>	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 <sup>1/2</sup>	1 <sup>b,c</sup>	1 <sup>b,c</sup>	0 <sup>c</sup>	1 <sup>b,c</sup>	0	HT	1 <sup>b,c</sup>	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating required by other sections of this code.

e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

f. Not less than the fire-resistance rating as referenced in Section 704.10.

**Figure 1: 2015 IBC Table 601 Fire Resistance Rating Requirements for Building Elements**

<b>TABLE 602 FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE<sup>a, d, g</sup></b>				
FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H <sup>e</sup>	OCCUPANCY GROUP F-1, M, S-1 <sup>f</sup>	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U <sup>h</sup>
X < 5 <sup>b</sup>	All	3	2	1
5 ≤ X < 10	IA	3	2	1
	Others	2	1	1
10 ≤ X < 30	IA, IB	2	1	1 <sup>c</sup>
	IIB, VB	1	0	0
	Others	1	1	1 <sup>c</sup>
X ≥ 30	All	0	0	0

For SI: 1 foot = 304.8 mm.

a. Load-bearing exterior walls shall also comply with the fire-resistance rating requirements of Table 601.

b. See Section 706.1.1 for party walls.

c. Open parking garages complying with Section 406 shall not be required to have a fire-resistance rating.

d. The fire-resistance rating of an exterior wall is determined based upon the fire separation distance of the exterior wall and the story in which the wall is located.

e. For special requirements for Group H occupancies, see Section 415.6.

f. For special requirements for Group S aircraft hangars, see Section 412.4.1.

g. Where Table 705.8 permits nonbearing exterior walls with unlimited area of unprotected openings, the required fire-resistance rating for the exterior walls is 0 hours.

h. For a building containing only a Group U occupancy private garage or carport, the exterior wall shall not be required to have a fire-resistance rating where the fire separation distance is 5 feet (1523 mm) or greater.

**Figure 2: 2015 IBC Table 602 Fire Resistance Requirements for Exterior Walls**

### **Building Type III-A:**

Building Type III-A may consist of both combustible and noncombustible materials as long as they meet the building code specified for that particular building. As stated in [IBC Section 602.3](#), type III-A building construction requires the exterior walls to be of noncombustible materials and have a fire-resistance rating of 2 hours or less but the interior building elements are of any material allowed by the code.

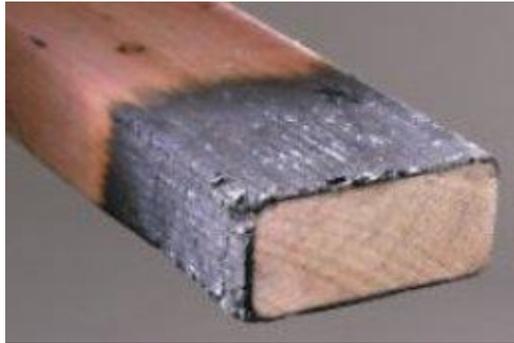
Since the building is a type A building, the primary structural frame is required to have a fire-resistance rating of 1 hour. The primary structural frame may have a standalone 1 hour fire-resistance rating, or it may need to be protected with additional fire-resistant materials. These materials may include gypsum wall board or spray on fire resistance rated coatings.

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The exterior walls are required to be built of noncombustible materials. However, fire-retardant-treated wood (FRTW) framing is permitted. FRTW does not meet the criteria of ASTM E 136 Section 8 to be considered as a noncombustible material.<sup>5</sup> The 2015 [IBC Section 602.3](#) states that as long as the FRTW complies with [IBC Section 2303.2](#), it shall be permitted within exterior wall assemblies of a 2 hour rating or less. Note also that there are other products on the market which are not FRTW, but have been approved for use in this application as an alternative material as allowed in the *IBC*, section 104.11.

### **Fire-Retardant-Treated Wood (FRTW):**

FRTW is treated with chemicals that react to the combustible gas released from the burning wood to create carbon dioxide, water and a carbon char layer to slow down the burning process as shown in [Figure 3](#). Overall, the chemical applied to the wood helps slow down the spreading of flames which results in a structure to be more effective for a longer period of time. Another benefit from FRTW is that the chemical treatment typically protects the wood from termites and fungal decay.



**Figure 3:** FRTW carbon char example

For any FRTW to be eligible for construction, FRTW would have to meet all requirements from [IBC Section 2303.2](#). The treatment for fire-retardant-treated (FRT) products should occur during manufacturing either by using the pressure process or by other means. Requirements and regulations are as given in the *IBC*:

**[2303.2.1 Pressure process.](#)** For wood products impregnated with chemicals by a pressure process, the process shall be performed in closed vessels under pressures not less than 50 pounds per square inch gauge (psig) (345kPa).

**[2303.2.2 Other means during manufacture.](#)** For wood products produced by other means during manufacture, the treatment shall be an integral part of the manufacturing process of the wood product. The treatment shall provide permanent protection to all surfaces of the wood product.

**[2303.2.3 Testing.](#)** For wood products produced by other means during manufacture, other than a pressure process, all sides of the wood product shall be tested in accordance with and produce the results required in [Section 2303.2](#). Wood structural panels shall be permitted to test only the front and back faces.

The process of manufacturing FRTW will have an effect on the strength of the product. Due to the chemicals applied, high humidity, exposure to high heat and redrying procedures of the FRT process, the strength of the FRT product will need to be adjusted from the untreated product. Strength adjustments in the building code mainly focus on wood structural panels and lumber in [IBC Sections 2303.2.5.1](#) and [2303.2.5.2](#) respectively. The strength adjustment factors and the effect of FRT process of wood structural panels shall be determined by ASTM D 5516 and ASTM D 6305. As for lumber, the strength adjustment factors and the effect of FRT process of lumber shall be determined by ASTM D 5664 and ASTM D 6841. The strength adjustment factors for these products are found in the products' code evaluation report.

**[2303.2.5.1 Wood structural panels.](#)** The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated softwood plywood shall be determined in accordance with ASTM D 5516. The test data developed by ASTM D 5516 shall be used to develop adjustment factors, maximum loads and spans, or both, for untreated plywood design values in accordance with ASTM D 6305. Each manufacturer shall publish the allowable maximum loads and spans for service as floor and roof sheathing for its treatment.

**[2303.2.5.2 Lumber.](#)** For each species of wood that is treated, the effects of the treatment, the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be

<sup>5</sup> www.ncdoi.com, NCDOT OSFM Evaluation Services, [http://www.ncdoi.com/OSFM/Engineering\\_and\\_Codes/Documents/whitepaper\\_2012/2012%20Non-Combustible%20Material\\_.pdf](http://www.ncdoi.com/OSFM/Engineering_and_Codes/Documents/whitepaper_2012/2012%20Non-Combustible%20Material_.pdf)  
Accessed: 25 February 2016.

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determined in accordance with ASTM D 5664. The test data developed by ASTM D 5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with ASTM D 6841. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (27°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

Prior to testing the FRT product, if the product is for interior applications [IBC Section 2303.2.7](#) requires the moisture content to be no greater than 28 percent. The testing must be in accordance to ASTM D 3201 procedures at 92 percent relative humidity. If the FRT product is meant for exterior applications, it shall be marked “Exterior” and meet the requirements of [IBC Section 2303.2.6](#). All FRT products must be tested in accordance with ASTM E 84 or [UL 723](#) and must have a listed flame spread index of 25 or less and when the testing period is extended an additional 20 minutes there shall be no sign or evidence of any significant flame spread. Also, during the test, the flame front must only have a maximum of 10 ½ feet (3200mm) progression beyond the centerline of the burners.

**2303.2.6 Exposure to weather, damp or wet locations.** Where fire-retardant-treated wood is exposed to weather, or damp or wet locations, it shall be identified as “Exterior” to indicate there is no increase in the listed flame spread index as defined in [Section 2303.2](#) when subjected to ASTM D 2898.

**2303.2.7 Interior applications.** Interior fire-retardant-treated wood shall have moisture content of not over 28 percent when tested in accordance with ASTM D 3201 procedures at 92-percent relative humidity. Interior fire-retardant-treated wood shall be tested in accordance with [Section 2303.2.5.1](#) or [2303.2.5.2](#). Interior fire-retardant-treated wood designated as Type A shall be tested in accordance with the provisions of this Section.

The final FRT product should have a specific moisture content if processed correctly. According to [IBC Section 2303.2.8](#), FRT lumber should be at moisture content of no greater than 19 percent and no greater than 15 percent for wood structural panels. The finished product should also be labeled with the following items shown in [IBC Section 2303.2.4](#). [Figure 2](#) (below) shows an example of a FRTW label.

**2303.2.8 Moisture content.** Fire-retardant-treated wood shall be dried to a moisture content of 19 percent or less for lumber and 15 percent or less for wood structural panels before use. For wood kiln-dried after treatment (KDAT), the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in [Section 2303.2.5.1](#) for plywood and [2303.2.5.2](#) for lumber.

**2303.2.4 Labeling.** Fire-retardant-treated lumber and wood structural panels shall be labeled according to [IBC Section 2303.2.4](#). The label shall contain the following items:

1. The identification mark of an approved agency in accordance with [IBC Section 1703.5](#).
2. Identification of the treating manufacturer.
3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. Flame spread and smoke-developed index.
6. Method of drying after treatment.
7. Conformance with appropriate standards in accordance with [IBC Sections 2303.2.5](#) through [2303.2.8](#).
8. For fire-retardant-treated wood exposed to weather, damp or wet locations, include the words “No increase in the listed classification when subjected to the Standard Rain Test” (ASTM D 2898).

<p><b>Product Name and Manufacturer</b></p> <p><b>Treating Plant</b></p> <p>Treating standards Reference adjusted design values Conforms to <a href="#">IBC Sections 2303.2.5 - 8</a></p> <p><b>Drying Method</b></p>	<p><b>Approved Agency Name and Logo</b></p> <p>Product Species</p> <p>Surface Burning Characteristics Flame spread 25 or less Smoke developed 450 or less</p> <p>Duration test (should be 30 minutes)</p>
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**Figure 4:** Interior FRTW Label layout example

**Connectors and Fasteners for FRTW:**

FRTW used in exterior applications are most likely to be exposed to weather, or damp or wet conditions. When exposed to these conditions, corrosion in connectors and fasteners occurs frequently especially when the chemical used in FRTW can contribute to the cause of corrosion as well. To prevent or reduce the chances of corrosion, [IBC Sections 2304.10.5.3](#) and [2304.10.5.4](#) requires the connectors and fasteners shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Other fasteners other than nails, timber rivets, wood screws and lag screws shall be zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.<sup>6</sup>

[2304.10.5.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations.](#) Fasteners, including nuts and washers, for fire-retardant-treated wood used in exterior applications or wet or damp locations shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Fasteners other than nails, timber rivets, wood screws and lag screws shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B 695, Class 55 minimum.

[2304.10.5.4 Fasteners for fire-retardant-treated wood used in interior applications.](#) Fasteners, including nuts and washers, for fire-retardant-treated wood used in interior locations shall be in accordance with the manufacturer's recommendations. In the absence of the manufacturer's recommendations, [Section 2304.10.5.3](#) shall apply.

[Figure 5, 6, 7 and 8](#) shows examples of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze and silicon copper nails respectively.



**Figure 5:** Hot-dipped zinc-coated galvanized steel



**Figure 6:** Stainless Steel nails



**Figure 7:** Silicon Bronze



**Figure 8:** Silicon Copper Nails

<sup>6</sup> IBC 2015, International Building Code, International Code Council, Inc., Washington, DC.

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### **Conclusion:**

In conclusion, A type III-A building needs to stay within the limitations of allowable height, allowable number of stories and allowable area requirements of [IBC Tables 504.3](#), [504.4](#) and [506.2](#). Type III-A buildings are required to have exterior walls of noncombustible materials to meet a 2 hour fire-resistance rating which permits FRTW to be used. The noncombustible material must meet the criteria called out in Section 8 of ASTM E 136 and FRTW must comply with [IBC Section 2303.2](#). Different types of materials will require different specifications for connectors and fasteners. Some buildings may consist of two different construction types but the building will be classified as the lowest of the two types present. No matter what, a building only fits the classification when it is within the limitations and meets all the requirements of that particular construction type

### **Building Designer Responsibility:**

Unless the Authority Having Jurisdiction (AHJ) allows otherwise, the Construction Documents shall be prepared by a Building Designer (e.g., Owner, Registered Design Professional, etc.) for the Building and shall be in accordance with [IRC Section R106](#) and [IBC Section 107](#). The Construction Documents shall be accurate and reliable and shall provide the location, direction and magnitude of all applied loads and shall be in accordance with [IRC Section R301](#) and [IBC Section 1603](#). Construction Documents shall be submitted to the Building Official for approval and shall contain the plans, specifications and details needed for the Building Official to approve such documents.

#### Responsibilities:

- The information contained herein is a product, engineering or building code compliance research report prepared in accordance with the referenced building codes, testing and/or analysis using accepted engineering procedures, experience, and good technical judgment.
- Product design and code compliance quality control are the responsibility of the referenced company. Consult the referenced company for the proper detailing and application for the intended purpose. Consult your local jurisdiction or design professional to assure compliance with the local building code.
- SBCA Research Reports provide an assessment of only those attributes specifically addressed within a given report.
- The engineering evaluation was performed on the dates provided in this report, within SBCA's scope of work.

This research report is subject to periodic review and revision. For the most recent version of this report, visit [sbcindustry.com](http://sbcindustry.com). For information on the current status of this report, contact SBCA.

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