

**THINK**  
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# Wood Performance: Fire Safety

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# Introduction

Fire is a danger for all buildings and construction sites – regardless of building material. Fires start in the contents and furnishings we bring into our homes and offices, and occur in concrete, steel, masonry, and wood buildings alike. What's most important is building to code to ensure safe buildings for occupants and first responders.

All building materials experience negative impacts from prolonged exposure to fire: steel buckles, concrete spalls, wood burns.

Mass timber is a category of framing often using large panelized solid wood construction including cross-laminated timber (CLT), nail laminated timber (NLT), dowel-laminated timber (DLT), and glued laminated timber (glulam) panels for floor and wall framing.

As mass timber construction ramps up around the world, it is important to understand wood's performance capacity under fire. This eBook explores the properties of mass timber products along with fire safety for construction sites and occupied buildings.

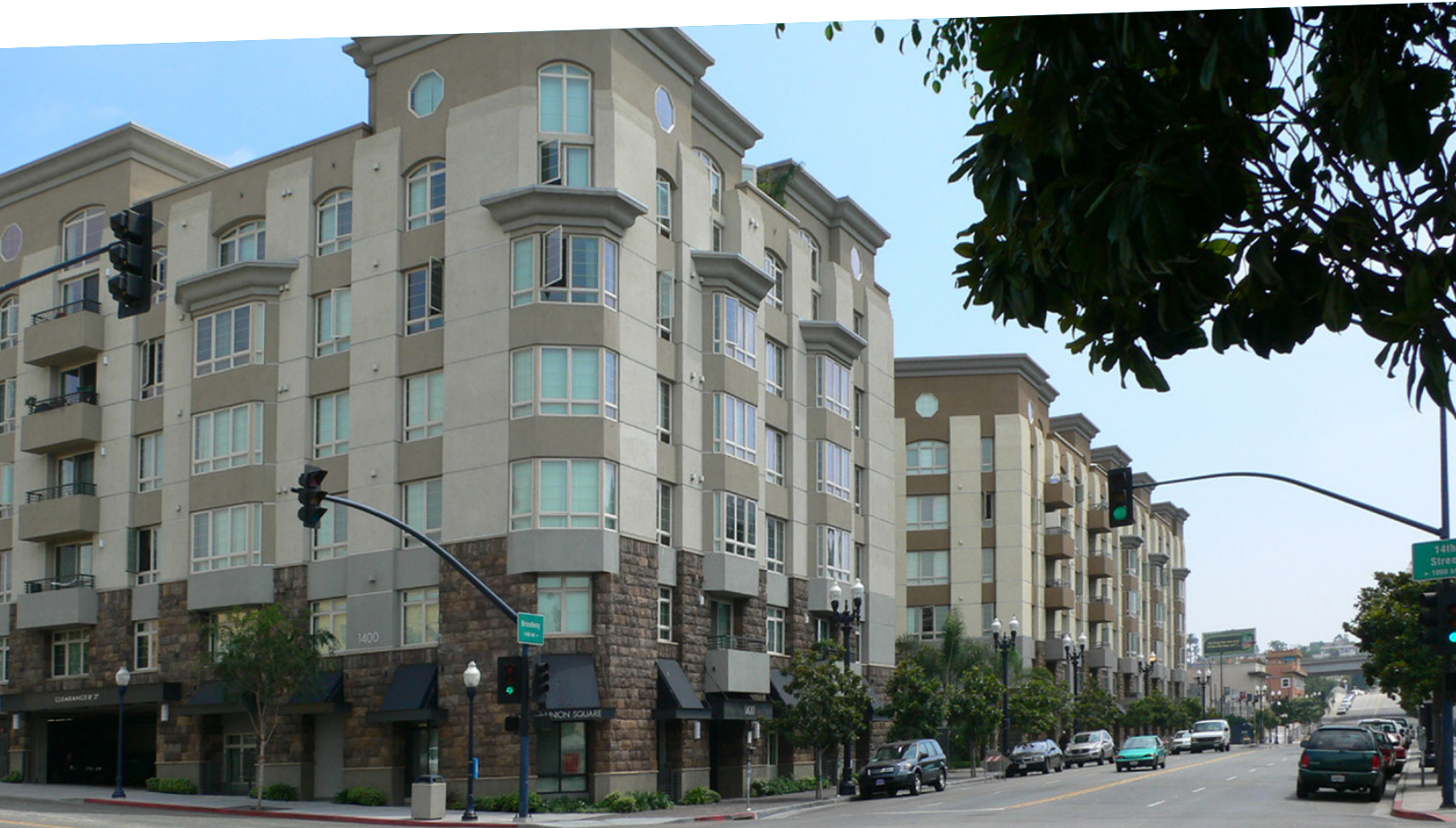


# Chapter 1

## International Building Code®

Fire resistance requirements in the *International Building Code*® (IBC®) depend on the structural element, type of construction, use and occupancy classifications, distance from property line and other factors. Fire resistance ratings are determined by three criteria\*:

- **Structural Resistance**  
Supporting the applied load for the duration of the test.
- **Integrity**  
Preventing passage of flame or gases hot enough to ignite a cotton pad.
- **Thermal Separation**  
Preventing temperature rise from greater than 325° F (180° C) at any location, or an average of 250° F (140° C) across the assembly.



\*Source - American Wood Council: [Mass Timber Performing to the Highest Standards](#)

## Mass Timber Chars and Slows Combustion

Regardless of the primary structural building material, fire can have devastating effects. Whether it's minor smoke damage from a quickly-extinguished fire or more extensive damage from a longer burn, fire takes its toll.

Mass timber enables inherent fire resistance through the insulation of inner layers.\*

1. When wood is exposed to fire, the exposed surface burns, creating a natural protective charred layer.
2. Char acts as insulation, delaying the onset of heating of the core of wood below. Due to the solid block makeup of mass timber, air and fire are inhibited in their travel.
3. Char forms at a predictable rate (1.5in/hr), which slows combustion, and the spread of fire.

### WOOD CHARRING PROTECTS

**CHAR Layer**  
**HEATED Zone**



**AMBIENT TEMPERATURE**  
**Wood**



**Case in Point:** A successful ASTM E119 fire endurance test of a cross-laminated timber wall was key to the decision to recognize CLT in the 2015 edition of the IBC®. While only seeking a two-hour rating as required by building code provisions, the test specimen lasted three hours and six minutes.\*

\*Source - American Wood Council: Mass Timber Performing to the Highest Standards

## Mass Timber: New Approved Provisions

Tall mass timber is an industry term to identify mass timber buildings, constructed of mass timber elements, that exceed current height limits for wood buildings set by the IBC®. However, recently approved provisions allowing for the construction of tall mass timber buildings up to 18 stories will be published in the 2021 edition of the IBC®. Mass timber includes any product currently permitted for use in Type IV construction, such as Cross Laminated Timber, Structural Composite Lumber, glued-laminated timber, mechanically-laminated decking (aka nail-laminated timber), and large section sawn lumber.

Because of the unique structural and fire resistance characteristics of CLT timber walls, floors and mass timber structures, in 2016 the International Code Council appointed a balanced committee of building officials, fire officials, architects, fire protection engineers, and industry experts to examine and propose appropriate code requirements. The committee's work can be followed at this link: [ICC Ad Hoc Committee on Tall Wood Buildings](#)



## Mass Timber Fire Safety Test Results

A team of fire experts from the U.S. Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) working alongside scientists from the U.S. Forest Products Laboratory put identically furnished, multistory, one-bedroom apartments constructed of exposed, partially exposed, and unexposed (protected) five-ply cross-laminated timber (CLT) through a series of rigorously monitored fire tests. The tests provided valuable data that was used in the development of code change proposals submitted by the ICC Ad Hoc Committee on Tall Wood Buildings (TWB) for the 2021 International Building Code. A series of five tests were conducted. Each test was designed to replicate real world conditions across five scenarios. Identical, furnished, one bedroom apartments were constructed in a multistory building. The door between the living and sleeping areas was left open in both apartments. A three-minute video capturing the highlights of each test is included in this [playlist](#).\*

### Test 1

**100 Percent Gypsum Wall Board Coverage** - The mass timber living area was fully sheathed with a double layer of 5/8" Type X gypsum wall board in a large furnishings and contents fire. The test was terminated after three hours without significant wood charring.

[Watch the Video >](#)

### Test 2

**Partially Exposed CLT Ceiling** - The mass timber living area was fully sheathed with a double layer of 5/8" Type X gypsum wallboard, except that thirty percent of the CLT ceiling surface areas in the living room and bedroom was left exposed. The test was terminated after four hours. The exposed CLT stopped burning after the apartment furnishings and contents were consumed.

[Watch the Video >](#)

### Test 3

**Parallel CLT Walls Exposed** - The mass timber living area was fully sheathed with a double layer of 5/8" Type X gypsum wallboard, except that one wall in the living room and one wall in the bedroom were left exposed. The exposed CLT stopped burning after the apartment furnishings and contents were consumed.

[Watch the Video >](#)

### Test 4

**Active Sprinkler Protection with No Gypsum Wall Board Coverage** - Sprinkler test with 100 percent exposed mass timber in the living room and bedroom. Test 4 demonstrated the effect of a single automatic sprinkler (it easily contained the fire).

[Watch the Video >](#)

### Test 5

**Active Sprinkler Protection with No Gypsum Wall Board Coverage** - Sprinkler test with 100 percent exposed mass timber in the living room and bedroom. In Test 5, the fire was allowed to freely burn for 23 minutes before the sprinkler was activated. The fire was quickly controlled.

[Watch the Video >](#)

\*Source - American Wood Council: Tall Mass Timber

## Fire Safety: Construction Sites & Occupied Buildings

The U.S. Fire Administration reports that **less than 1%** of building fires occur during construction, and the fires that do occur are often when required elements – like fire-limiting gypsum board, fire doors, smoke alarms, and sprinkler systems – have not been put in place.

Buildings under construction sometimes have large quantities of combustible material, plastics, paneling, paints, gases, and refuse on sites. When there are large amounts of flammable materials present on a building site, fire protection must be taken very seriously. IBC® Chapter 33 and the International Fire Code (IFC) provide safety precautions and requirements for fire during construction, including:

- **Access to fire extinguishers.** One portable fire extinguisher must be placed at each stairway on all floor levels with combustible materials.
- **Maintaining a means of egress.** Means of egress must be maintained during construction, demolition, remodeling, or alterations and additions to buildings.

- **Availability of standpipes.** In buildings required to have standpipes, not less than one standpipe must be available during construction for fire department use.
- **Commissioning of a sprinkler system.** The sprinkler system must be tested and approved before the certificate of occupancy is awarded

Fire departments are called to control fires in non-sprinklered buildings almost three times more often than buildings with adequate fire protection measures in place. Fires in sprinkler-protected buildings were smaller and contained to a single room over 96% of the time.\*

Fire safety protection measures:

- Consulting with Fire Departments
- Constructing Firewalls
- Using Gypsum Encapsulation
- Installing Automatic Sprinkler Systems
- Implementing Fire Detection Systems
- Developing Comprehensive Evacuation Plans

\*Source - American Wood Council: Fire Safety and Protection





## Additional Resources

Browse the resources below for more information about the fire-resistive qualities of mass timber products and discover the possibilities for building with wood on your next project.

[Think Wood Research Library](#)

[Fire Safety and Protection](#)

[Mass Timber](#)

[American Wood Council Fire Safety](#)

[WoodWorks Inventory of Fire Resistance-Tested Mass Timber Assemblies & Penetrations](#)

[WoodWorks Fire Design of Mass Timber Members: Code Applications, Construction Types and Fire Ratings](#)

[2018 International Building Code - Chapter 33 - Safeguards During Construction](#)

[Construction Fire Safety Coalition](#)

[WoodAware](#)

[National Fire Protection Association](#)

[NFPA 241: Standard for Safeguarding Construction, Alteration, and Demolition Operations](#)

