Code Environment and Trends in California:

With consideration of wood vs seismic, wildfire, & termite risk

Susan Dowty
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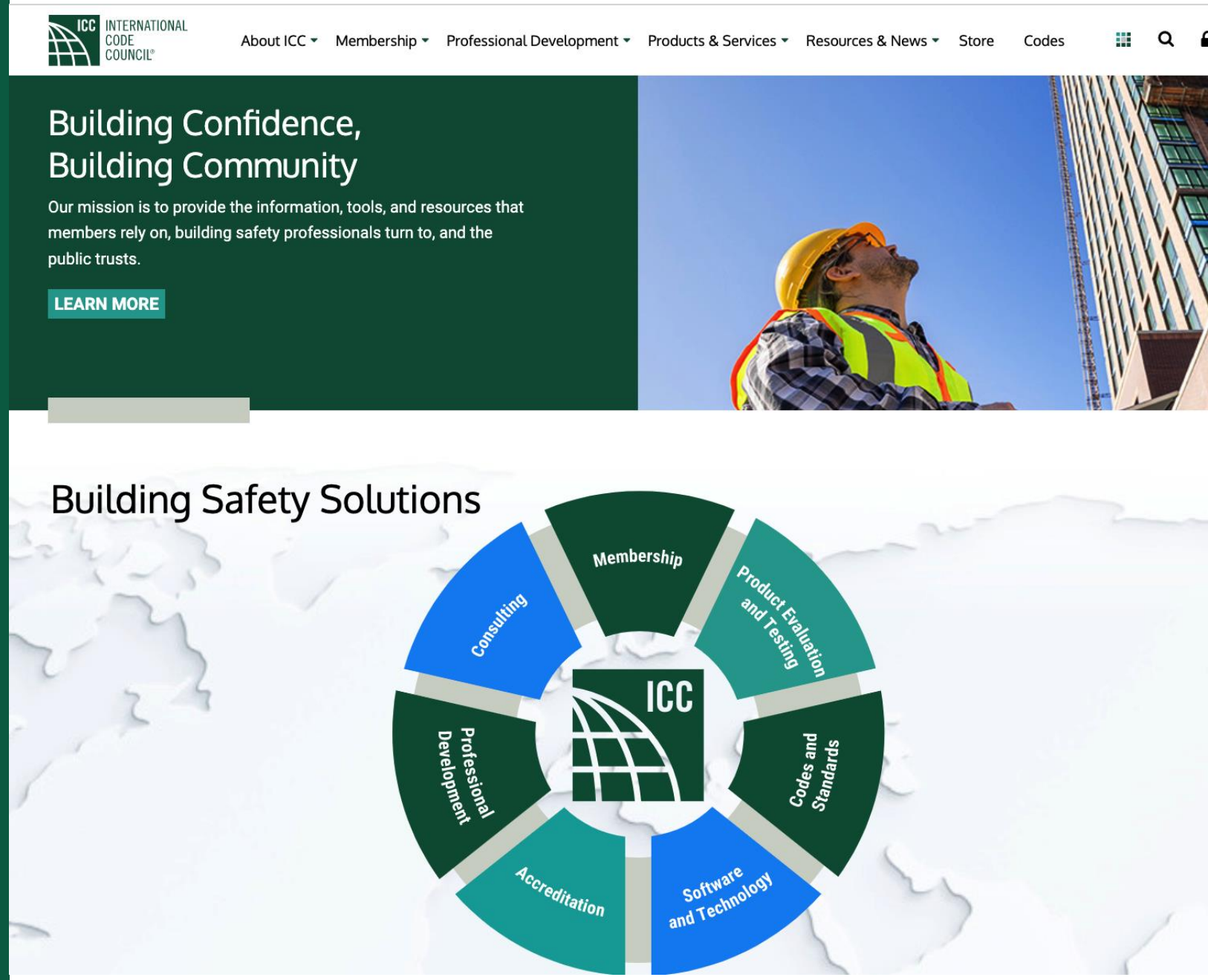
QWEB California Mission

Oct 28, 2022

Iccsafe.org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2021 I-Codes


IPSDC
INTERNATIONAL PRIVATE SEWAGE DISPOSAL CODE
IPMC
INTERNATIONAL PROPERTY MAINTENANCE CODE
IZC
INTERNATIONAL ZONING CODE
ICCPC
INTERNATIONAL CODE COUNCIL PERFORMANCE CODE for Buildings and Facilities
ISPSC
INTERNATIONAL SWIMMING POOL AND SPA CODE
IWUIC
INTERNATIONAL WILDLAND-URBAN INTERFACE CODE
IFGC
INTERNATIONAL FUEL GAS CODE
IMC
INTERNATIONAL MECHANICAL CODE
IgCC
INTERNATIONAL GREEN CONSTRUCTION CODE
IEBC
INTERNATIONAL EXISTING BUILDING CODE
IECC
INTERNATIONAL ENERGY CONSERVATION CODE
IPC
INTERNATIONAL PLUMBING CODE
IFC
INTERNATIONAL FIRE CODE
IRC
INTERNATIONAL RESIDENTIAL CODE for One- and Two-Family Dwellings
IBC
INTERNATIONAL BUILDING CODE
2021

ICC Code Development Process

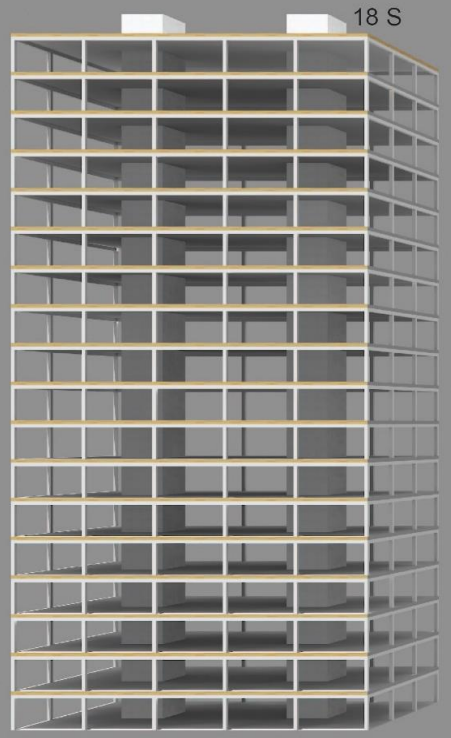
Current Cycle vs New Process in 2024 - 2026 Cycle

	Current Cycle			2024 - 2026 Cycle		
	Year 1	Year 2	Year 3	Year 1: 2024	Year 2: 2025	Year 3: 2026
January	CC due – Grp A	CC due – Grp B	Publication process for next edition	CC due – Grp A	CC due – Grp B Grp A Public Comments due (PCH year 3)	Grp B Public Comments due
April	CAH – Grp A 11 days/2 tracks	CAH – Grp B 11 days/2 tracks		CAH #1 – Grp A 9 days/2 tracks	CAH #1 – Grp B 9 days/2 tracks	PCH – Public Comments for Grps A & B 10 days/ 1 track
May					Initiate publication process for Group A codes w/o Public Comments	OGCV – Grps A & B 3 weeks Continue publication process
July				Comments due on CAH #1 action	Comments due on CAH #1 action	
Sept/Oct	Annual Conf. PCH – Grp A 7 days/1 track	Annual Conf. PCH – Grp B 7 days/1 track	Annual Conf.	Annual Conf. CAH #2 – Grp A Comments 9 days/2 tracks	Annual Conf. CAH #2 – Grp B Comments 9 days/2 tracks	Annual Conf. Includes education sessions on approved code changes
Oct/Nov	OGCV – Grp A 2 weeks	OGCV – Grp B 2 weeks				
Next Edition			October			2027 I-Codes October – December Next cycle starts Jan/2027

Business Occupancy

Fully sprinklered, no open perimeter

IV-A

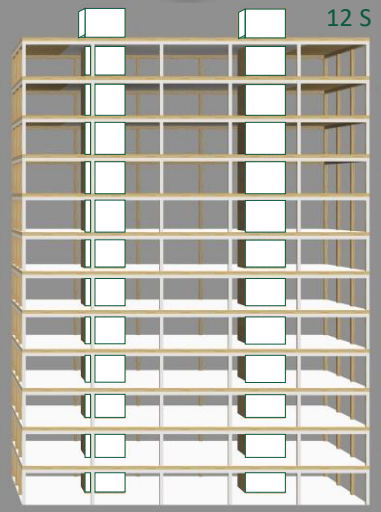


18 STORIES

BUILDING HEIGHT	270 FT
ALLOWABLE BUILDING AREA	972,000 SF
AVERAGE AREA PER STORY	54,000 SF

TYPE IV-A

IV-B

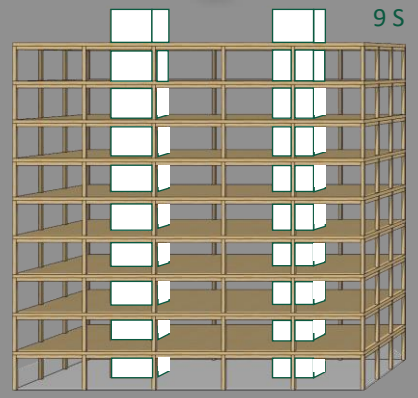


12 STORIES

BUILDING HEIGHT	180 FT
ALLOWABLE BUILDING AREA	648,000 SF
AVERAGE AREA PER STORY	54,000 SF

TYPE IV-B

IV-C

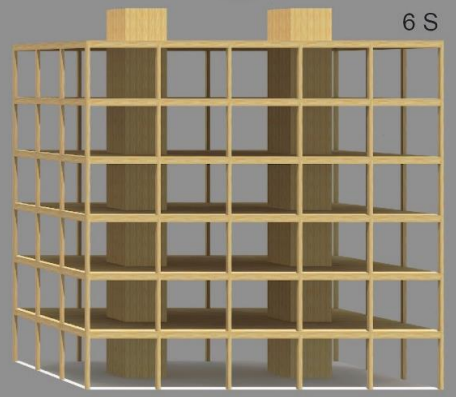


9 STORIES

BUILDING HEIGHT	85 FT
ALLOWABLE BUILDING AREA	405,000 SF
AVERAGE AREA PER STORY	45,000 SF

TYPE IV-C

IV-HT



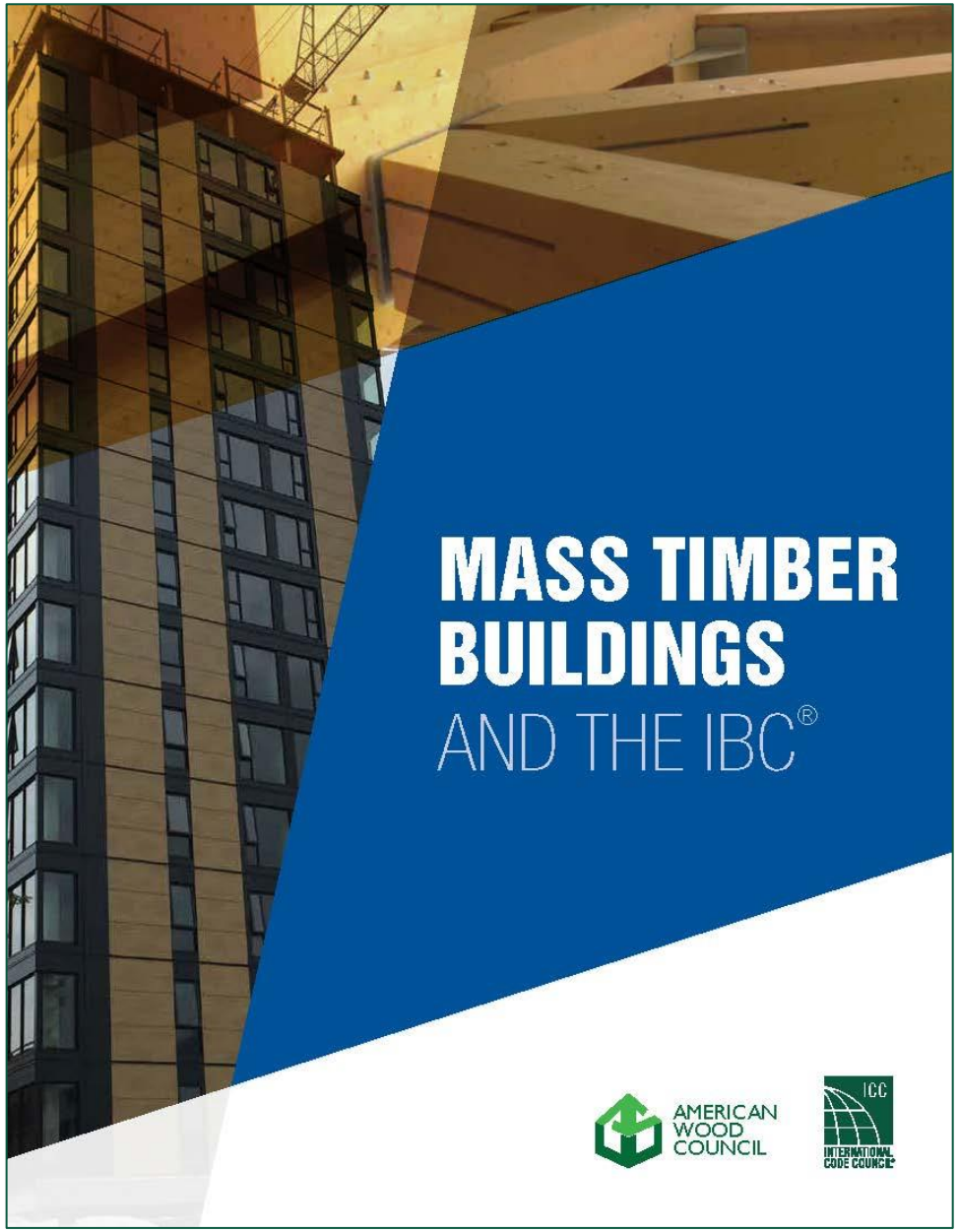
6 STORIES

BUILDING HEIGHT	85 FT
ALLOWABLE BUILDING AREA	324,000 SF
AVERAGE AREA PER STORY	54,000 SF

TYPE IV-HT

2021 IBC

2018 & 2021 IBC



722.7

Fire-Resistance Rating Of Mass Timber

Figure 7-3 The TWB-AHC determined fire testing was necessary to validate established performance objectives. Consequently five, full-scale, multiple-story fire tests were conducted to simulate the three new construction types (Types IV-A, IV-B and IV-C)..

CHANGE TYPE: Addition

CHANGE SUMMARY: New provisions provide a prescriptive approach to achieve the required fire-resistance ratings for mass timber members and assemblies. The 2021 IFC includes new provisions requiring the building owner to maintain an inventory of all required fire-resistance-rated construction for Type IV-A and IV-B buildings.

2021 IBC Cover

2021 IBC: **722.7 Fire-resistance rating of mass timber.** The required fire-resistance of *mass timber* elements in Section 602.4 shall be determined in accordance with Section 703.2 or Section 703.3. The *fire-resistance rating* of building elements shall be as required in Tables 601 and 602 and as specified elsewhere in this code. The *fire-resistance rating* of the mass timber elements shall consist of the fire-resistance of the unprotected element added to the protection time of the *noncombustible protection.*

722.7.1 Minimum required protection. Where required by Section 602.4.1 through 602.4.3, *noncombustible protection* shall be provided for *mass timber* building elements in accordance with Table 722.7.1(1). The rating, in minutes, contributed by the *noncombustible protection* of *mass timber* building elements, components, or assemblies, shall be established in accordance with Section 703.8. The protection contributions indicated in Table 722.7.1(2) shall be deemed to comply with this requirement when installed and fastened in accordance with Section 722.7.2.

ICC INTERNATIONAL CODE COUNCIL®

July 1, 2021 to Dec 31, 2022

2019 California Building Code, Title 24, Part 2 (Volumes 1 & 2) with July 2021 Supplement

Effective
January 1, 2023

California state amendments to the International Codes are shown in *italic text*.

Resources

CodeMaster

Design of Tall Mass Timber (2021 IBC, 2021 IFC, 2021 SDPWS, 2018 NDS)

CodeMaster

Tall Mass Timber

2021 IBC | 2021 IFC | 2021 SDPWS | 2018 NDS

Introduction and Definitions

This CodeMaster identifies 11 steps for determining structural and fire protection, special inspection, energy, sound transmission, and construction fire safety requirements for tall mass timber buildings per the 2021 *International Building Code* (IBC), 2021 *International Fire Code* (IFC), and the 2021 *International Energy Conservation Code* (IECC). While not every applicable code provision is discussed, this CodeMaster highlights key requirements. Structural and fire design provisions for mass timber elements and their connections are found in the 2018 *National Design Specification®* (NDS®) for *Wood Construction*. Additional background and examples for fire design of wood members and connections is contained in *Technical Report 10 – Calculating the Fire Resistance of Wood Members and Assemblies* (TR10). Design provisions for the lateral force-resisting system are found in the 2021 *Special Design Provisions for Wind and Seismic* (SDPWS).

Three new types of construction are included in the 2021 IBC: Types IV-A, IV-B, and IV-C. Existing Type IV Construction was re-named Type IV-HT to differentiate it from the new mass timber provisions. For Type IV-HT buildings, compliance for fire-resistive purposes is typically based upon the minimum cross-sectional dimensions of the timber members as established by IBC Table 2304.11. Timber elements used in Types IV-A, IV-B and IV-C must also meet the minimum sizes in IBC Table 2304.11. For the three new construction types, the required fire-resistance ratings are achieved by the inherent fire resistance of the mass timber members themselves, in addition to the added fire resistance from any protection applied directly to the mass timber members and connections. Type IV-HT will not be discussed in this CodeMaster except as necessary to differentiate new mass timber provisions.

The following definitions are important to these new construction types:

- **Mass Timber:** Structural elements of Type IV construction primarily of solid, built-up, panelized or engineered wood products that meet minimum cross-section dimensions of Type IV construction.
- **Noncombustible Protection (for Mass Timber):** Noncombustible material, in accordance with IBC Section 703.6, designed to increase the fire-resistance rating and delay the combustion of mass timber.
- **Cross-laminated Timber (CLT):** A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or structural composite lumber where the adjacent layers are cross oriented and bonded with structural adhesive to form a solid wood element.

SECRETS OF THE CODEMASTER: See the *Structural Wood Design (ASD/LRFD) CodeMaster* for guidance on the structural design of common wood members. Also see the ICC/AWC publication *Mass Timber Buildings and the IBC* for a comprehensive overview of requirements for mass timber construction as found in the 2021 IBC and 2021 IFC.

STEP 1 — Determine Construction Type, Number of Stories, Height and Area

IBC Chapter 5 includes provisions and tables for determining maximum building heights and areas based on the occupancy classification of the building, type of construction and whether the building is provided with automatic fire sprinklers. The following IBC tables are the starting point for this determination:

- Table 504.3 – Allowable Building Height in Feet above Grade Plane
- Table 504.4 – Allowable Number of Stories above Grade Plane
- Table 506.2 – Allowable Area Factor in Square Feet

Allowable building areas may be increased based on open space around the building for fire department access. The maximum available frontage increase is 75 percent of the allowable area factor as noted in IBC Table 506.3.3. Maximum story areas and overall allowable building areas are based on whether the building contains single or multiple occupancies and the type of sprinkler system installed.

Example: Determine the maximum height in stories and feet and overall allowable building area for a multi-story Group B business occupancy protected by a NFPA 13 sprinkler system assuming no frontage increase.

Group B Business Occupancy	Type IV-A	Type IV-B	Type IV-C
Table 504.3 Height (ft)	270	180	85
Table 504.4 Stories	18	12	9
Table 506.2 Building Area (ft²)	972,000	648,000	405,000

SECRETS OF THE CODEMASTER: The allowable area of each story is determined in accordance with IBC Equation 5-1. This value is multiplied by the number of stories, up to three stories, to determine the total allowable area of single-occupancy buildings. For a building with a single occupancy and more than three stories, IBC Equation 5-2 is used to calculate total allowable building area, which is generally limited to three times the allowable area of each story.

STEP 2 — Design Structural Elements and Connections for Applicable Loads

Design of mass timber elements and connections for IBC-specified gravity loads can be accomplished using the NDS. The NDS includes structural and fire design criteria for all code-defined mass timber products including solid sawn timbers, structural composite lumber (SCL), glued laminated timber (glulam), and CLT. The applicable IBC- and NDS-referenced CLT product standard is ANSI/APA PRG 320 *Standard for Performance-Rated Cross-Laminated Timber* and applicable design values are to be obtained from the manufacturer's literature or code evaluation report. Connection provisions are also included in the NDS.

The SDPWS includes CLT shear wall and diaphragm provisions. The ASCE 7-16 version of *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* does not contain seismic design coefficients for CLT shear wall systems. In the interim, 2020 *NEHRP Recommended Seismic Provisions for New Buildings and Other Structures (NEHRP Provisions)* provide the following seismic design coefficients and height limits and have been proposed for inclusion in ASCE 7-22. The response modification factor R = 3 for CLT shear walls and R = 4 for CLT shear walls with shear resistance provided only by high aspect ratio panels apply for CLT shear walls designed in accordances with SDPWS Appendix B.

Bearing Wall Shear Walls	Individual Panel Aspect Ratio	R	Ω_0	C_d	Height Limit SDC B-F
CLT	$2 \le h/b_s \le 4$	3	3	3	65
CLT – high h/b_s	$h/b_s = 4$	4	3	4	65

SDPWS Section 4.5 includes provisions for the design of CLT diaphragms using principles of engineering mechanics and values of wood member and connection strength in accordance with the NDS. Requirements include use of dowel-type fasteners exhibiting NDS yield Mode III_s or Mode IV to transfer diaphragm shear forces between CLT panels and between CLT panels and diaphragm boundary elements and use of design force increase factors for the design of wood elements, steel parts, and wood or steel chord splice connections. The combination of these requirements is intended to ensure development of a minimum level of diaphragm overstrength consistent with that provided by nailed wood-frame, wood structural panel diaphragms.

SDPWS Section 4.6 includes provisions for the design of CLT shear walls including prescriptive requirements for fasteners, connectors, and individual CLT panel aspect ratios per SDPWS Appendix B. Two CLT shear wall systems are defined: i) *CLT shear wall*, and ii) *CLT shear wall with shear resistance provided by high aspect ratio panels only*. CLT shear walls not conforming to requirements of Appendix B are subject to approval as an alternative method of construction, with default use limited to Seismic Design Categories A

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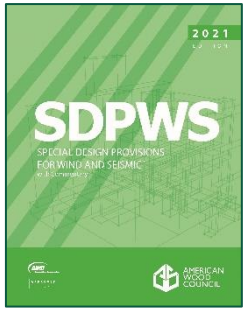
For answers to questions regarding design of non-residential and multi-family wood buildings free of charge, please contact: help@woodworks.org

CLT Shear Walls

CLT Shear Wall Capacities* (ASD)					
		Seismic		Wind	
Panel b_s x h (ft)	No. of Angles (n)	Shear (plf)	Hold-down (lbs)	Shear (plf)	Hold-down (lbs)
4 x 8	2	465	7443	651	7815
4 x 8	3	698	11,164	977	11,723
4 x 8	4	930	14,886	1303	15,630
4 x 8	5	1163	18,607	1628	19,538

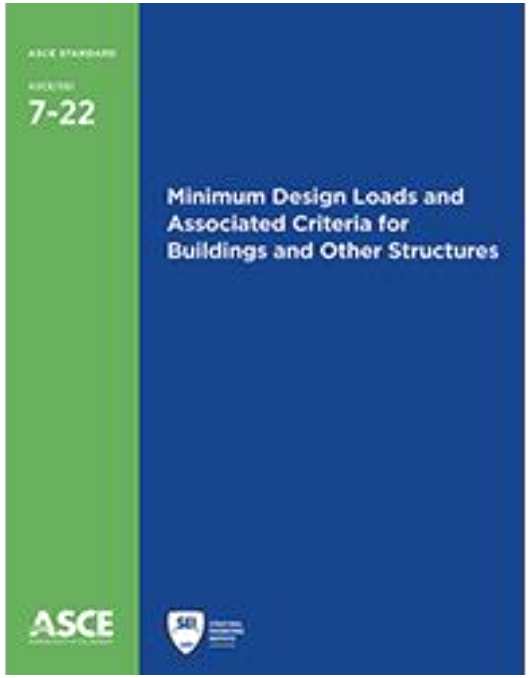
*Capacity based on angles on one face



§ 4.6 & App. B

Seismic Design Options

Bearing Wall Shear Walls	h/b_s	R	Ω_0	C_d	Height Limit SDC B-F
CLT	$2 \leq h/b_s \leq 4$	3	3	3	65’
CLT – high h/b_s only	$h/b_s = 4$	4	3	4	65’



Wildfires

2022 CA Building Code, Chapter 7A,
Materials and Construction Methods for Exterior Wildfire Exposure

+

California State Fire Marshal's Office IWUIC Workgroup is meeting regularly to consider the 2024 International Wildland Urban Interface Code as a model code for the 2025 California WUI Code.

+

ICC 605 - Standard for Residential Construction in Regions with Wildfire Hazard is under development

International Mass Timber Report 2022

The mass timber market has few options for treated wood, owing, in part, to the large dimensions of mass timber components, but several testing efforts are in progress to analyze the structural performance of treated mass timber and its interactions with adhesives. Treated mass timber panels could also have insect repellent capabilities, expanding geographic acceptance into regions with termites. The large size of the panels makes post-treatment impractical.

Special Inspection: Section 1705.5.3

TABLE 1705.5.3 REQUIRED SPECIAL INSPECTIONS OF MASS TIMBER CONSTRUCTION

TYPE			CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1.	Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.		—	X
2.	Inspect erection of mass timber construction.		—	X
3.	Inspection of connections where installation methods are required to meet design loads.			
	Threaded fasteners	Verify use of proper installation equipment.	—	X
		Verify use of pre-drilled holes where required.	—	X
		Inspect screws, including diameter, length, head type, spacing, installation angle and depth.	—	X
	Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads.		X	—
	Adhesive anchors not defined in preceding cell.		—	X
	Bolted connections.		—	X
	Concealed connections.		—	X

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IV-A

IV-B

IV-C

Tall Mass Timber Special Inspector Exam

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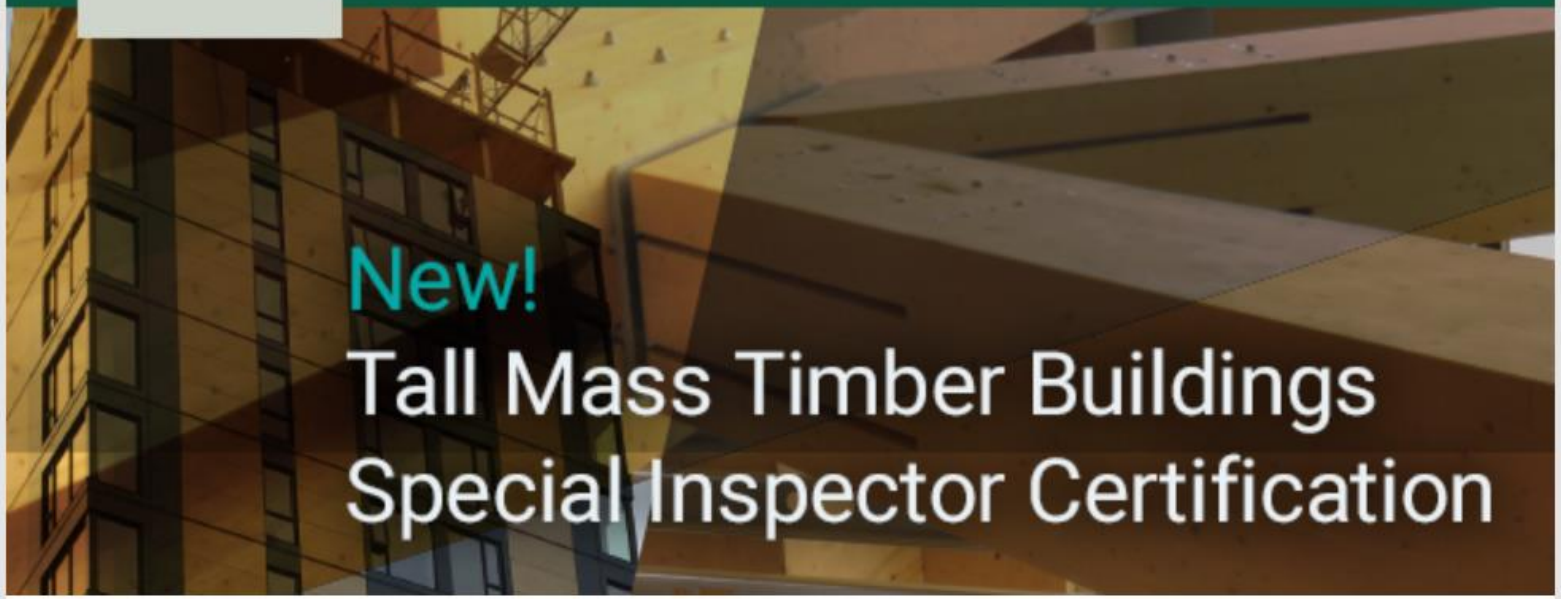


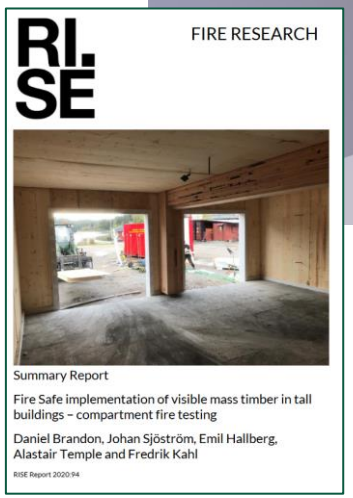
The Assessment Center at the International Code Council is pleased to introduce the Tall Mass Timber Buildings Special Inspector Certification

The certification exam is conveniently available via the **PRONTO** (Proctored Remote Online Testing Option) platform. Take the online exam from any secure location.

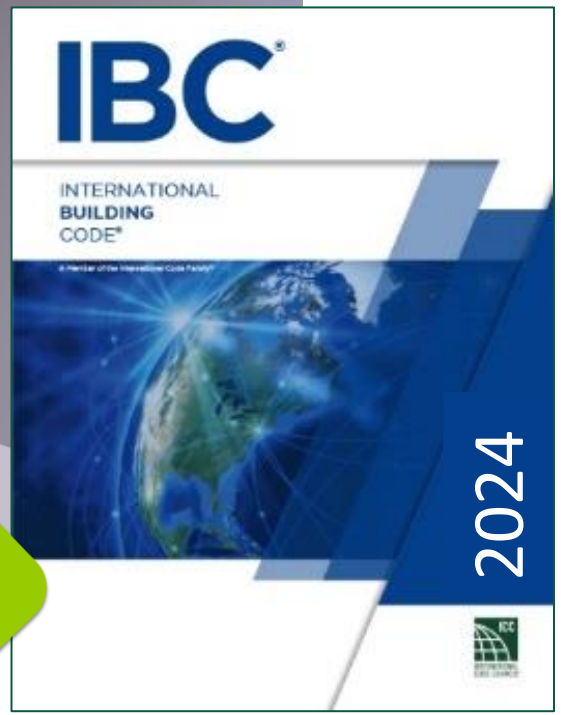
CERTIFICATION EXAM

The Code Council has collaborated extensively with the American Wood Council to prepare

2024 IBC – 100% Exposed Ceilings



IV-B



Michael Temesvary, P.E.

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ICC – ES Acceptance Criteria

- AC14 - Prefabricated Wood I-joists
- AC47 - Structural Wood-based Products
- AC202 - Wood-based Studs
- AC124 - Rim Board Products
- AC13 - Joist Hangers and Similar Devices
- AC233 - Dowel-type Threaded Fasteners Used in Wood
- AC455 - Cross-laminated Timber Panels for Use as Components in Walls, Floors and Roofs

AC455 - Cross-laminated Timber Panels for Use as Components in Walls, Floors and Roofs

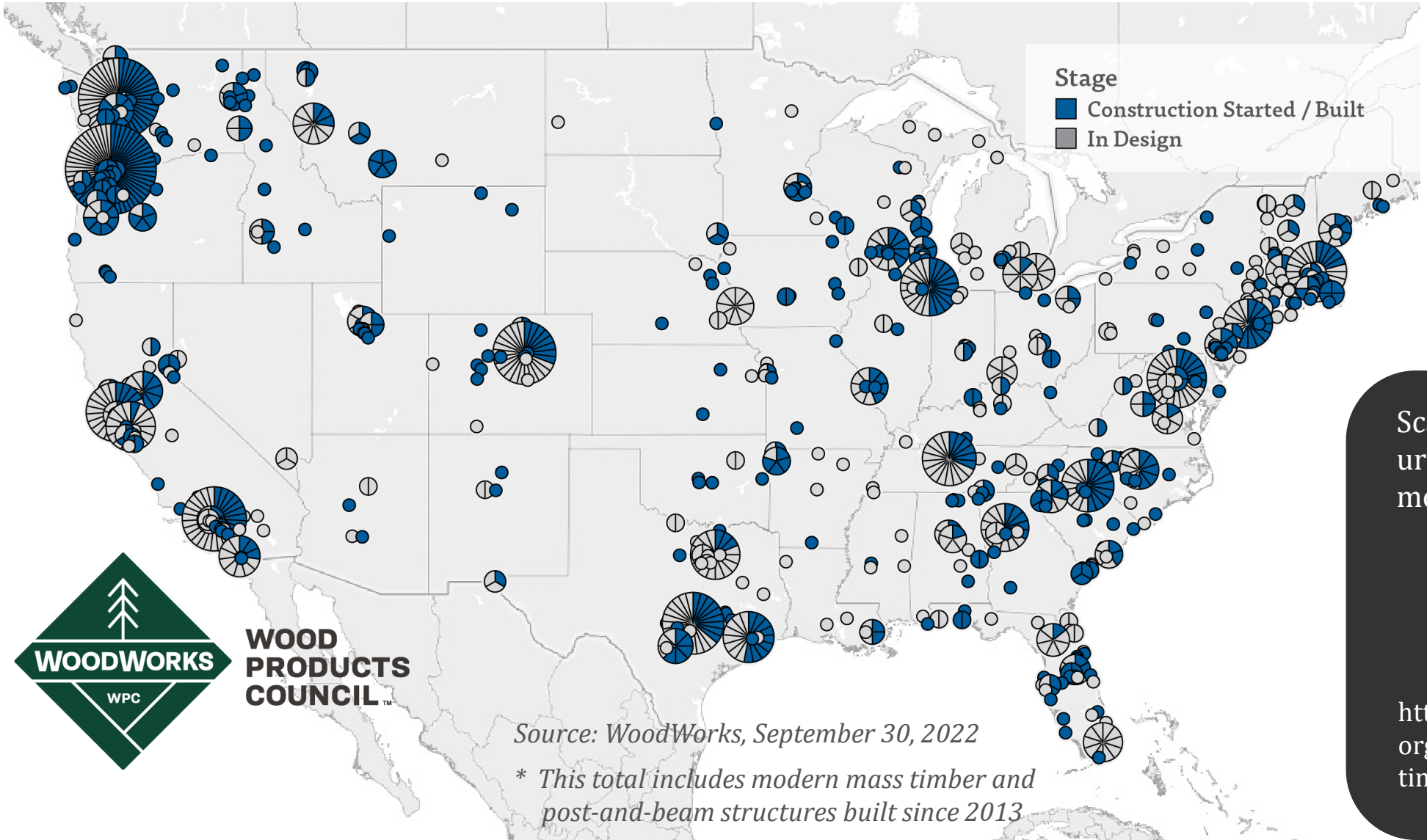
- ESR-3631 - Structurlam Mass Timber Corporation
- ESR-5053 - Sterling Site Access Solutions, LLC
- ESR-4081 - Binderholz Bausysteme GmbH
- ESR-4381 - STORA ENSO OYJ
- ESR-4760 - Freres Lumber Co., Inc.
- ESR-5105 - Kalesnikoff Mass Timber Inc.
- ESR-4733 - SmartLam, LLC
- ESR-4875 - Nordic Structures

AC13 - Joist Hangers and Similar Devices

- ESR-2551 - Simpson Strong-Tie Company Inc
- ESR-4568 - Sekisui House, LTD
- ESR-4569 - Sekisui House, LTD

Current State of Mass Timber Projects

As of September 2022, in the US, **1,571** multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.



WOODWORKS
WPC
WOOD PRODUCTS COUNCIL™

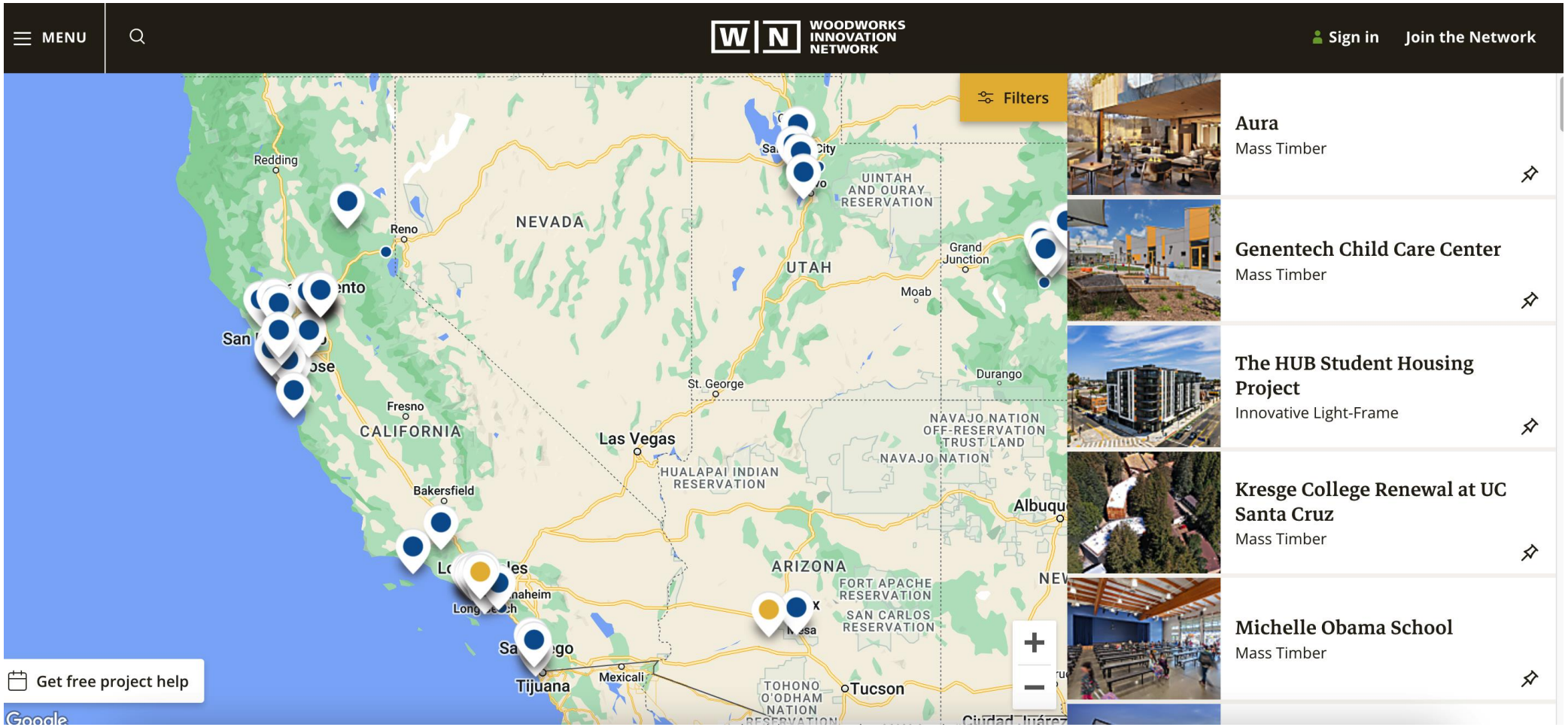
Source: WoodWorks, September 30, 2022

** This total includes modern mass timber and post-and-beam structures built since 2013*

Scan this code or use the url to find the map and more details online.

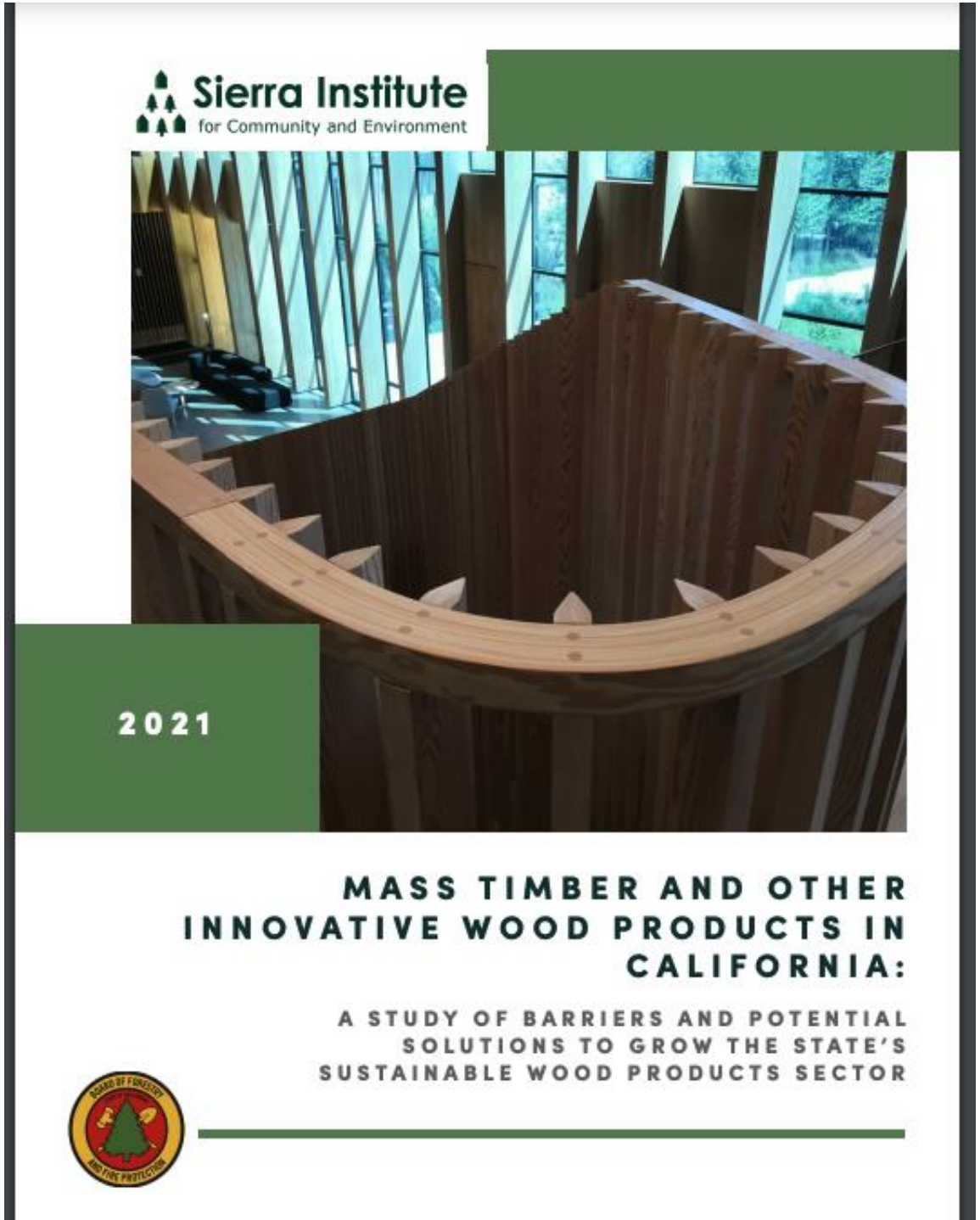
https://www.woodworks.org/resources/u-s-mass-timber-projects/

woodworksinnovationnetwork.org



Mass Timber and Other Innovative Wood Products in California: A Study of Barriers and Potential Solutions to Grow the State's Sustainable Wood Products Sector

https://sierrainstitute.us/



Resources

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International Code Council at Greenbuild 2022

Greenbuild | International Conference + Expo

NOVEMBER 1-3, 2022 | MOSCONE CENTER | SAN FRANCISCO

FEATURING IWBC

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Energy Code Specialist
Product Development
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Come visit us at booth # 1250

Offsite Construction: https://solutions.iccsafe.org/offsite

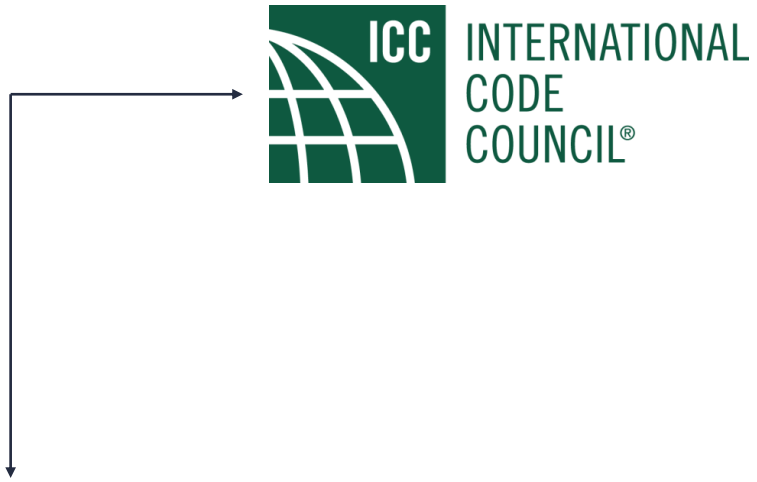
Solutions for Today's Challenges

What is Off-Site Construction?

The process of constructing buildings or components of buildings in a factory to increase quality, sustainability and job site safety to project completion over site-building projects. The International Code Council helps project teams and communities unlock the potential of off-site construction.

WATCH VIDEO

Thank you!



Family of Solutions

Susan Dowty
sdowty@iccsafe.org

nheritallwood.mines.edu

Shake Table Testing Full-Scale 10-Story Mass Timber Building

Other Resources

- AWC – awc.org - wood industry standards developer. Code-referenced NDS and SDPWS provide engineering provisions for mass timber (including CLT) structural and fire design.

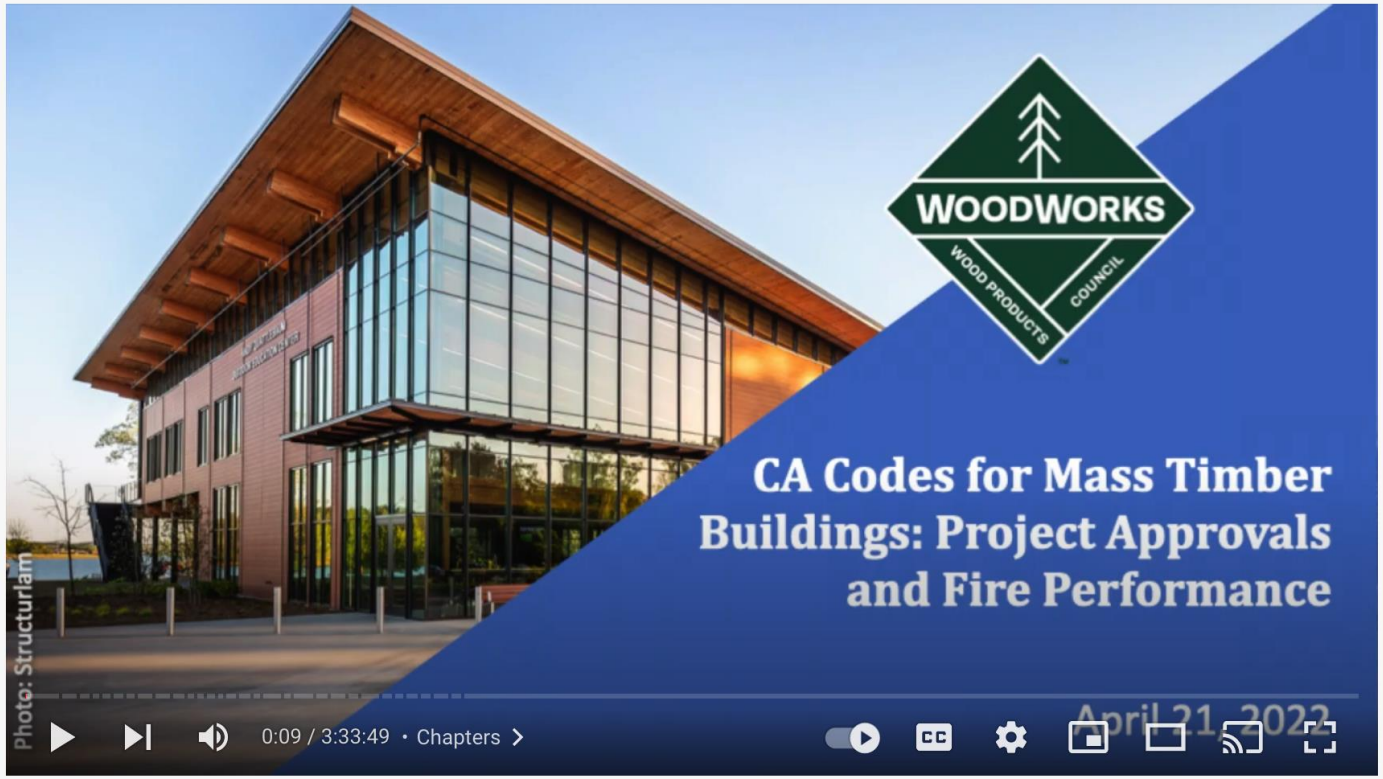
- APA – The Engineered Wood Association- apawood.org. Industry leader in manufacturing and QC standards. Many CLT, glulam and SCL manufacturers use APA for third-party QC.

- Woodworks – woodworks.org - education arm of the industry. Their technical staff also provide free design support for non-residential construction.

April 21, 2022 Recording

YouTube

Search



WoodWorks | California Codes for Mass Timber Buildings Project Approvals and Fire Performance

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