MASS TIMBER BUILDINGS AND THE IBC®

AMERICAN WOOD COUNCIL

ICC INTERNATIONAL CODE COUNCIL®

MASS TIMBER BUILDINGS AND THE IBC®
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International Code Council

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Introduction

This document provides an overview of provisions for mass timber construction as found primarily in the *International Building Code*® (IBC®). Cross-laminated timber (CLT) is a relatively new engineered wood product increasingly being found in US construction markets. Changes to the 2015 IBC to recognize CLT and reorganization of heavy timber provisions in the 2018 IBC set the stage for historic changes in the 2021 IBC and *International Fire Code*® (IFC®) for tall mass timber construction.

The 2021 International Building and Fire Codes include important changes in material technologies and approved uses proposed by the International Code Council (ICC) Ad Hoc Committee on Tall Wood Buildings (TWB). Three new types of construction, Types IV-A, IV-B and IV-C, have been defined and are included in IBC Chapter 6, "Types of Construction," Section 602.4. Additionally, requirements were added to other chapters of the IBC, including Chapter 5, "General Building Heights and Areas"; Chapter 7, "Fire and Smoke Protection Features"; Chapter 17, "Special Inspections and Tests"; Chapter 23, "Wood"; and Chapter 33, "Safeguards During Construction", among others. Collectively, these new requirements allow the use of mass timber and CLT (a type of mass timber) for buildings of taller heights, more stories above grade, and greater allowable areas compared to existing provisions for heavy timber buildings.

According to Evans, et al. (March 2018), "Expanding the use of mass timber will have environmental benefits; provide economic opportunities to disadvantaged rural communities with timber resources; make possible significant energy efficiency benefits; address construction labor shortfalls; shorten construction schedules; and have the potential to provide needed fire safety benefits, including wildland fire mitigation and more fire-safe construction sites."

Given the anticipated demand for taller mass timber buildings, it was deemed in the best interests of the building safety community to develop comprehensive and enforceable construction requirements. At the July 9, 2015 meeting of the ICC Board of Directors (BOD), the American Wood Council requested the establishment of a technical committee to study the introduction of building and fire code requirements to permit

construction of taller mass timber buildings. Consistent with Council Policy 07-04, anyone may petition the ICC BOD for establishment of a technical committee when "… an issue of concern to the ICC …" is brought to its attention. In the fall of 2015, the ICC BOD authorized a survey of its membership regarding the need to study tall wood buildings. "The ICC Board carefully considered more than 160 comments from stakeholders prior to establishing this committee," explained Board President Alex "Cash" Olszowy, III, with the Lexington Fayette Urban County Government in Lexington, Kentucky. "Many of the comments emphasized the need for ICC to comprehensively investigate all aspects of this new construction technology, acknowledging its design flexibility, significant sustainability attributes, and the potential economic impact to our nation's built environment."[1]

In recognition of the array of benefits provided by large mass timber buildings, but also cognizant of the fire safety implications of taller buildings constructed with combustible materials, the ICC BOD established the TWB in December 2015. The Committee was tasked with exploring the building science of mass timber and, if supported by the science, investigating the feasibility of and developing code changes for safe, tall mass timber buildings. Any such proposals were to provide assurance to the public and the fire service that code-compliant tall mass timber buildings have rigorous and redundant systems of fire protection, both passive and active, suitable for protecting the public and fire responders. More than 60 applications were received for membership on the TWB. In March 2016, the ICC BOD announced committee appointments that formed a group ideally suited to the task of exploring the science and creating proposed code changes. The TWB consisted of subject matter experts, including members of building departments, architects, structural engineers, representatives of testing laboratories, representatives of multiple structural materials, and members of the fire service, including firefighters, fire chiefs and fire protection engineers.[2]

Consistent with the professional expertise and stakeholder interest of the TWB, a rigorous set of performance objectives was adopted to provide guidance in the development of code change proposals. Those performance objectives were:

- No collapse under reasonable scenarios of complete burn-out of fuel without automatic sprinkler protection being considered.
- No unusually high radiation exposure from the subject building to adjoining properties to present a risk of ignition under reasonably severe fire scenarios.
- No unusual response from typical radiation exposure from adjacent properties to present a risk of ignition of the subject building under reasonably severe fire scenarios.
- No unusual fire department access issues.
- Egress systems designed to protect building occupants during the design escape time, plus a factor of safety.
- Highly reliable fire suppression systems to reduce the risk of failure during reasonably expected fire scenarios. The degree of reliability should be proportional to evacuation time (height) and the risk of collapse.

1. ICC Accepting Applications for Ad Hoc Committee on Tall Wood Buildings. International Code Council. January 6, 2016.
2. https://cdn-web.iccsafe.org/wp-content/uploads/com_coun/roster_TWB.pdf.

To address these criteria, and in response to the very large body of technical subject matter to evaluate, four work groups were formed. Anyone with an interest in tall mass timber buildings could participate. These work groups included: Standards/Definitions, Fire, Code (Height and Area), and Structural. TWB members were surveyed to develop an extensive list of issues and concerns to be addressed during the study period. Eighty-two specific items were identified and assigned to the most appropriate work group. Each issue was thoroughly discussed at the work group level and findings were provided during each of nine in-person meetings held by the TWB over the course of 3½ years of study.

As anticipated, the greatest challenge for the TWB involved developing an approach to compensate for the combustible nature of the material while recognizing its inherent fire-resistance and fire performance. The first step was to develop a protection system which would result in performance akin to that of existing Type I-B construction, then assigning fire-resistance requirements to a proposed new construction type (IV-B) for mass timber buildings. The same process was used to evaluate IV-A and IV-C in turn. Table 1 identifies the new fire-resistance requirements and compares them to existing requirements for other building types.

One TWB guiding principle was that it would not propose any requirement which had not been tested. As such, the TWB determined fire testing was necessary to validate its established performance objectives. Consequently, five full-scale, multiple-story fire tests were developed to simulate the three new construction types (Types IV-A, IV-B and IV-C). The successful results of those tests, as well as testing for structural performance in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, and additional testing by others, helped establish the basis on which the TWB developed new mass timber code provisions.

Table 1. Required Fire-resistance Ratings of Building Elements in Hours

Existing Construction Types	**TYPE I-A—Fire-resistance-rated, noncombustible**			
	Exterior Bearing Walls 3 Hrs.*	Structural Frame 3 Hrs.*	Floors 2 Hrs.*	Roofs 1½ Hrs.*
	Note: Dual water supply for fire suppression systems required at 420 feet elevation and above. *Permitted to be reduced by 1 Hr. ($^1/_2$ Hr. for roofs) with certain fire sprinkler controls for buildings less than 420 feet high.			
	TYPE I-B—Fire-resistance-rated, noncombustible			
	Exterior Bearing Walls 2 Hrs.*	Structural Frame 2 Hrs.*	Floors 2 Hrs.	Roofs 1 Hr.
	Note: *Permitted to be reduced by 1 Hr. with certain fire sprinkler controls for less hazardous uses, smaller fuel loads			
	TYPE II-A—Fire-resistance-rated, noncombustible			
	Exterior Bearing Walls 1 Hr.	Structural Frame 1 Hr.	Floors 1 Hr.	Roofs 1 Hr.
	TYPE II-B—Unrated, noncombustible			
	Noncombustible materials, but no fire resistance required			
	TYPE III-A—Fire-resistance-rated, combustible, with fire-resistance-rated, noncombustible or FRTW exterior walls			
	Exterior Bearing Walls 2 Hrs.	Structural Frame 1 Hr.	Floors 1 Hr.	Roofs 1 Hr.
	TYPE III-B—Unrated, combustible, with fire-resistance-rated, noncombustible or FRTW exterior walls			
	Exterior Bearing Walls 2 Hrs.	Structural Frame None	Floors None	Roofs None
New Construction Types	**TYPE IV-A—Fire-resistance-rated, protected mass timber**			
	Exterior Bearing Walls 3 Hrs.	Structural Frame 3 Hrs.	Floors 2 Hrs.	Roofs 1½ Hrs.
	Note: Dual water supply for fire suppression systems required at 120 feet elevation and above. No reductions in ratings permitted.			
	TYPE IV-B—Fire-resistance-rated, protected mass timber with limited unprotected elements			
	Exterior Bearing Walls 2 Hrs.	Structural Frame 2 Hrs.	Floors 2 Hrs.	Roofs 1 Hr.
	Note: Dual water supply for fire suppression systems required at 120 feet elevation and above. No reductions in ratings permitted.			
	TYPE IV-C—Fire-resistance-rated, exposed mass timber with limited protected elements			
	Exterior Bearing Walls 2 Hrs.	Structural Frame 2 Hrs.	Floors 2 Hrs.	Roofs 1 Hr.
	Note: No reductions in ratings permitted.			
Existing Construction Types	**TYPE IV-HT—Heavy Timber**			
	Exterior Bearing Walls 2 Hr.	Structural Frame Heavy Timber or 1 Hr.	Floors Heavy Timber	Roofs Heavy Timber
	TYPE V-A—Fire-resistance-rated, combustible			
	Exterior Bearing Walls 1 Hr.	Structural Frame 1 Hr.	Floors 1 Hr.	Roofs 1 Hr.
	TYPE V-B—Unrated, combustible			

Document Use, Structure and Limitations

This document is valuable for instructor-led programs on mass timber and new, tall mass timber design and construction. For training, the document, the IBC and material standards can be the basis for instruction. Each chapter begins with a summary, the specific sections of the code under consideration and background on the code change significance or topic being discussed. Each chapter addresses specific IBC chapters where mass timber construction is applicable and may include provisions from the 2015, 2018 and 2021 IBC, the 2021 IFC or the 2021 *International Energy Conservation Code*® (IECC®).

The information presented in this publication is believed to be accurate; however, it is provided for informational purposes only and is intended for use only as a guide. As there is a limited discussion of selected code provisions, the code itself should always be referenced for more complete information. In addition, the commentary set forth may not necessarily represent the views of any enforcing agency, as such agencies have the sole authority to render interpretations of the IBC and IFC.

This document was developed cooperatively by the American Wood Council and International Code Council.

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 nonprofit association that provides a wide range of building safety solutions including product evaluation, accreditation, certification, codification and training. It develops model codes and standards used worldwide to construct safe, sustainable, affordable and resilient structures. The mission of the Code Council is to provide the highest quality codes, standards, products and services for all concerned with the safety and performance of the built environment. 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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