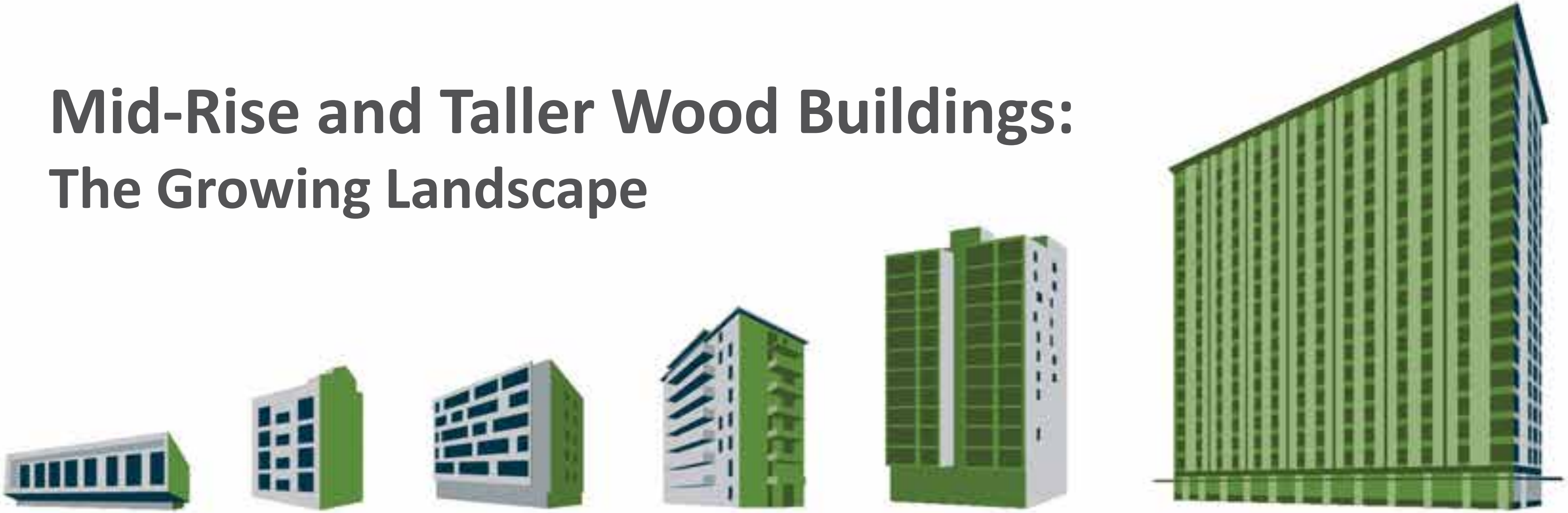
WoodWorks™
WOOD PRODUCTS COUNCIL

Mid-Rise and Taller Wood Buildings:
The Growing Landscape



credit: Think Wood

Mark Bartlett, PE
mark.bartlett@woodworks.org

WoodWorks
WOOD PRODUCTS COUNCIL

FUNDING PARTNERS

SLB
SOFTWOOD LUMBER BOARD

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

Forestry Innovation Investment

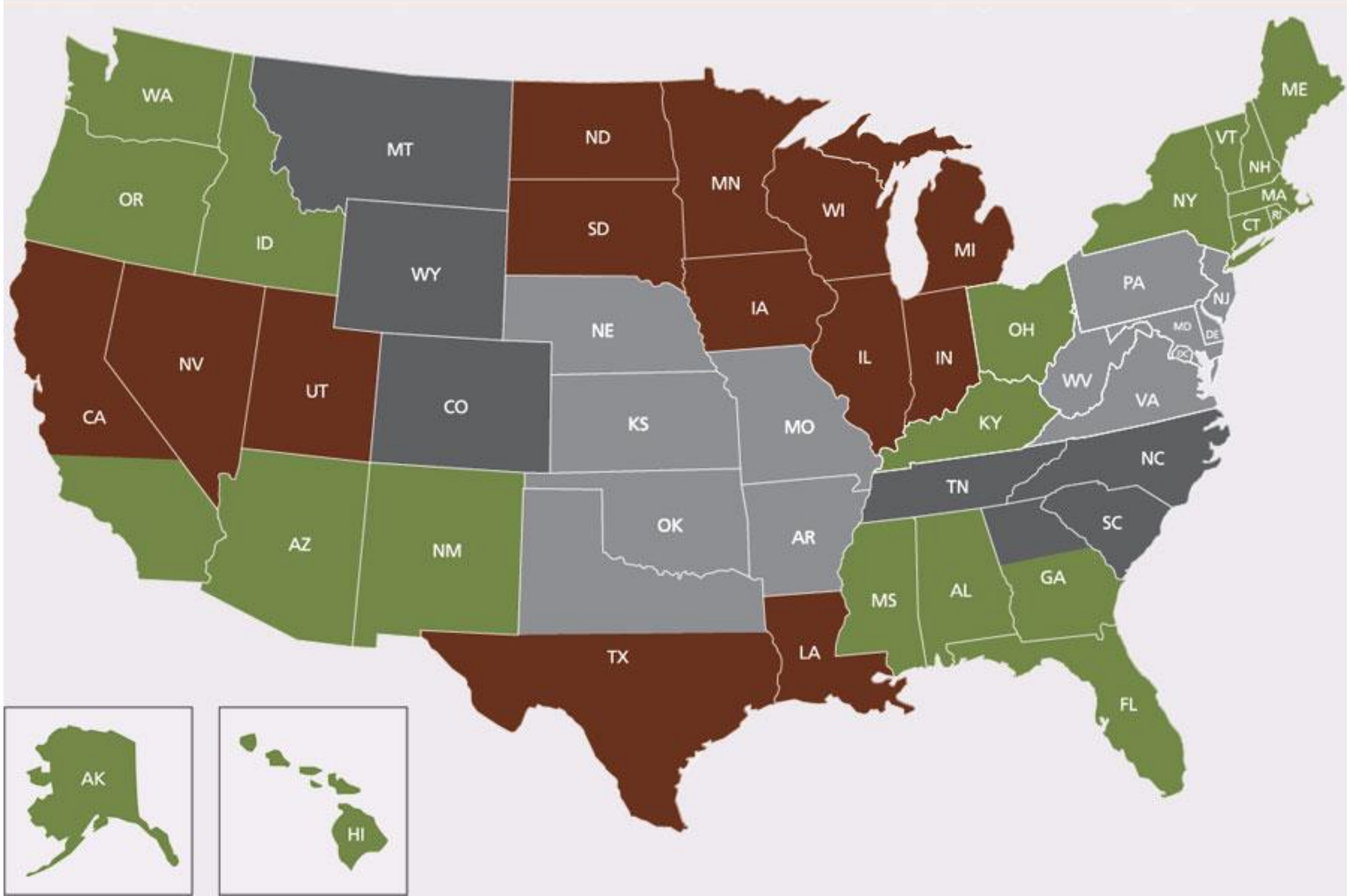
WHAT WOODWORKS DOES

UW MercerCourt, credit WG Clark Construction and
Ankrom Moisan Architects

credit www.naturallywood.com

Cathedral of Christ the Light
Skidmore, Owings & Merrill LLP
Cesar Rubio Photography

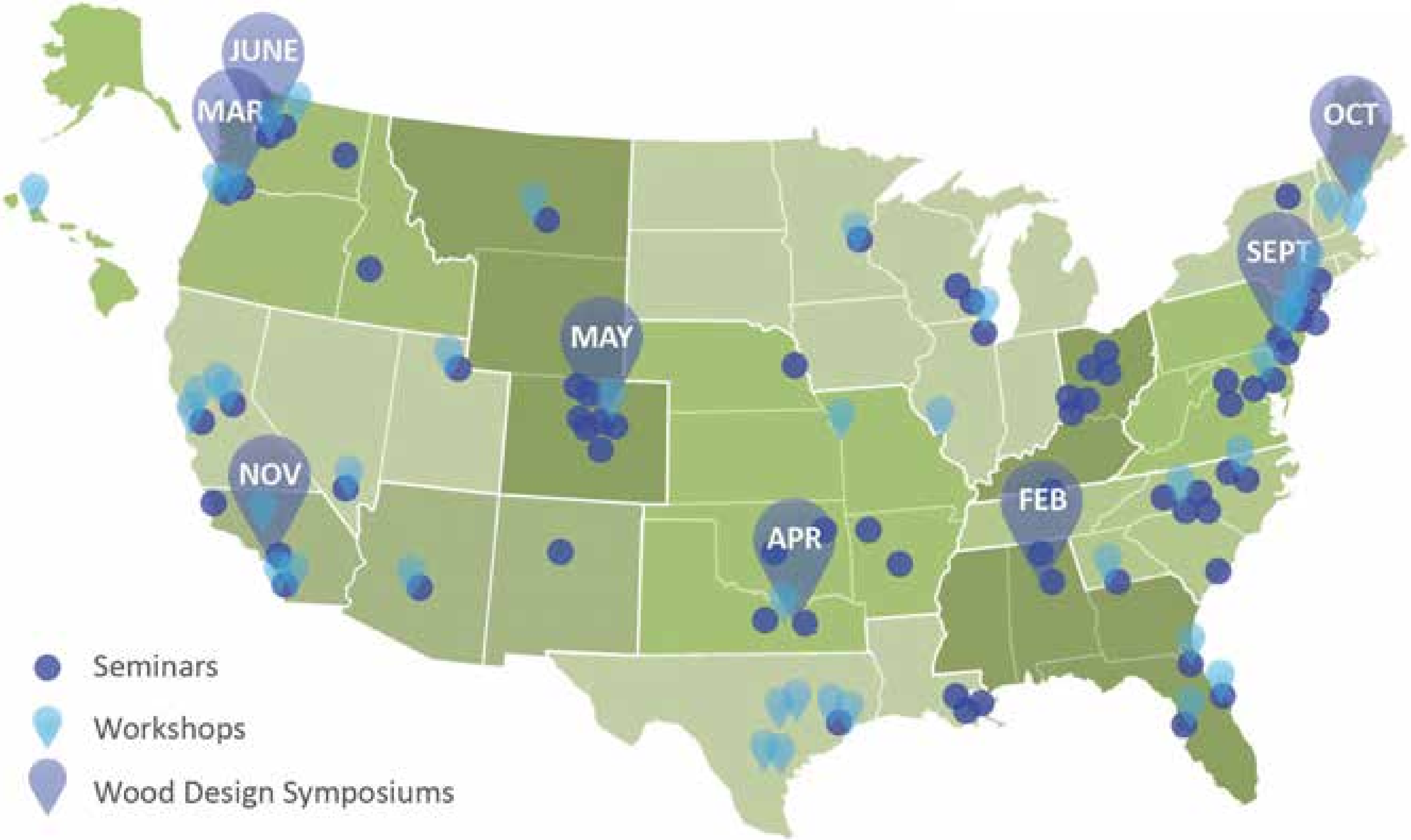
Project Assistance



ASSISTANCE EXAMPLE

2019 EDUCATION EVENTS

WoodWorks will host or speak at almost 400 events, and provide close to 35,000 education hours in 2019, all related to the design, engineering and construction of commercial and multi-family wood buildings.



All credits are AIA/CES HSW LUs, PDH and ICC eligible.

UPCOMING EVENTS

WOOD DESIGN SYMPOSIUMS

June 19 | Seattle, WA

September 19 | Philadelphia, PA

October 16 | Portland, ME

November 13 | Long Beach, CA

SEMINARS & WORKSHOPS

Various topics and locations throughout the Summer and Fall: NYC, San Antonio, Omaha, Charlotte, Atlanta, St Louis, Kansas City and more

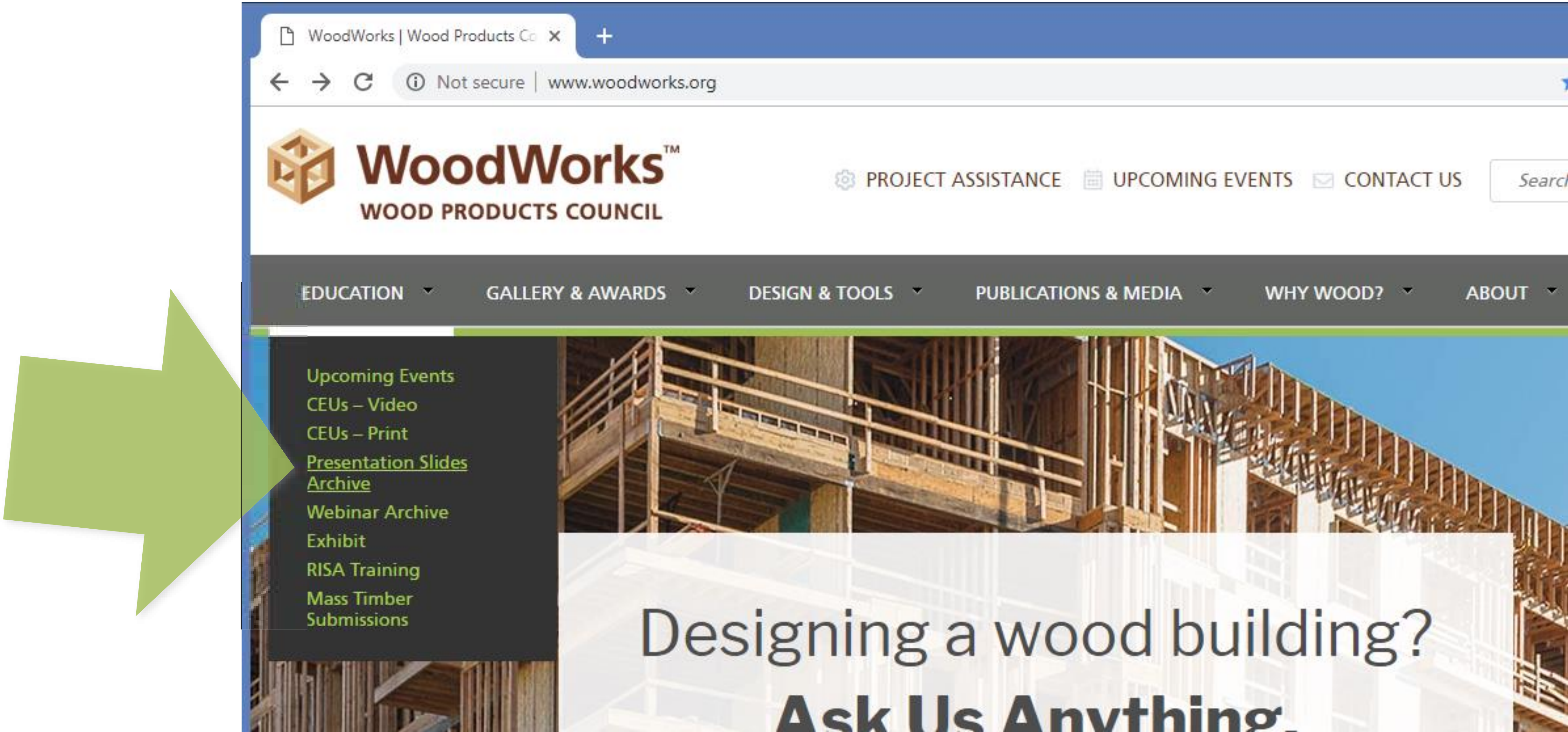
WEBINARS

June 12 | Maximizing Mid-Rise Value with Wood: Design Tips for Podiums, Sloped Sites and Other Complexities

July 10 | Timber-Concrete Composite Floor Technology: Research, Design and Implementation

August 14| Mass Timber Connections: Building Structural Design Skills

WOODWORKS: PRESENTATION SLIDE ARCHIVE



2020 WOOD DESIGN AWARDS

"The Wood Products Council" is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

Innovative use of wood is changing the skyline. Increasingly, mid-rise wood buildings are rising up among traditional concrete and steel shells as designers and developers recognize timber’s performance capabilities while embracing its vast potential for lower costs, faster installation, and a significantly lighter carbon footprint. Through the use of case studies, this session will showcase recently completed projects that illustrate this trend. Topics will include current code allowances for mid-rise wood buildings, design strategies and environmental performance. Discussion will then shift to taller wood buildings, made possible by emerging research and the development of advanced wood products and technologies. Project examples will be highlighted and design approaches for topics such as fire-resistance, structure and acoustics will be covered.

Learning Objectives

1. Evaluate the opportunities for wood-frame mid-rise projects.
2. Interpret local code language on the allowance of wood framing above three stories.
3. Learn how tall timber can achieve design goals beyond code requirements, including high acoustical performance, unique aesthetics and sustainability.
4. Discover how tall timber can achieve structural performance and approval in the US including fire performance.

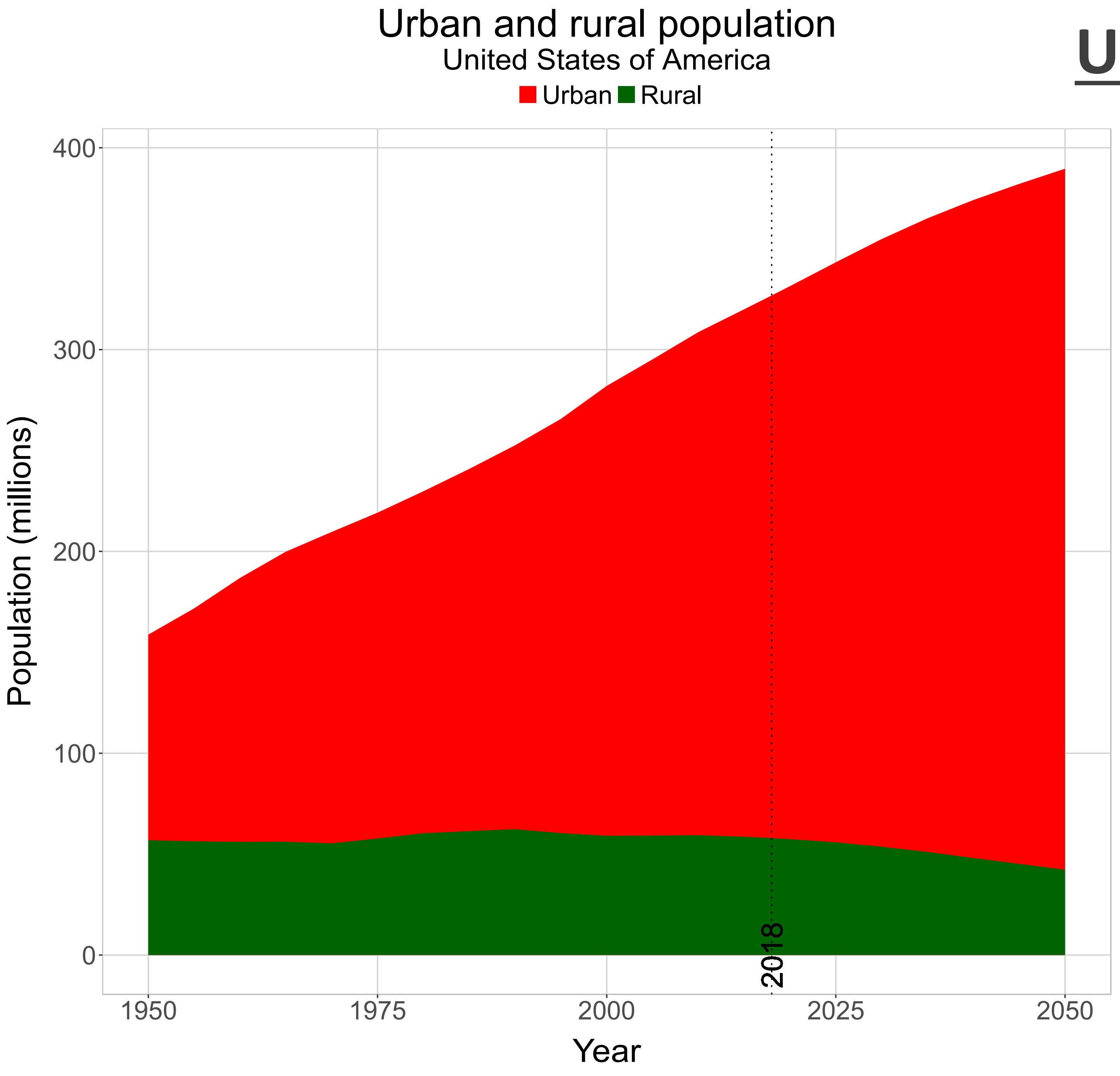
Global Population Boom

Global Population
7.3 billion today

9.5 billion by 2050
30% increase

Urban Population
6.3 billion by 2050
60% increase

Source: United Nations, World Urbanization Prospects, 2014 Revision



US URBAN POPULATION BOOM

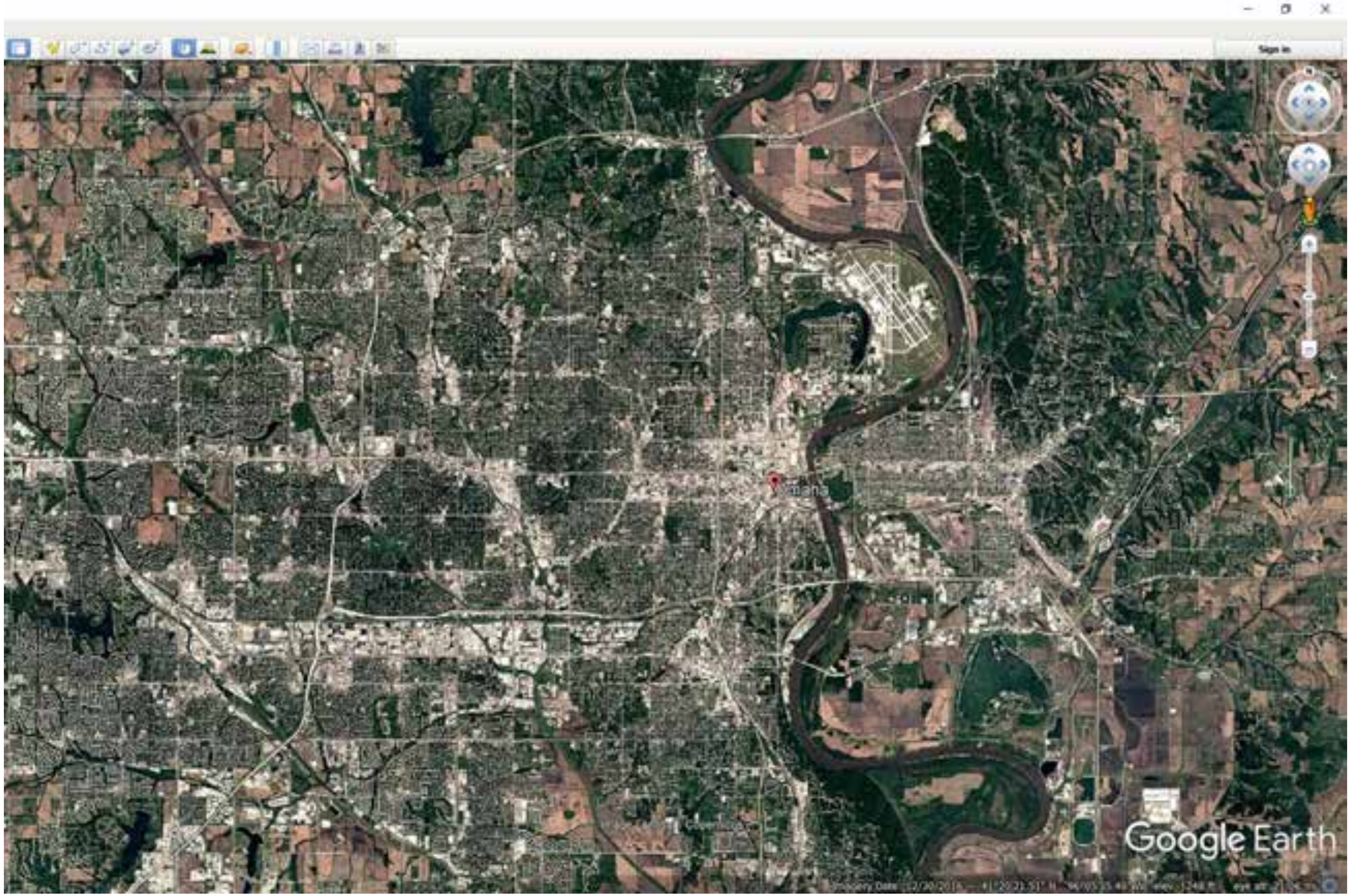
	URBAN	RURAL
2019	271.4 M	57.7 M
2030	301 M	53.7 M
2050	347.3 M	42.2 M

Omaha

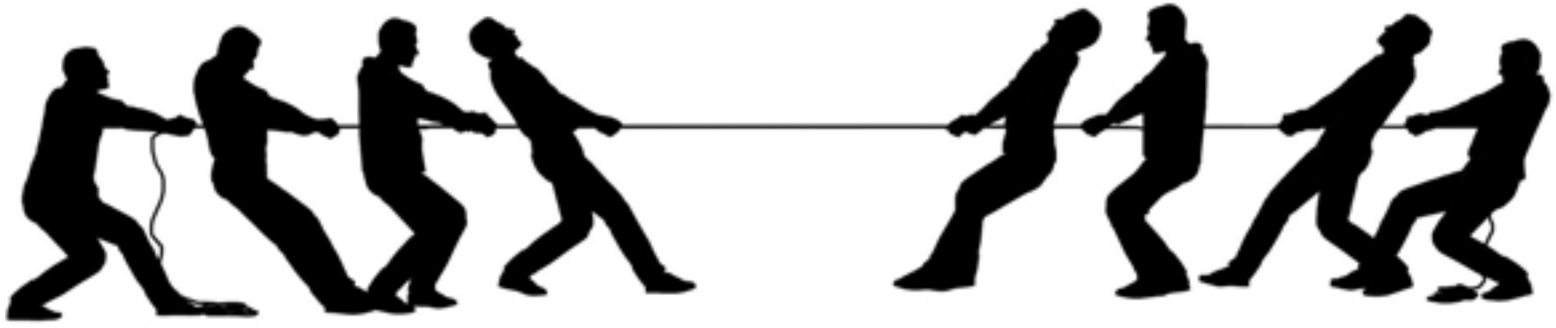
1984

2000

2016



Need for Sustainable Structures

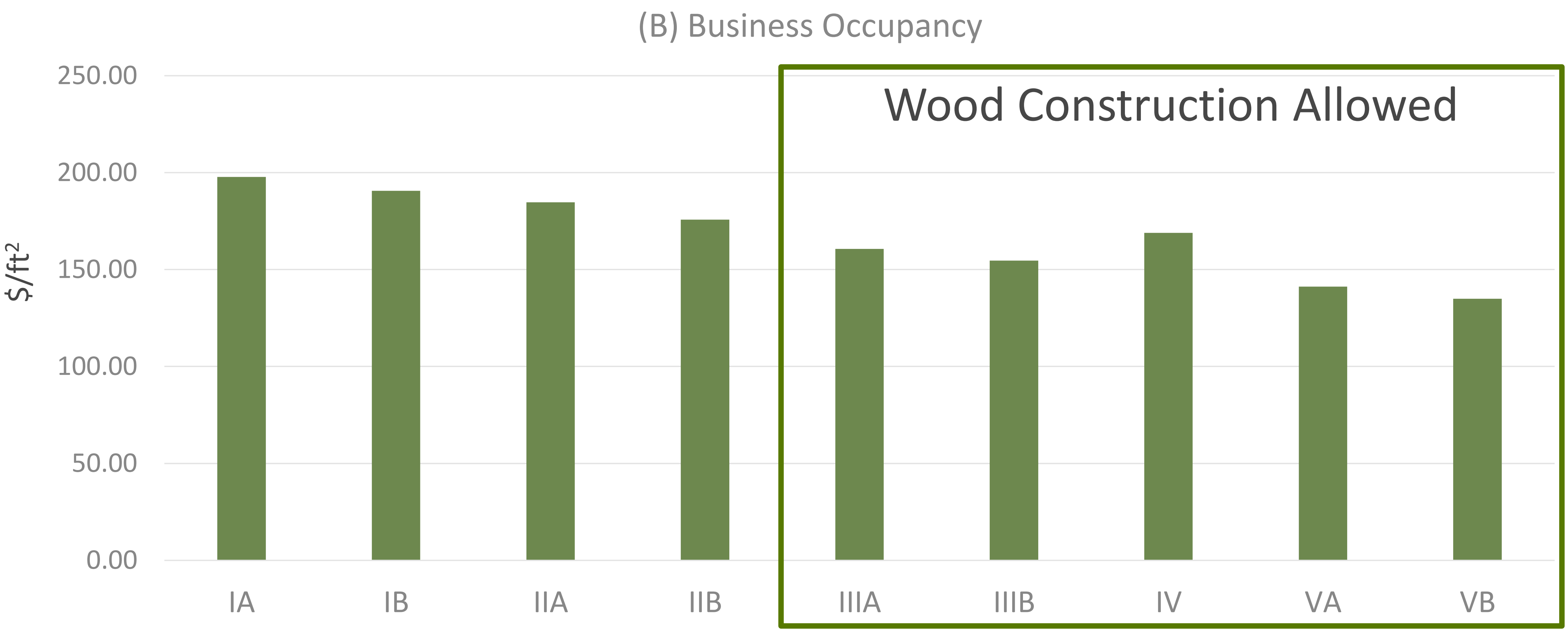


Economically Meet Urban Housing and Business Needs

Increase Environmental Responsibility

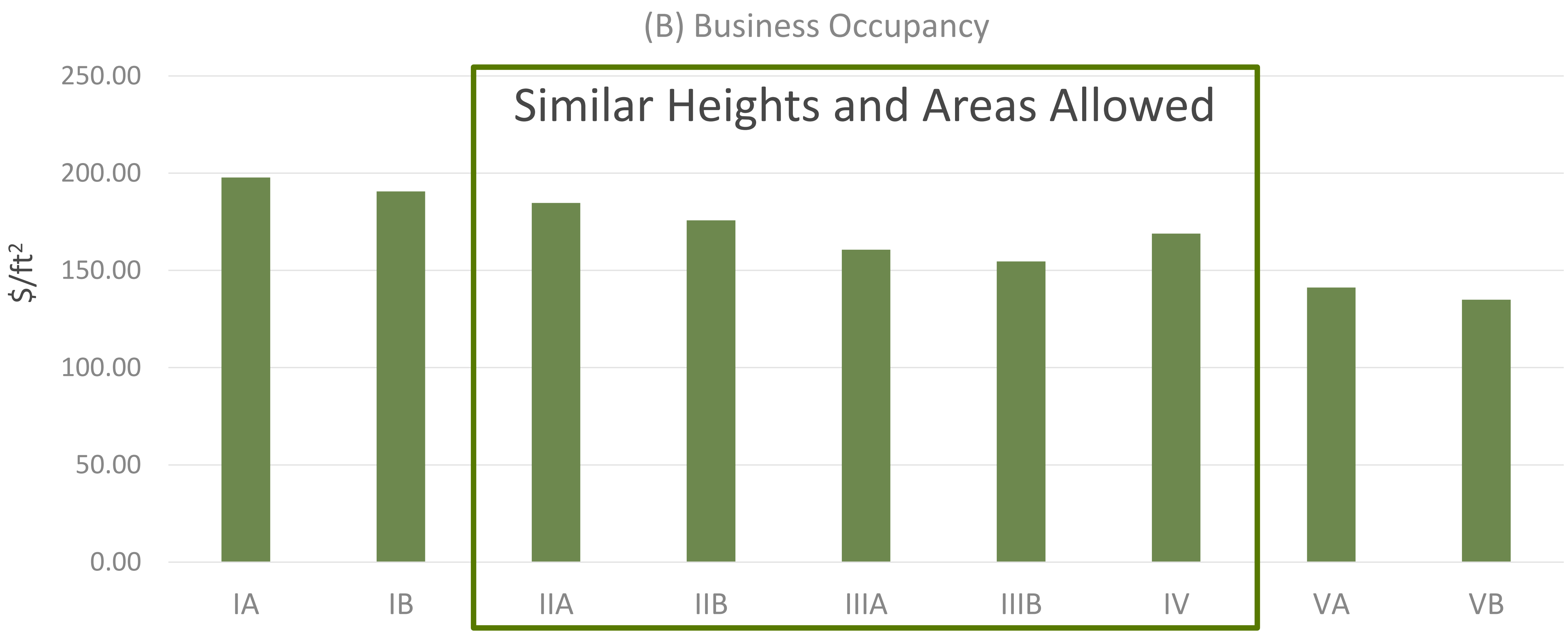
These 2 items don't need to be in opposition- Wood framing helps them work together!

Office Construction Costs – ICC Building Valuation



Source: ICC Building Valuation Data, Feb 2019
http://evstudio.com/construction-cost-per-square-foot-for-office-buildings/construction-cost-office-building-2-to-4-stories-2/

Office Construction Costs – ICC Building Valuation



Source: ICC Building Valuation Data, Feb 2019
http://evstudio.com/construction-cost-per-square-foot-for-office-buildings/construction-cost-office-building-2-to-4-stories-2/

Wood Mid-Rise Construction

How many stories can be wood framed in the IBC?

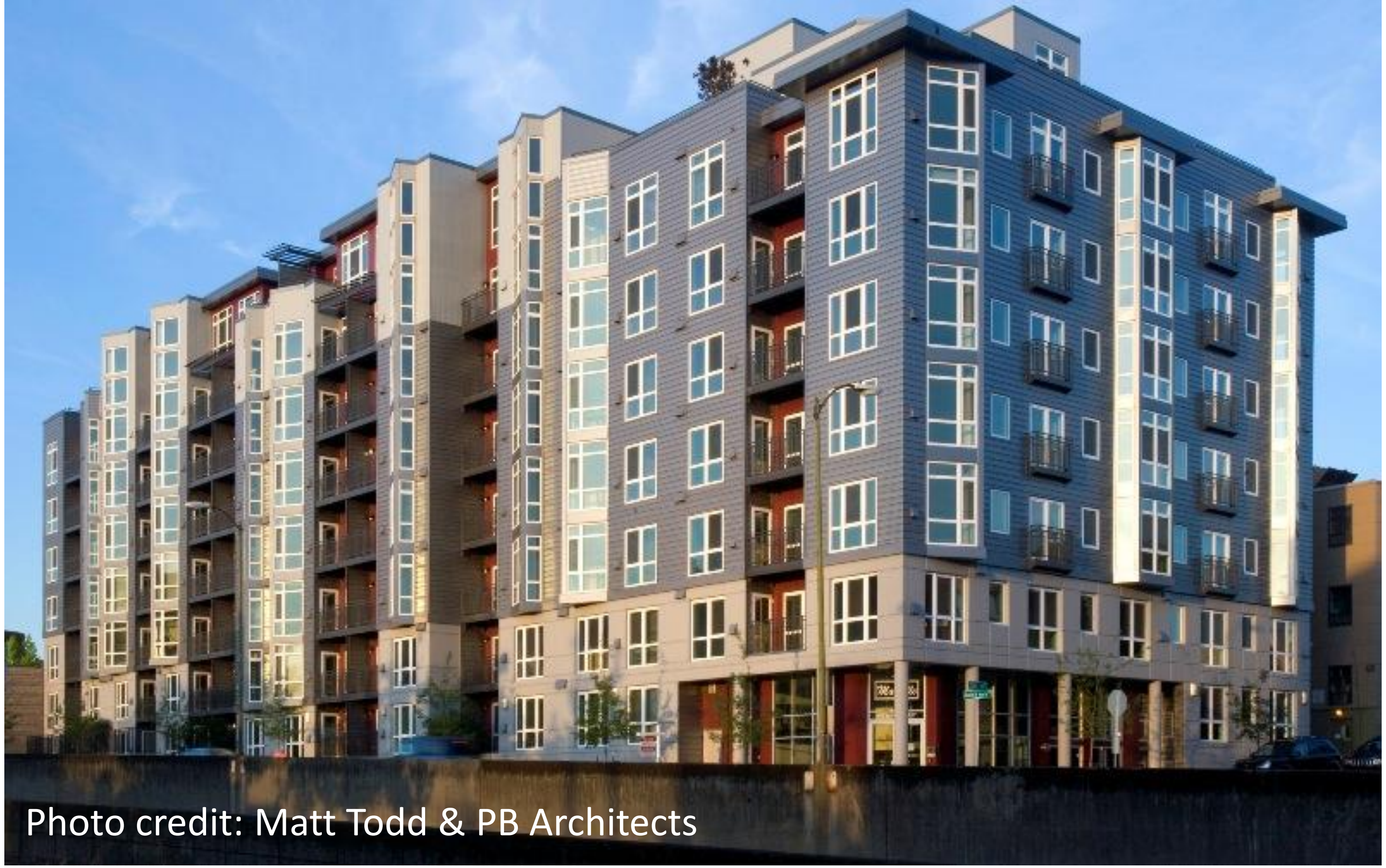


Photo credit: Matt Todd & PB Architects

6 stories for Offices, 5 stories for Residential

IBC Building Size Limits

Residential (R1, R2, and R4) Occupancies

Construction Type Allowable Limit	IIIA	IIIB	VA	VB
Stories	4	4	3	2
Height (ft)	65	55	50	40
Building Area/Story (ft^2)	24k	16k	12k	7k
Total Building Area* (ft^2)	72k	48k	36k	14k

* Assuming max stories built

IBC 2012 Table 503 Tabular Values

IBC Building Size Limits

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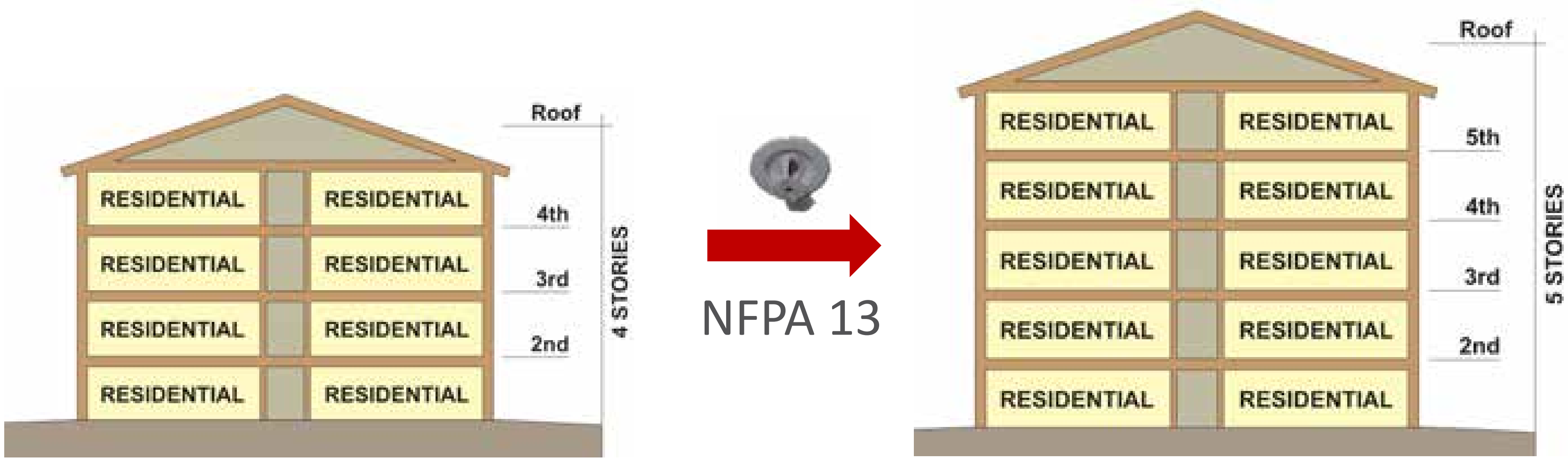
IBC Building Size Limits



Tabular Limits

Increased Limits

With NFPA Sprinklers IBC gives an allowable Heights and Area Increase

IBC Building Size Limits

Residential (R1, R2, and R4) Occupancies

Type IIIA Construction Allowable Limit	Table	NPFA 13	NPFA 13	Frontage Increase?
Stories	4	**5**	**5**	**5**
Height (ft)	65	**85**	**85**	**85**
Building Area/Story (ft^2)	24k	24k	**72k**	**90k**
Total Building Area* (ft^2)	72k	72k	**216k**	**270k**
IBC 2012 Section	503	504.2	506.3	506.2

* Assuming max stories built per IBC 506.4

? Maximum frontage increase possible

Type V Buildings

Multi-family

Restaurants

Retail

Office

Type V-B Height and Area Limits

V-B

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	2	60 ft	18,000 SF	36,000 SF
B	3	60 ft	27,000 SF	81,000 SF
M	2	60 ft	27,000 SF	54,000 SF
R-2	3	60 ft	21,000 SF	63,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

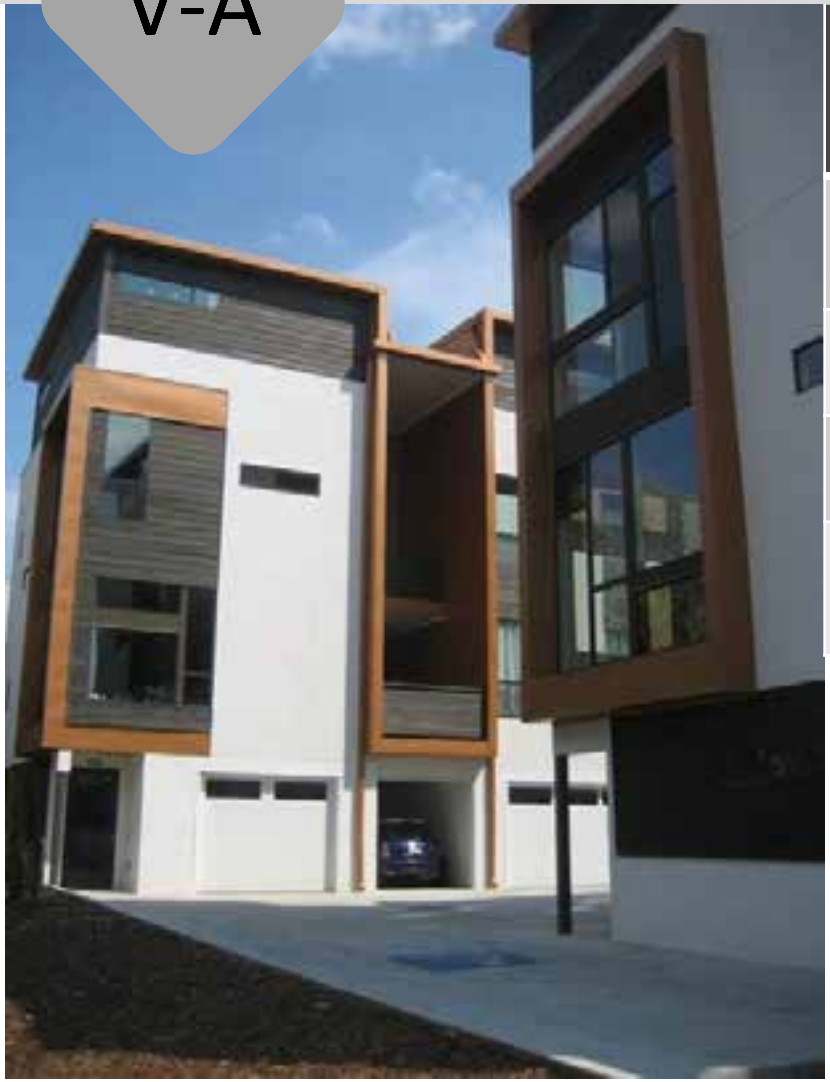
1-story retail and restaurants

2 to 3-story residential/office

No fire resistance ratings required

Type V-A Height and Area Limits

V-A



Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	3	70 ft	34,500 SF	103,500 SF
B	4	70 ft	54,000 SF	162,000 SF
M	4	70 ft	42,000 SF	126,000 SF
R-2	4	70 ft	36,000 SF	108,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

3 to 4-story residential/office

1-hour fire resistance rating required for most building elements

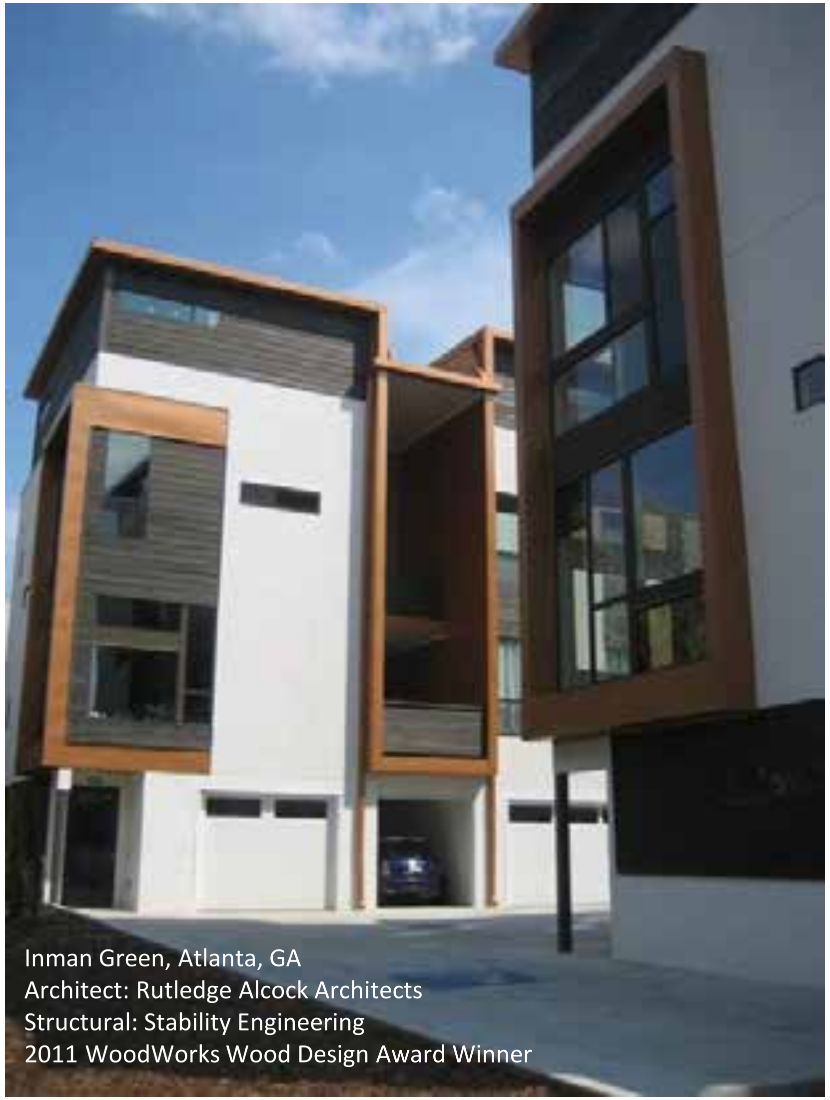
Walk-up/ Tuck Under

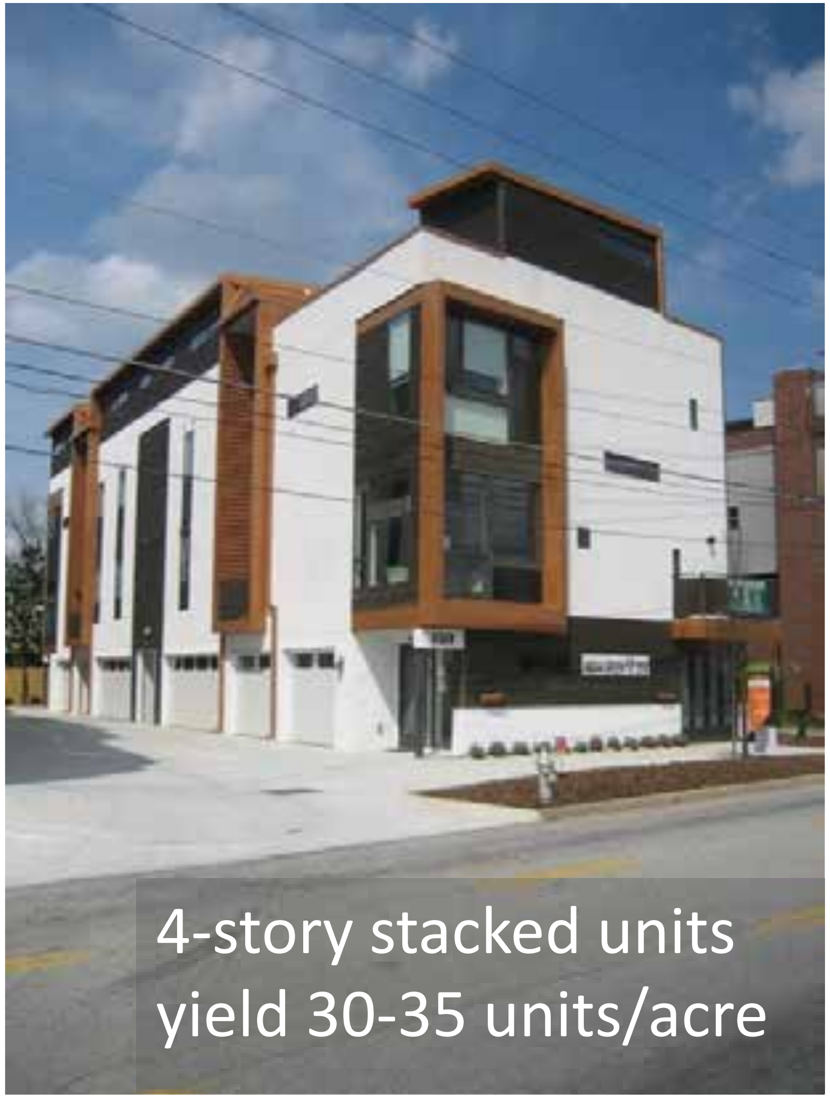
3-story Row-Houses (Type V) yield 20-30 units/acre

- No parking garage
- No major excavation
- All wood construction

Photos – Scott Breneman/WoodWorks

Walk-up/ Tuck Under





Type III Buildings

Multi-family

K-12/Higher Ed

Hospitality

Office

Type III-B Height and Area Limits

Credit: Lever Architecture

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	3	75 ft	28,500 SF	85,500 SF
B	4	75 ft	57,000 SF	171,000 SF
M	3	75 ft	37,500 SF	112,500 SF
R-2	5	75 ft	48,000 SF	144,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

4-story office / 5-story residential

2-hour fire resistance rating required for exterior bearing walls only (non combustible or FRT construction)

Type III-A Height and Area Limits

III-A

Credit: Christian Columbres

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	4	85 ft	42,000 SF	126,000 SF
B	6	85 ft	85,500 SF	256,500 SF
M	5	85 ft	55,500 SF	166,500 SF
R-2	5	85 ft	72,000 SF	216,000 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

5-story residential / 6-story office

2-hour rating for exterior bearing walls

1-hour rating for other building elements

Wrap-Around

5 story yields 60-80 units/acre

- No excavation
- Parking hidden
- Density still not maximized

Type IV Buildings

Residential / Mixed-Use

Higher Education

Office

IV

Type IV Height and Area Limits

Credit: John Staments

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	4	85 ft	45,000 SF	135,000 SF
B	6	85 ft	108,000 SF	324,000 SF
M	5	85 ft	61,500 SF	184,500 SF
R-2	5	85 ft	61,500 SF	184,500 SF

Stories/Heights/Areas include allowable increases for sprinklers, but exclude potential frontage increase

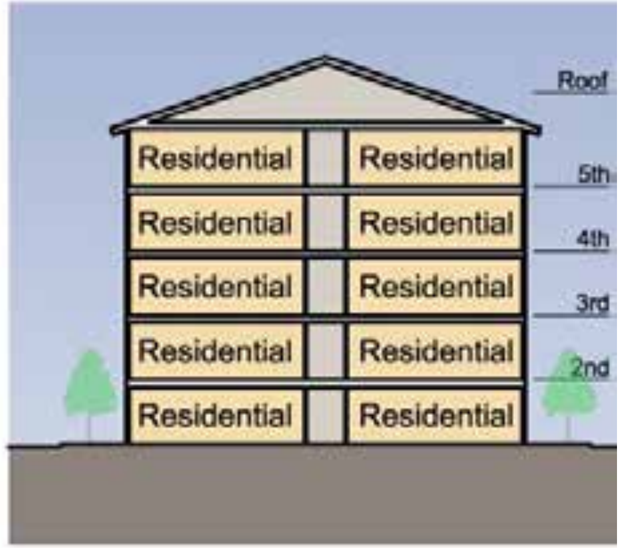
5-story residential / 6-story office

2-hour rating for exterior bearing walls

Interior elements must qualify as Heavy Timber

Podium

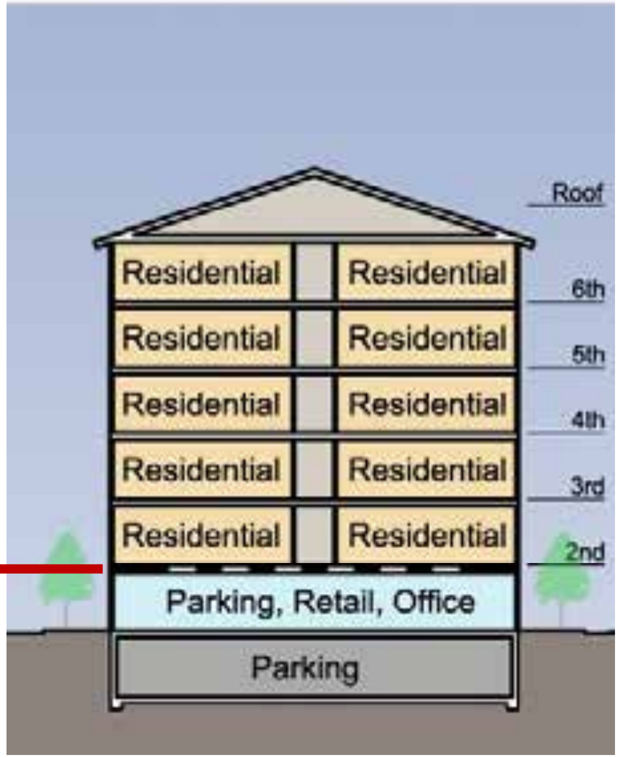
IBC Podium Provisions



5 story Type III Building

3Hr

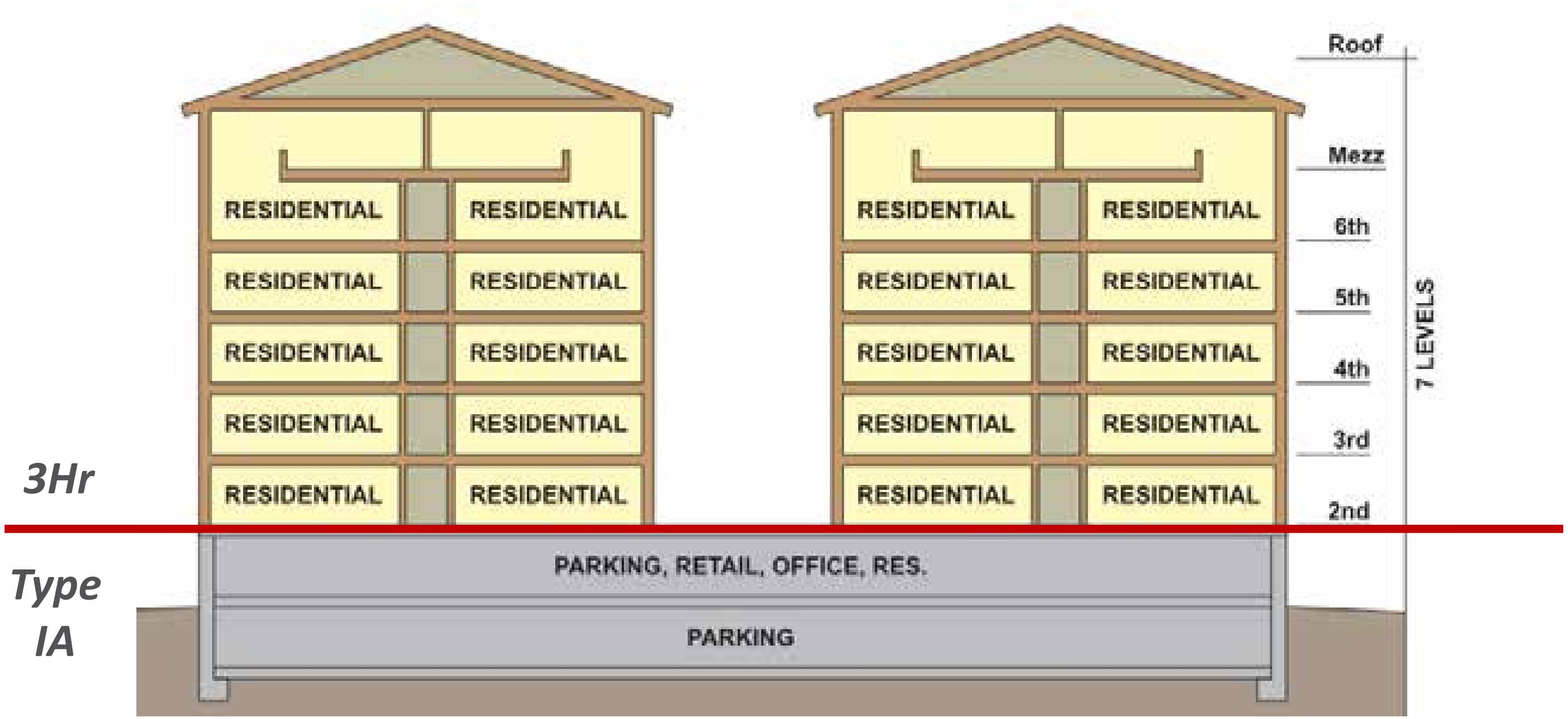
Type IA



5 story Type III Building
On Top of a Type IA Podium

See Special Provisions for Podiums in IBC 2012 510.2
Increases allowable stories… not allowable building height

IBC Podium Provisions



Multiple Buildings over one Podium
See Special Provisions for Podiums in IBC 2012 510.2

Podium Limits

Credit: Matt Todd & PB Architects

IBC	# of Podium Levels	Podium Occupancy
2009	1	S-2 Parking
2012	1	A, B, M, R or S-2 Parking
2015	Multi-story	Any except H
2018	Multi-story	Any except H

3-hour building separation

Pushing light-framed wood to the limits of code allowed heights

4 over 1 Podium

- 60-80 units/acre
- Max for Type V

Inman Park Condos, Atlanta, GA
Architect: Brown Doane Architects, Inc.
Structural: Davis & Church, LLC

5 over 1 Podium

- 100-120 units/acre

Inman Park Condos, Atlanta, GA
Architect: Brown Doane Architects, Inc.
Structural: Davis & Church, LLC

AvalonBay Stadium, Anaheim, CA
Architect: Withee Malcom Architects
Structural: VanDorpe Chou Associates

5 over 1 Podium with Mezzanine

- 125-145 units/acre
- Residential units below podium

120 Union, San Diego, CA
Togawa Smith Martin

Spartan Village, UNC Greensboro, NC

Lord, Aeck & Sargent Architecture
TFF Architects & Planners

"We assumed that wood framing would be a little less expensive, but actually found it gave us significant cost advantages. We saved $15 per square foot—which, for a 385,000-square-foot project, is a lot of savings"

Raymond Hunt
– EDC Development Management

Emory Point, Dekalb Co., GA

3 buildings

- Luxury Apartments, retail, restaurants
- (2) 4 stories of wood over 1 story concrete podium
- (1) 5 story Type III wood frame over slab on grade

Architects: Cooper Carry & The Preston Partnership

Photo : Gables Residential

Emory Point, Dekalb Co., GA

Architects: Cooper Carry & The Preston Partnership   Photo: Aerial Photography Inc.

Galt Place Apartments, Galt, CA

Mixed Use Residential
Over Retail and Parking

Applied Architecture, Inc.
Michael Malinowski

Crescent Terminus, Buckhead, Atlanta

Crescent Terminus, Buckhead, Atlanta

Crescent Terminus, Buckhead, Atlanta

Architect: Lord Aeck Sargent
Structural: SCA Consulting Engineers
Photos: Richard Lubrant

Crescent Terminus, Buckhead, Atlanta

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Marselle Condos, Seattle, WA

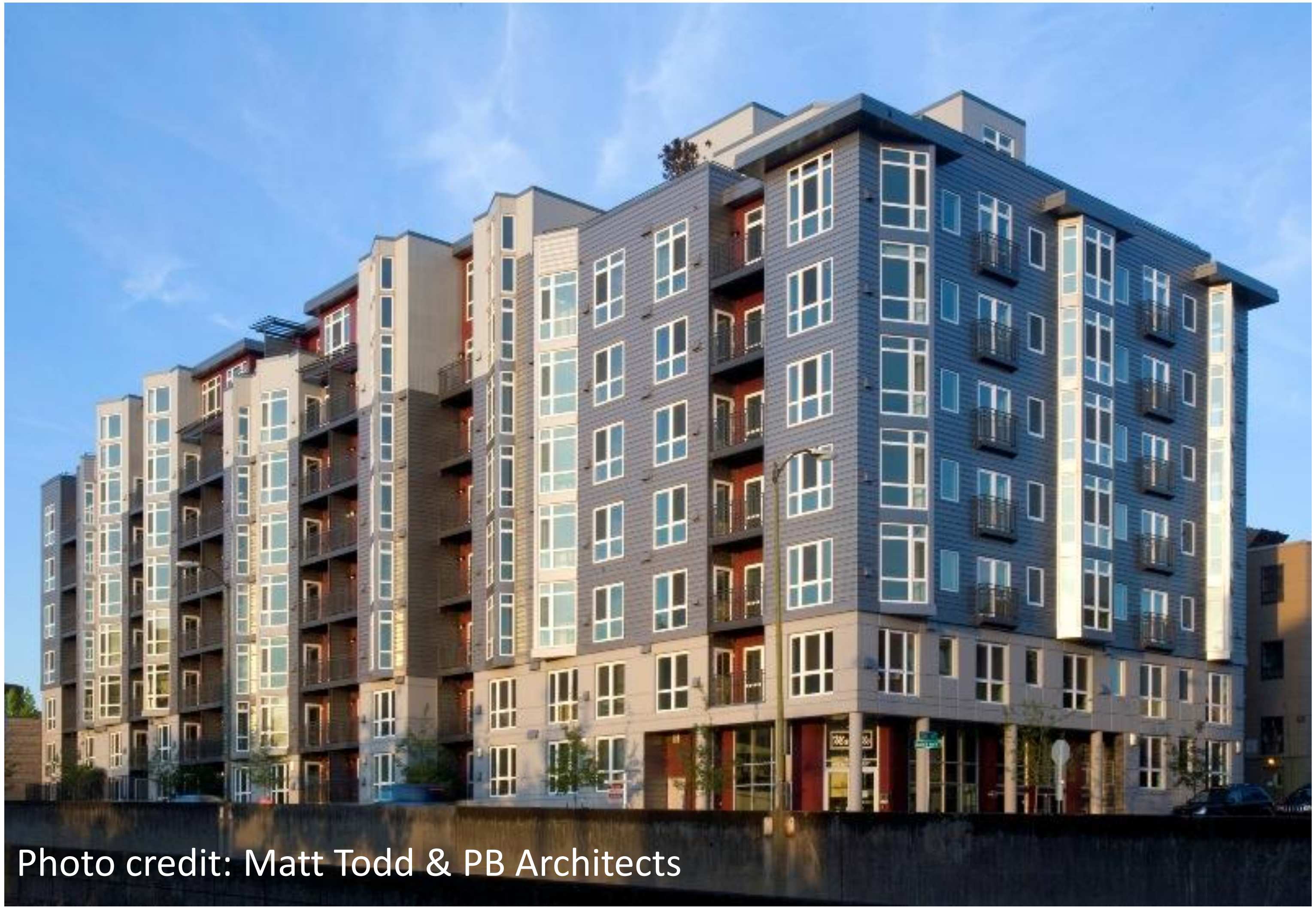


Photo credit: Matt Todd & PB Architects

Marselle Condos, Seattle, WA

Bullitt Center, Seattle, WA

Photos © Nick Lehoux for the Bullitt Center

Bullitt Center, Seattle, WA

Renderings: Miller Hull Partnership

Architect: Miller Hull Partnership
Living Building Challenge Building
Completed 2013

Tall Wood Overview

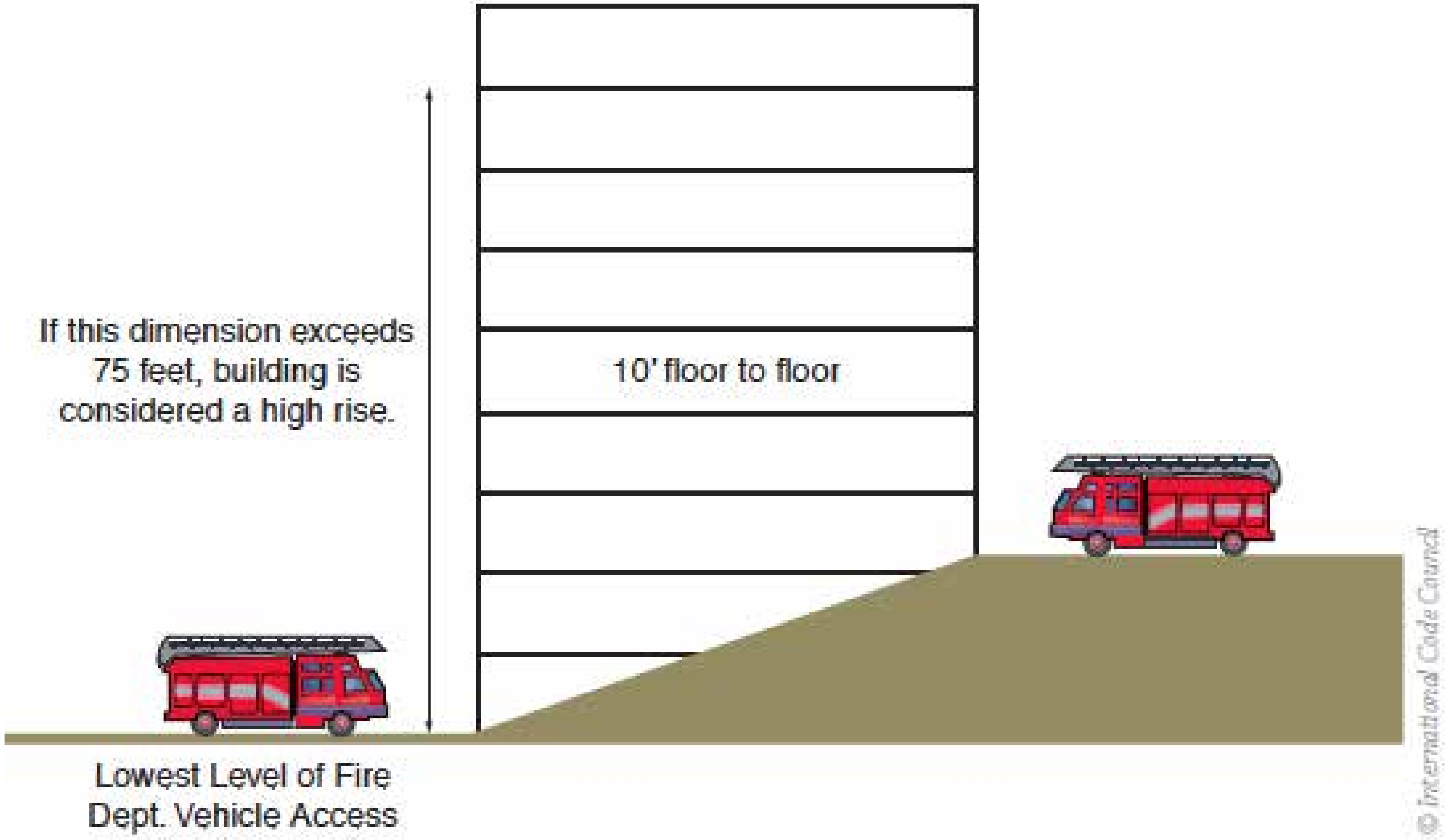
Defining Tall Wood

Precedence/Context

Motivation and Benefit

Execution Under U.S. Code

Mid-Rise vs. High-Rise Definition – IBC 202



Determination of high-rise building

Butler Brothers Building, Minneapolis MN

Built 1906 - 9 stories - 500,000 s.f.

Butler Square today…

Renovated 1974
9 Stories, 500,000 sf

Momentum Starts With a Disruption

Mass Timber Building Systems

Post and Beam

Light Frame

Mass Timber

Mass Timber Products

Nail-Laminated Timber (NLT)

Cross-Laminated Timber (CLT)

Glue-Laminated Timber (GLT)

Dowel-Laminated Timber (CLT)

Image source: StructureCraft

T3 Minneapolis

Minneapolis, MN

Image Credit: Michael Green Architects/Hines Group

T3 Minneapolis

Minneapolis, MN

Type IV Construction
7 stories (6 Timber on 1 Concrete)
234,000 sf
2x8 NLT Floor Panels w/3” Concrete Topping
Glulam Beam and Column Frame
20’x25’ Grid

T3 Minneapolis

Minneapolis, MN

Image Credit: Ema Peter

Overview

Defining Tall Wood

Precedence/Context

Motivation and Benefit

Execution Under U.S. Code

Disruption Causes a Ripple

Tall Wood Projects

Murray Grove
London, United Kingdom
8 Stories
2009

Forté
Melbourne, Australia
10 Stories
2012

TREET
Bergen, Norway
14 Stories
2015

Brock Commons
Vancouver, Canada
18 Stories
2017

HoHo
Vienna, Austria
24 Stories
2017

Source: ThinkWood

2009
MURRAY GROVE
STADTHAUS
LONDON, UK
9 STORIES

Architect:Waugh Thisleton Architects
Photo Credit:

2013

FORTE'

MELBOURNE, AUSTRALIA

10 STORIES

DESIGN BUILDER: Lend Lease
Photo Credit: Lend Lease

ARCHITECT: Artec
ENGINEER: Sweco

2015

TREET APARTMENTS,
BERGEN, NORWAY
14 STORIES
173 FT
~63K SQ.FT.

Source: Toward Taller Wood Buildings Symposium 2014

Brock Commons

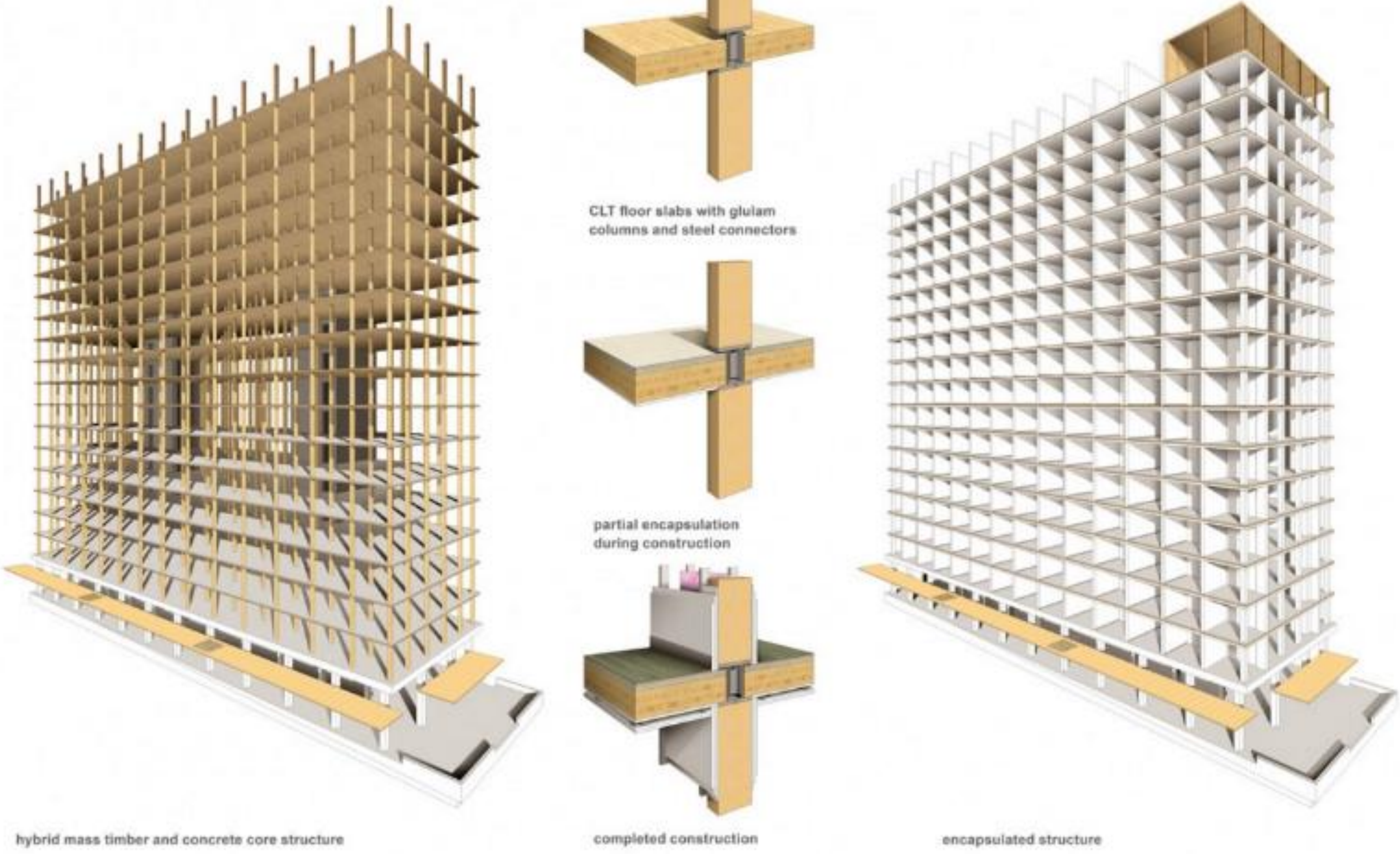
Vancouver, BC

- Completed Fall 2017
- 18 Stories
- 174 FT
- 156,000 SQ.FT.

Photo credit: Acton Ostry Architects

Brock Commons

Vancouver, BC



- 5-ply CLT panels, 2-way span
- ~9’X13’ column grid

Photo credit: Acton Ostry Architects

Brock Commons

Vancouver, BC

Brock Commons

Vancouver, BC

- 17 stories of timber installation
- Started
  - June 6, 2016
- Finished
  - August 10, 2016

Brock Commons

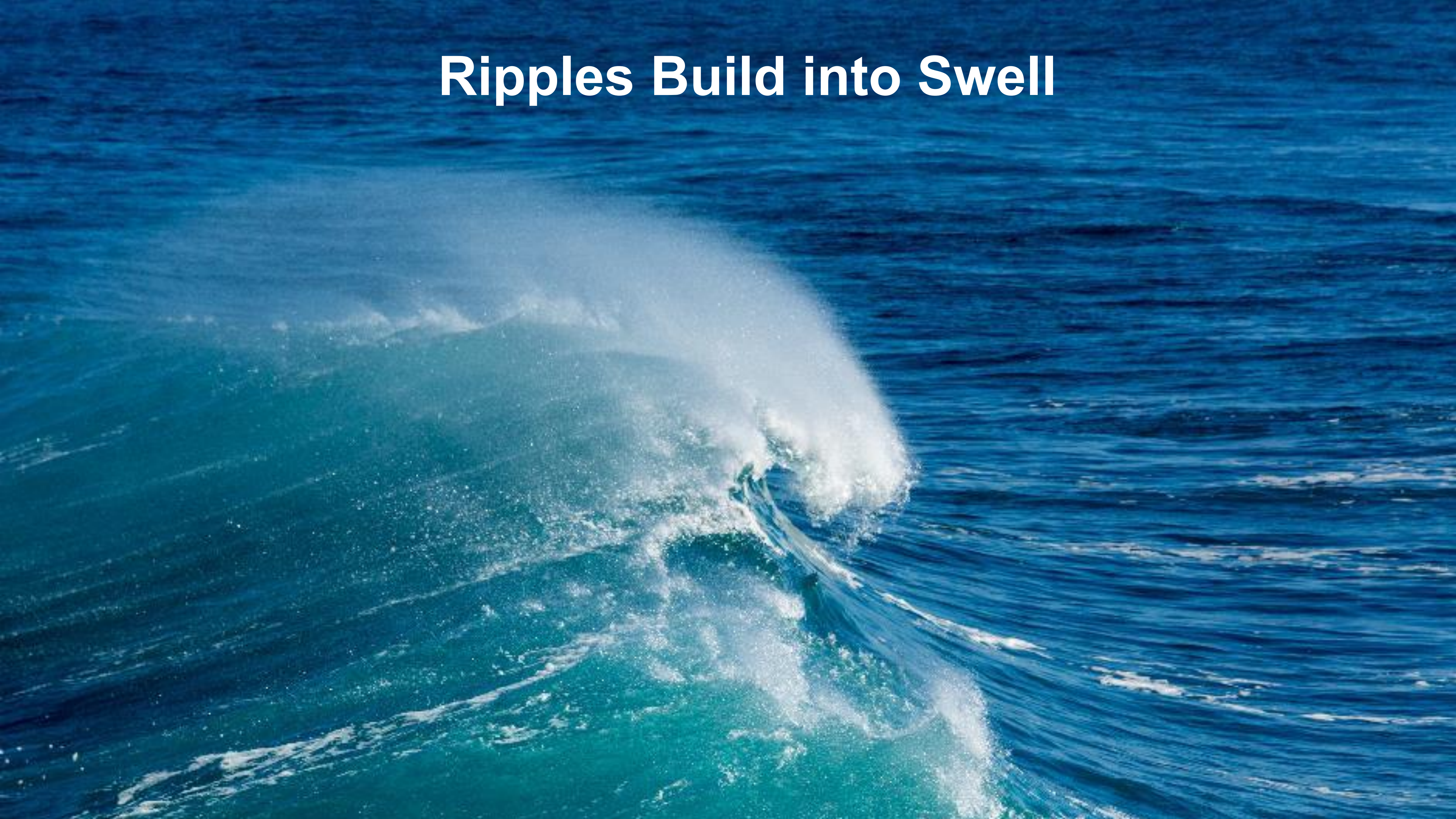
Overview

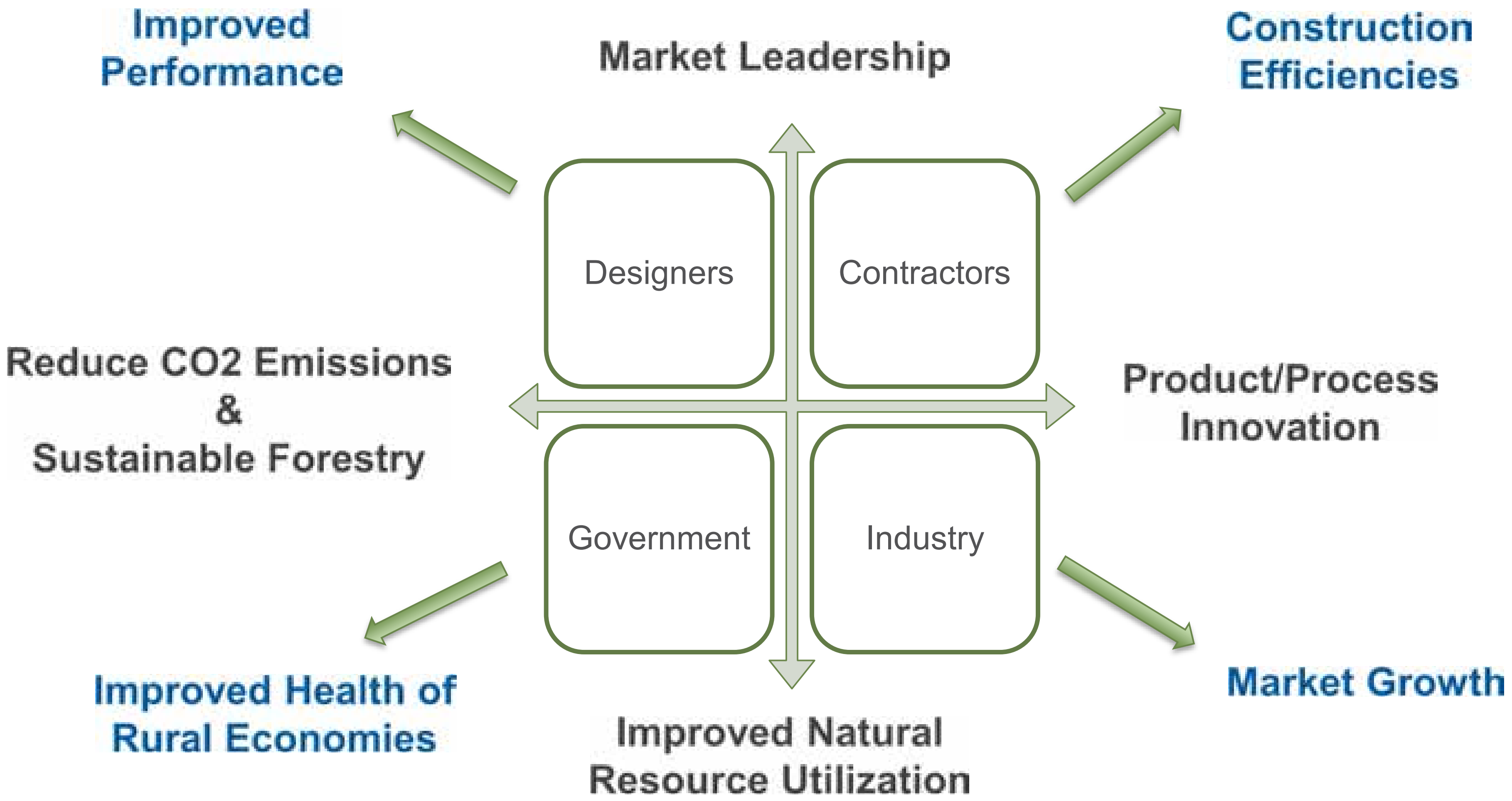
Defining Tall Wood

Precedence/Context

Motivation and Benefit

Execution Under U.S. Code

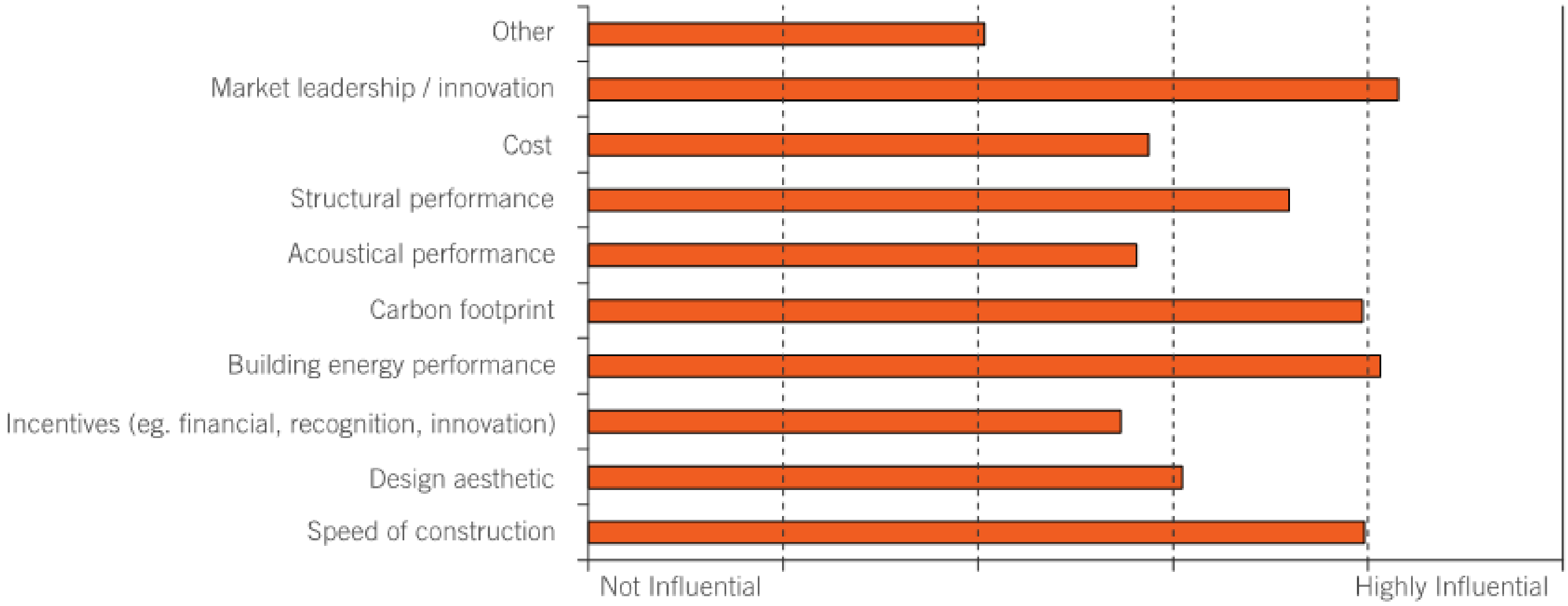

Ripples Build into Swell


Improved Performance
Market Leadership
Construction Efficiencies
Designers
Contractors
Reduce CO2 Emissions & Sustainable Forestry
Product/Process Innovation
Government
Industry
Improved Health of Rural Economies
Improved Natural Resource Utilization
Market Growth

Tall Wood Motivators – Design Team

Design Team: Online Questionnaire Participant Responses

Influential Factors on the Design Team's Decision to Use Structural Wood Technology:

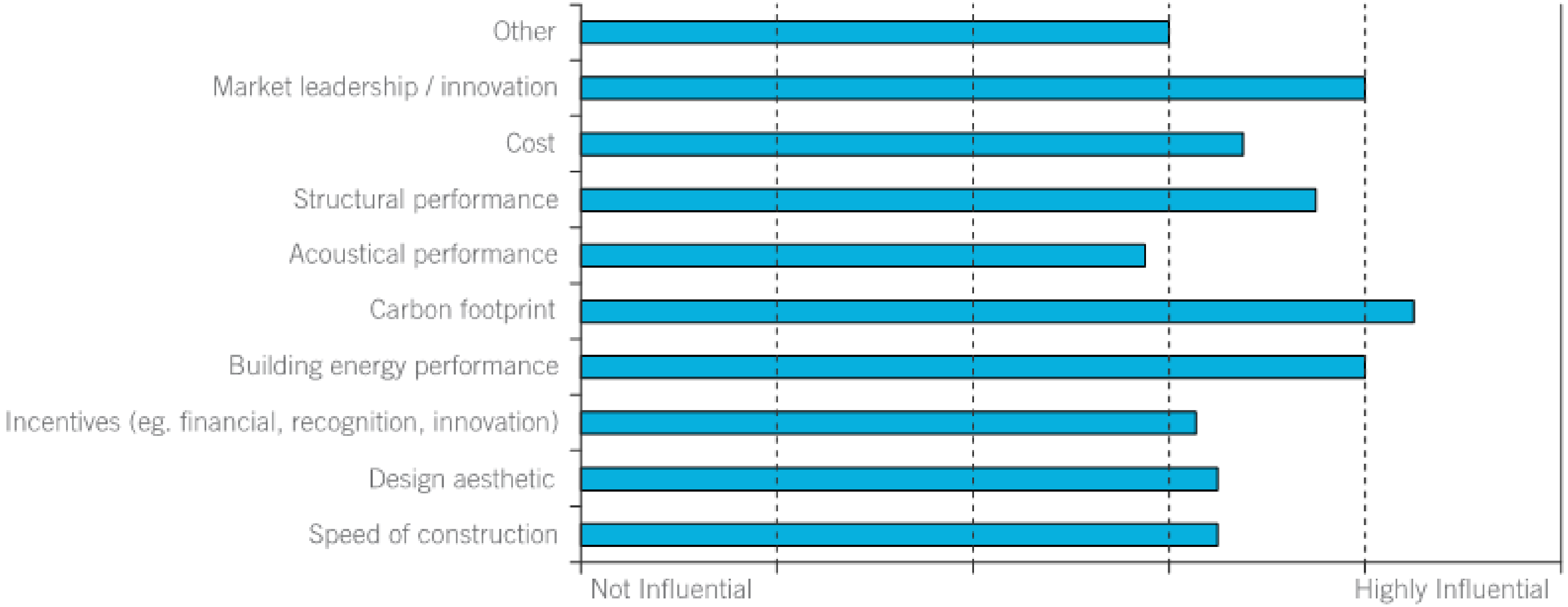


Source: Survey of International Tall Wood Buildings, 2014

Tall Wood Motivators – Owner/Developer

Owner/Developer: Online Questionnaire Participant Responses

Influential Factors on the Owner / Developer's Decision to Use Structural Wood Technology:



Source: Survey of International Tall Wood Buildings, 2014

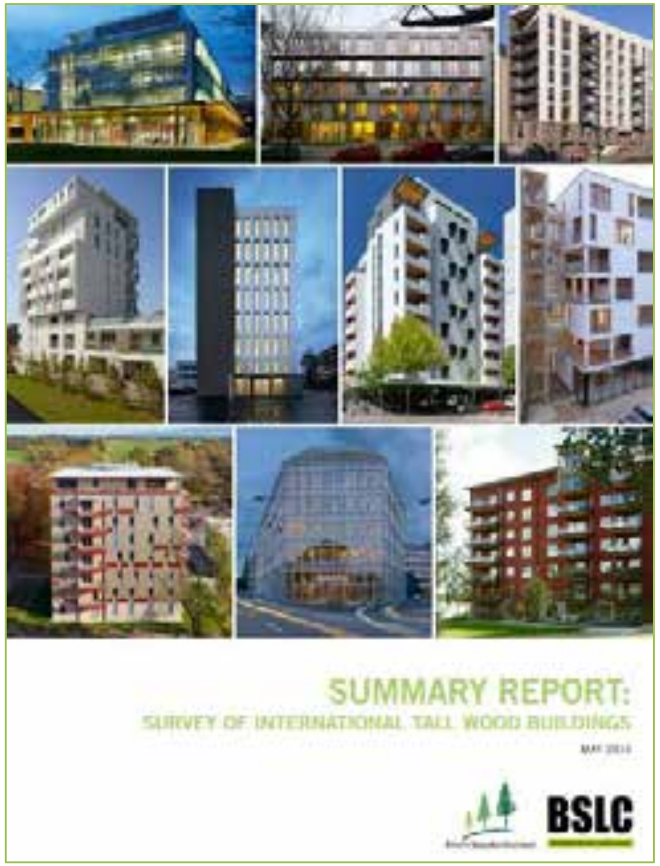
Tall Wood Motivators

Primary Motivators

- Market Leadership
- Aesthetic
- Carbon Reduction
- Schedule

Secondary Motivators

- Structural Performance
  - Light weight
- Speed of Construction

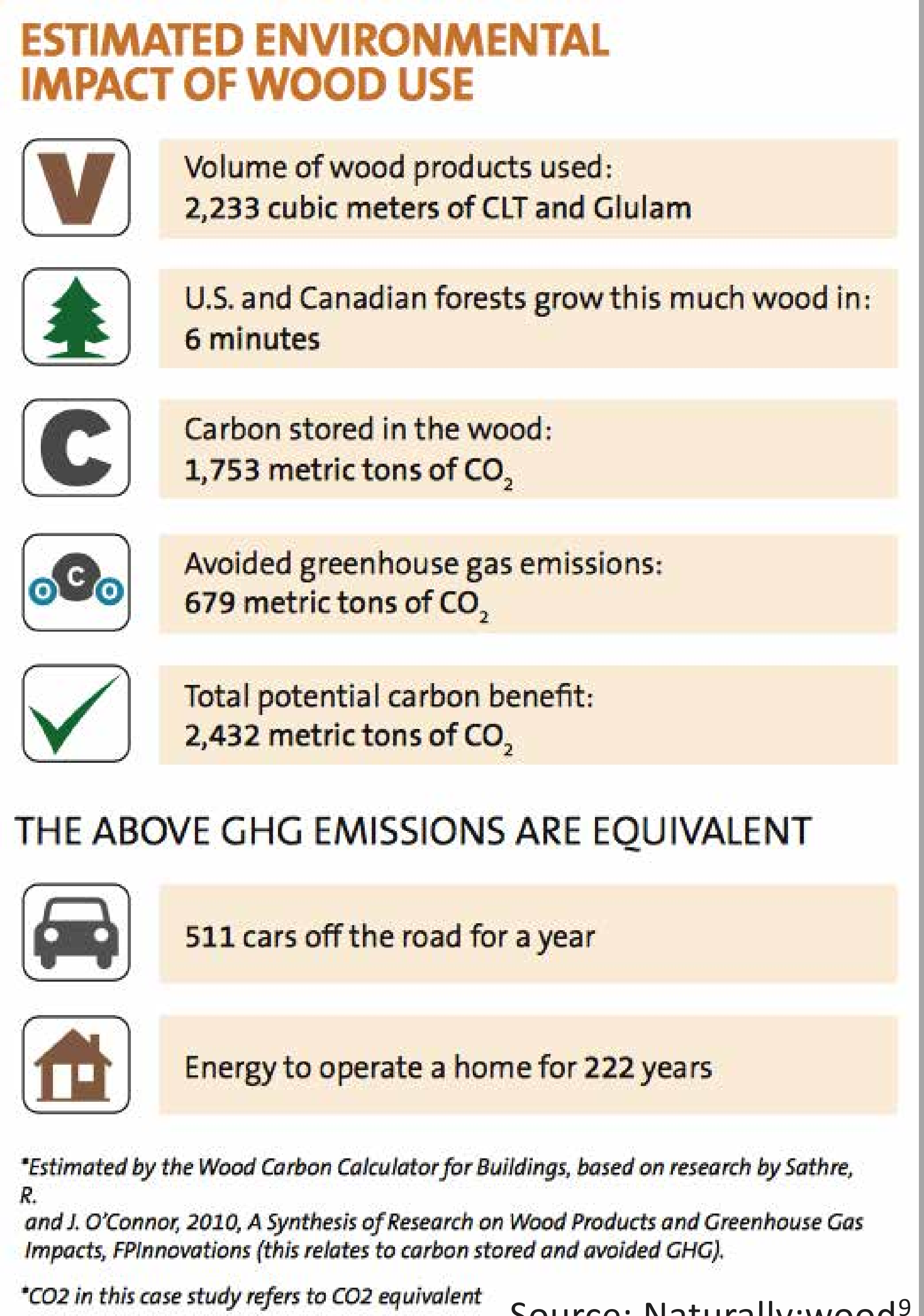


Source: Survey of International Tall Wood Buildings, 2014

Aesthetics

ARCHITECT: Michael Green Architecture
ENGINEER: Equilibrium Engineering
PHOTO CREDIT:

Carbon Reductions



Source: Naturally:wood[9]

Brock Commons, Vancouver, BC

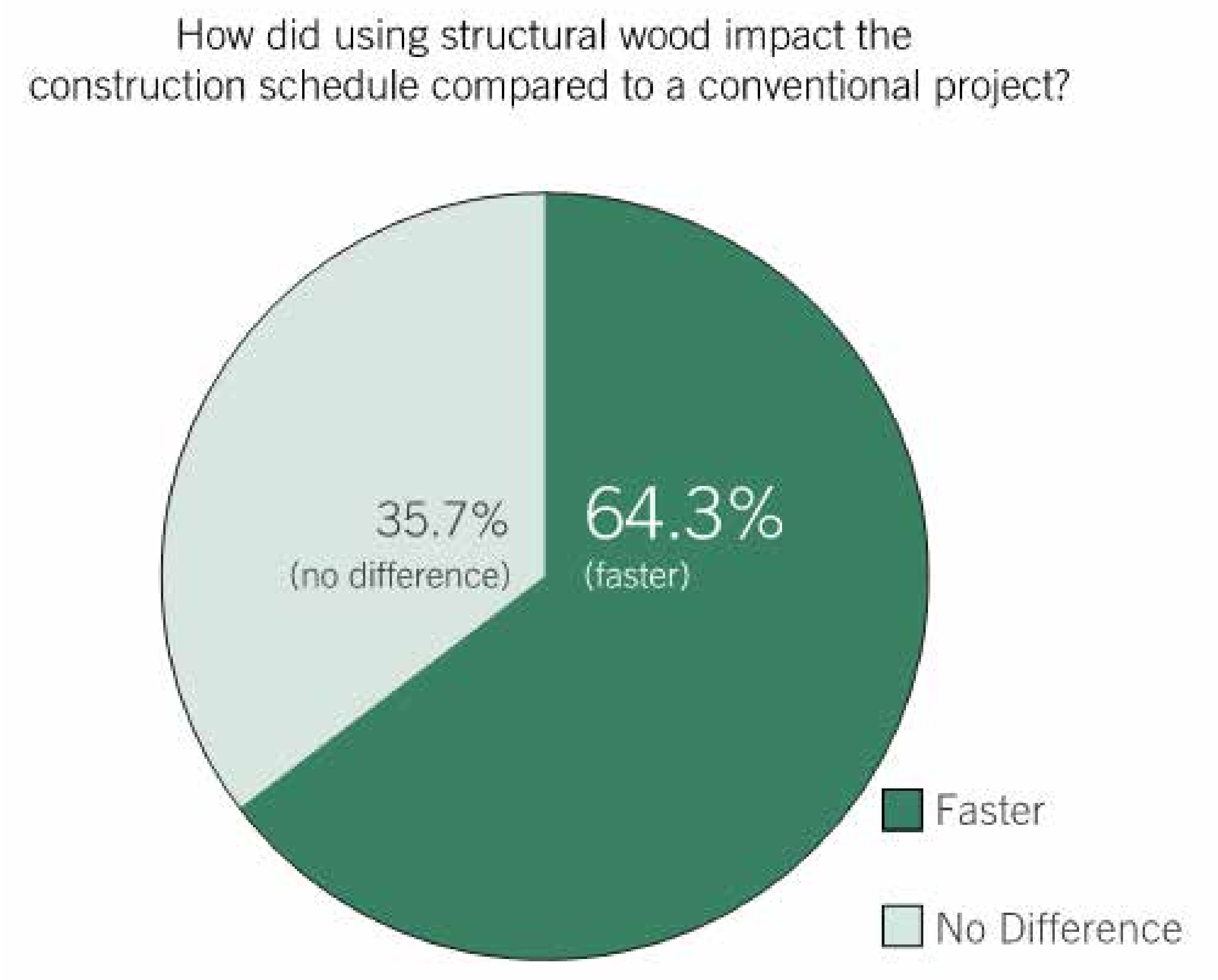
Photo credit: Acton Ostry Architects

Mass Timber Appeal

Reduced Construction Time

Forte time lapse video

Speed of Construction



Source: Survey of International Tall Wood Buildings, 2014

Speed of Construciton - Time is Money

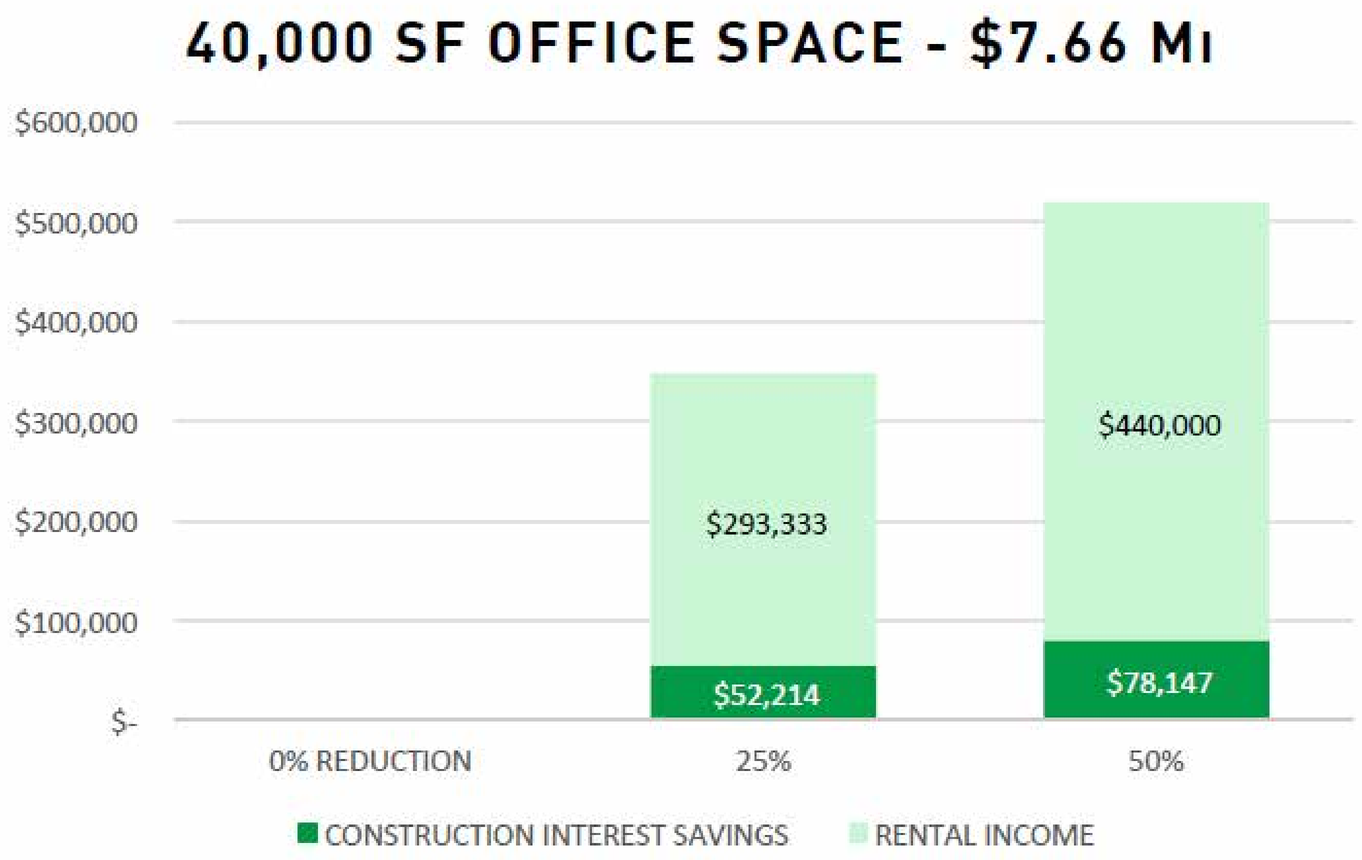


Figure 26

Pro-Formas include a cost reduction in terms of a 25% and 50% faster build time. The lease rate information assumes a 100% building occupancy to reflect the possible savings.

Source: Solid Wood Construction: Process Practice Performance, Smith, Griffin Rice, 2015

Mass Timber Appeal

Material Mass

75% lighter weight than concrete

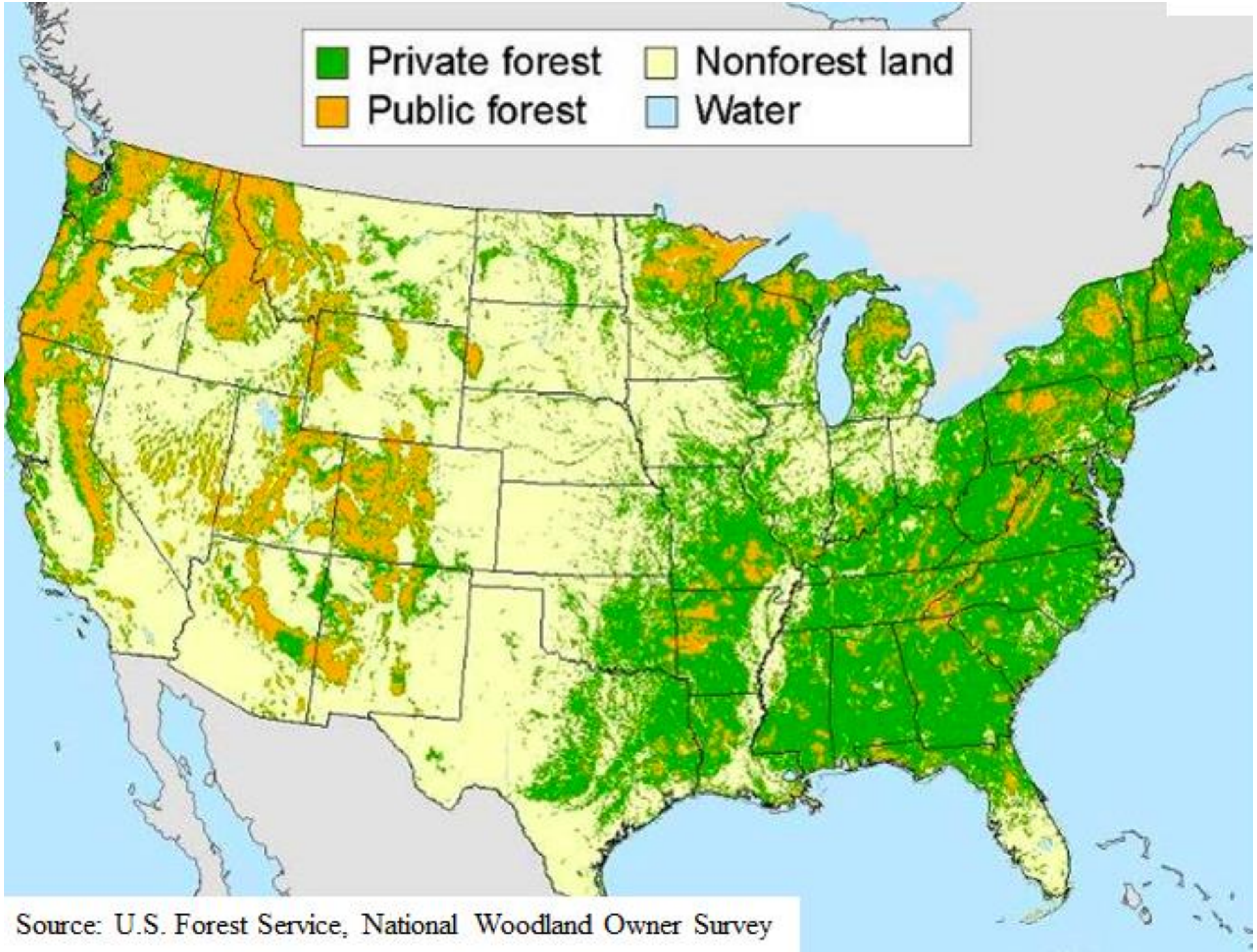
Mass Timber Appeal

Material Mass

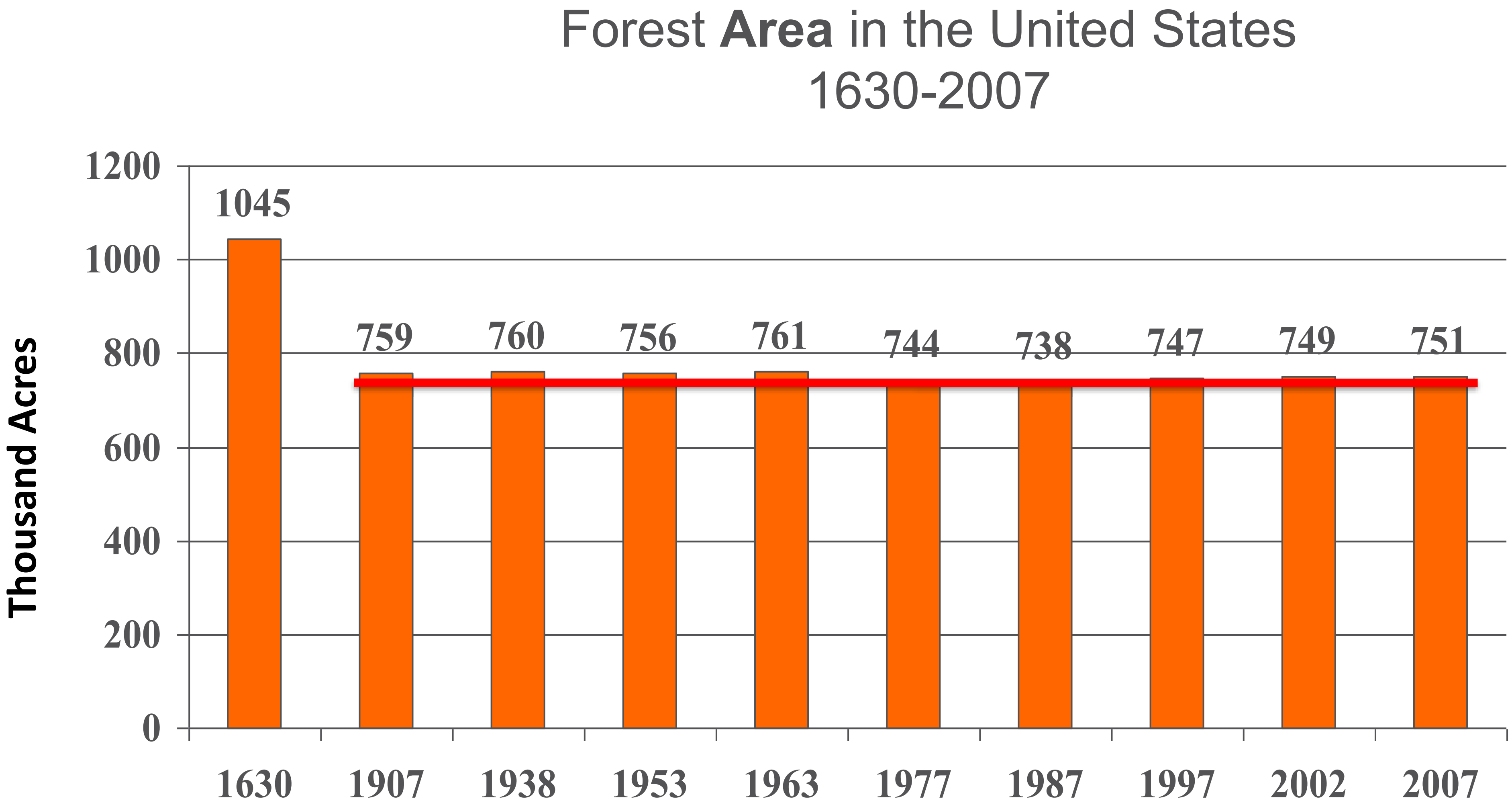
Forte', Victoria Harbor, Melbourne, Australia
Architect: Lend Lease

Completed in 2012
10 stories
~ 105 ft. tall, > 18.6 K sqft.
3 million in R&D
Poor soils required a much lighter building

US Forest Lands

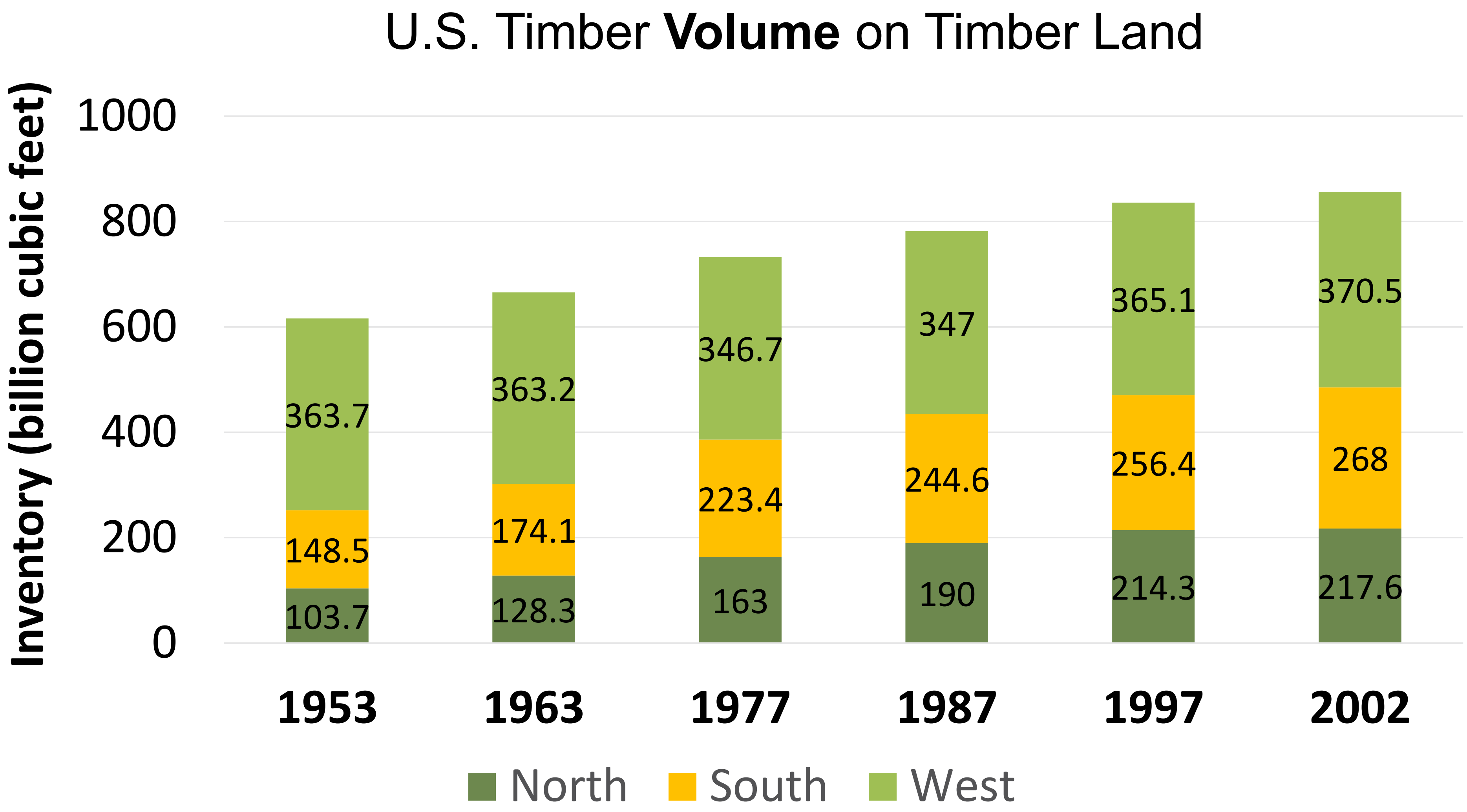


U.S. Forest Land



Source: USDA-Forest Service, General Technical Report WO-78. (2009).

U.S. Forest Land



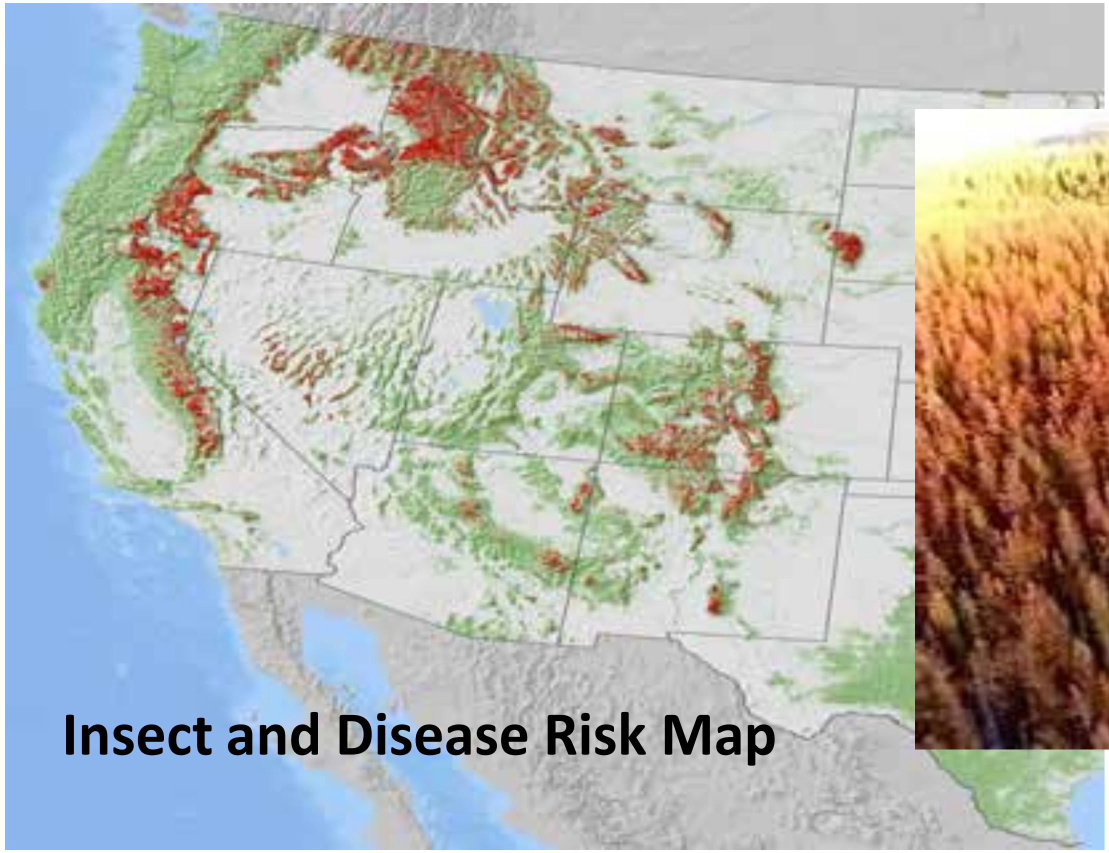
Source: USDA-Forest Service, US Forest Resource Facts and Historical Trends FS-801. (2004).

Western U.S. Wild Fire Epidemic

- Fire readiness and suppression has gone from 20% of the FS budget in 2001 to 52% in 2015.
- It is not uncommon to spend $1 million per hour fighting fires.

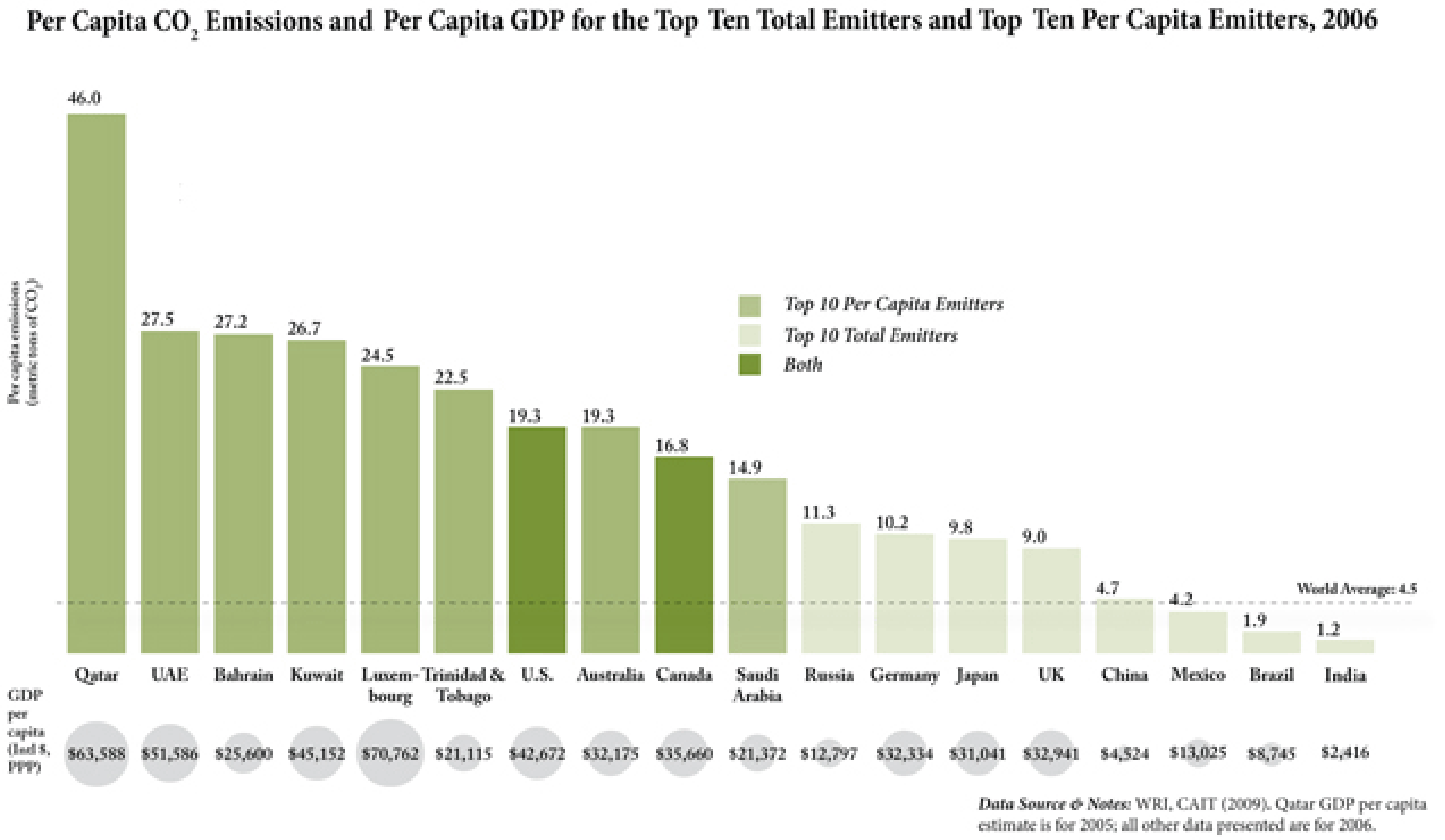
Source: US Forest Service – http://www.fs.fed.us/about-agency/budget-performance/cost-fire-operations

Inter-Mountain West Insect Devastation



Source: IDS- Insect and Disease Survey
USDA Forest Health Protection

U.S Contribution to World Emissions



Rural Economy Benefits

Overview

Defining Tall Wood

Precedence/Context

Motivation and Benefit

Execution Under U.S. Code

- Acoustics
- Structure
- Fire

Mass Timber Products

IBC

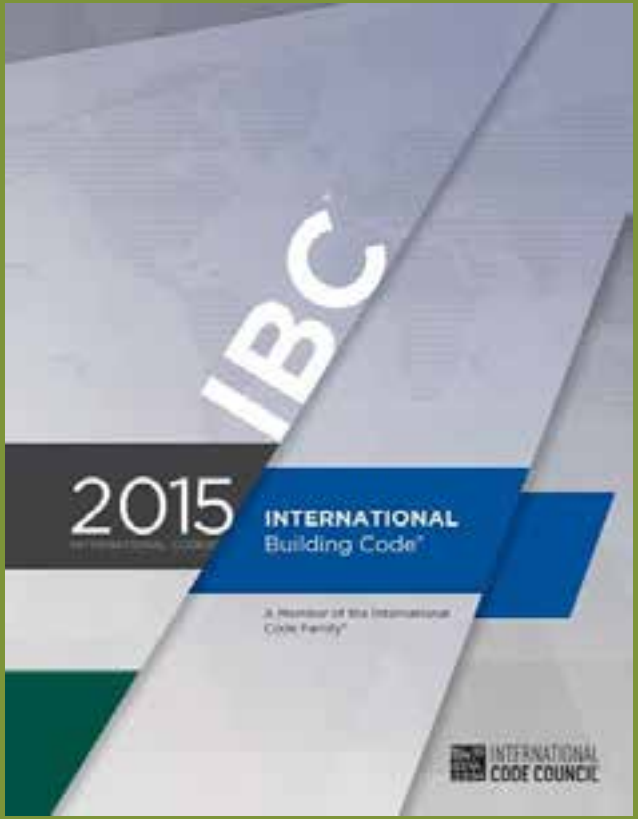
NLT / DLT*

- Recognized in IBC 2304.8.3 (mechanically laminated decking)

CLT / MPP

- In 2015 IBC, CLT is now defined in Chapter 2 Definitions
- And is referenced in Chapter 23:

2303.1.4 Structural glued cross-laminated timber. Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.



Acoustics

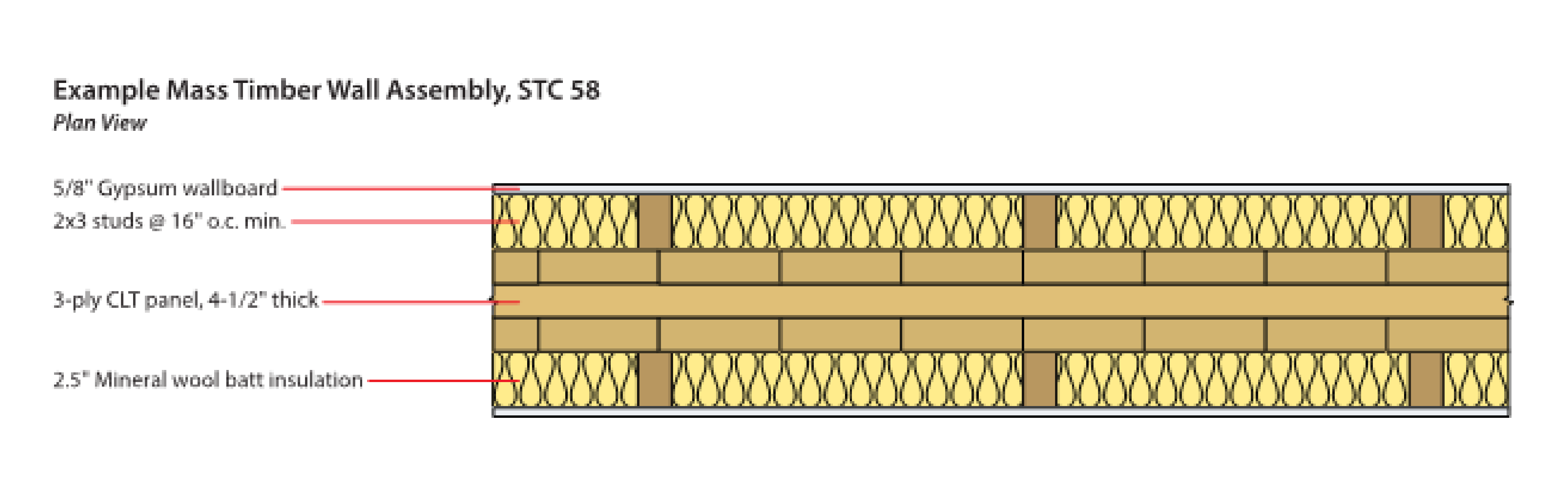
Common floor assembly:

- Finish floor (if applicable)
- Underlayment (if applicable)
- 1.5” to 3” thick concrete/gypcrete topping
- Acoustical mat
- Mass timber floor panels

Image credit: AcoustiTECH

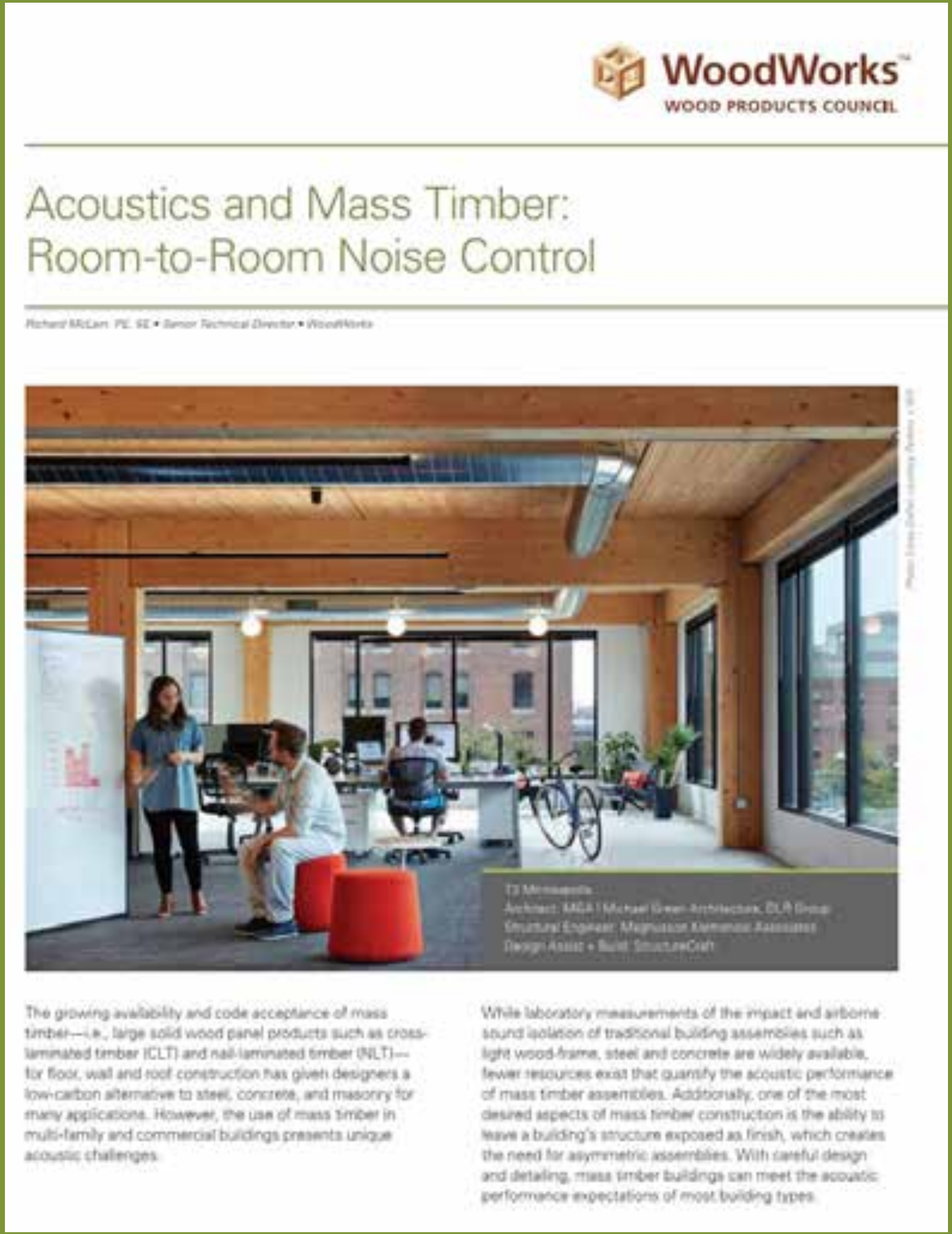
Acoustics

FIGURE 3:
Interior CLT partition wall with chase walls on both sides



Source: US CLT Handbook

Acoustics



WoodWorks™
WOOD PRODUCTS COUNCIL

Acoustics and Mass Timber:
Room-to-Room Noise Control

Richard McLain, PE, SE • Senior Technical Director • WoodWorks

T3 Minneapolis
Architect: MGA | Michael Green Architecture, DLR Group
Structural Engineer: Magnusson Klemencic Associates
Design Assist + Build: StructureCraft

The growing availability and code acceptance of mass timber—i.e., large solid wood panel products such as cross-laminated timber (CLT) and nail-laminated timber (NLT)—for floor, wall and roof construction has given designers a low-carbon alternative to steel, concrete, and masonry for many applications. However, the use of mass timber in multi-family and commercial buildings presents unique acoustic challenges.

While laboratory measurements of the impact and airborne sound isolation of traditional building assemblies such as light wood-frame, steel and concrete are widely available, fewer resources exist that quantify the acoustic performance of mass timber assemblies. Additionally, one of the most desired aspects of mass timber construction is the ability to leave a building's structure exposed as finish, which creates the need for asymmetric assemblies. With careful design and detailing, mass timber buildings can meet the acoustic performance expectations of most building types.

New WoodWorks – Wood Solutions Paper

Acoustics and Mass Timber:
Room-to-Room Noise Control

Structural Design

EOTA
European Organisation for Technical Assessment

ICC ES

APA
PRODUCT REPORTS

CCMC
Canadian Construction Materials Centre

CLT HANDBOOK

NDS®
National Design Specification® for Wood Construction
2015 EDITION

State of Oregon
Building Codes Division
Better Buildings for Oregon

Statewide Alternate Method
January 2015

No. 15-01
Cross-Laminated Timber Provisions
(Ref.: ORS 455.060)

Mass Timber Design

Lateral Framing Systems

Central Core –
Concrete Shearwalls

Photo Credit: StructureCraft

Mass Timber Design

Lateral Framing Systems

Interior Steel Moment Frame

Photo Credit: WoodWorks

Mass Timber Design

Lateral Framing Systems

Steel Braced Frame

Photo Credit: John Stamets

Mass Timber Design

Lateral Framing Systems

Timber Braced Frame

Photo Credit: Alex Schreyer

Mass Timber Design

Lateral Framing Systems

Interior Wood Shearwalls

Photo Credit: WoodWorks

Mass Timber Design

Lateral Framing Systems

Central core:
Mass Timber Shearwalls

Photo Credit: Alex Schreyer

Code Compliance Pathway – ASCE 7-10

12.2 STRUCTURAL SYSTEM SELECTION

12.2.1 Selection and Limitations

Seismic force-resisting systems not contained in Table 12.2-1 are permitted provided analytical and test data are submitted to the authority having jurisdiction for approval that establish their dynamic characteristics and demonstrate their lateral force resistance and energy dissipation capacity to be equivalent to the structural systems listed in Table 12.2-1 for equivalent values of response modification coefficient, R, overstrength factor, Ω_0, and deflection amplification factor, C_d.

EQUIVALENCY

1.3.1.3 Performance-Based Procedures

Structural and nonstructural components and their connections shall be demonstrated by analysis or by a combination of analysis and testing to provide a reliability not less than that expected for similar components designed in accordance with the Strength Procedures of Section 1.3.1.1 when subject to the influence of dead, live, environmental, and other loads. Consideration shall be given to uncertainties in loading and resistance.

1.3.1.3.1 Analysis Analysis shall employ rational methods based on accepted principles of engineering mechanics and shall consider all significant sources of deformation and resistance. Assumptions of stiffness, strength, damping, and other properties of components and connections incorporated in the analysis shall be based on approved test data or referenced Standards.

1.3.1.3.2 Testing Testing used to substantiate the performance capability of structural and nonstructural components and their connections under load shall accurately represent the materials, configuration, construction, loading intensity, and boundary conditions anticipated in the structure. Where an approved industry standard or practice that governs the testing of similar components exists, the test program and determination of design values from the test program shall be in accordance with those industry standards and practices. Where such standards or practices do not exist, specimens shall be constructed to a scale similar to that of the intended application unless it can be demonstrated that scale effects are not significant to the indicated performance. Evaluation of test results shall be made on the basis of the values obtained from not less than 3 tests, provided that the deviation of any value obtained from any single test does not vary from the average value for all tests by more than 15%. If such deviaton from the average value for any test exceeds 15%, then additional tests shall be performed until the deviation of any test from the average value does not exceed 15% or a minimum of 6 tests have been performed. No test shall be eliminated unless a rationale for its exclusion is given. Test reports shall document the location, the time and date of the test, the characteristics of the tested specimen, the laboratory facilities, the test configuration, the applied loading and deformation under load, and the occurrence of any damage sustained by the specimen, together with the loading and deformation at which such damage occurred.

1.3.1.3.3 Documentation The procedures used to demonstrate compliance with this section and the results of analysis and testing shall be documented in one or more reports submitted to the authority having jurisdiction and to an independent peer review.

1.3.1.3.4 Peer Review The procedures and results of

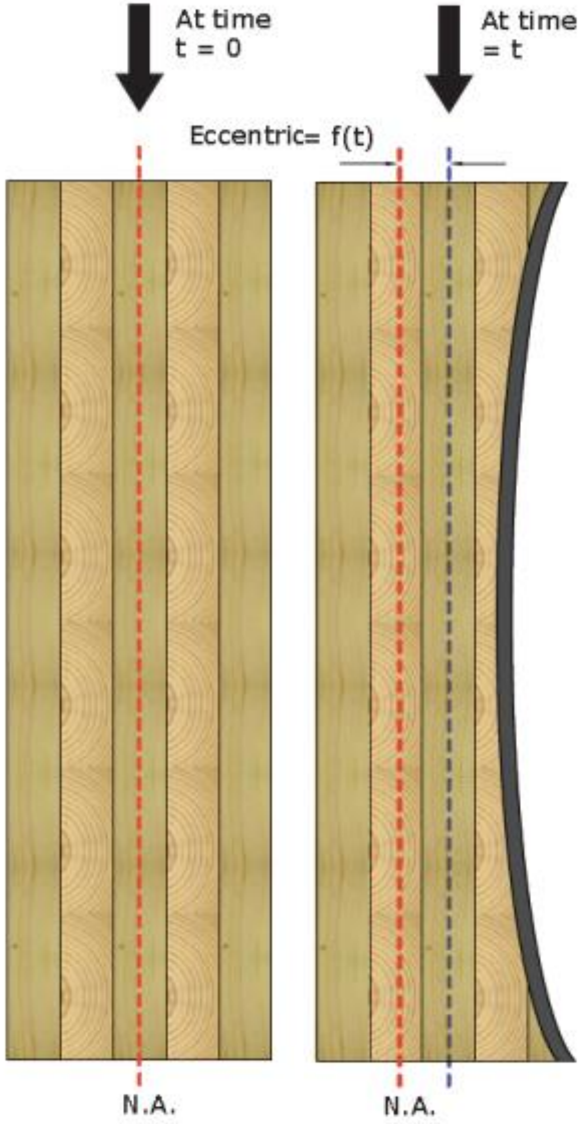
Authoritative Documents – eg. ASCE 41-13

Fire Resistance

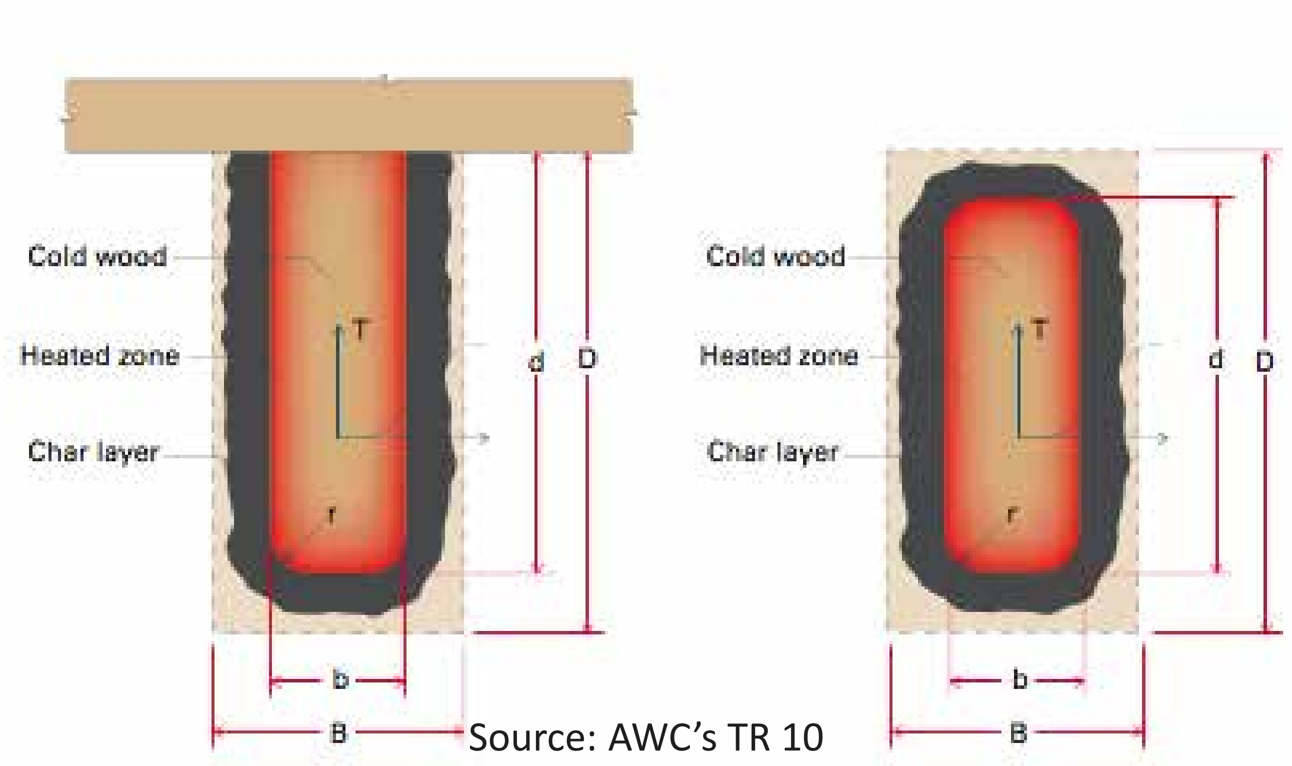
Photo Credit: FP Innovations

Mass Timber Design

Fire Resistance



Similar to heavy timber, mass timber products have inherent fire resistance properties

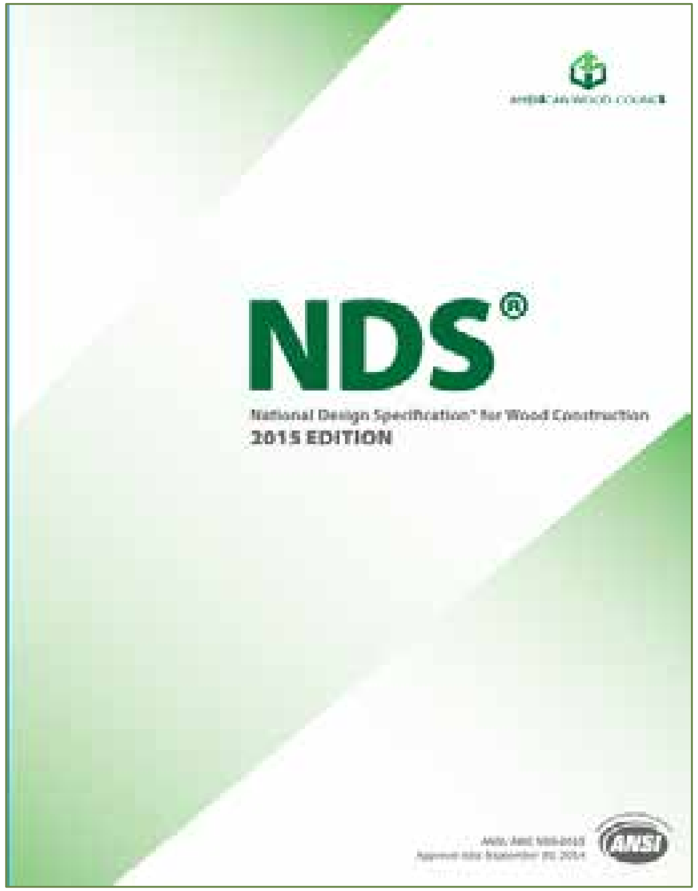


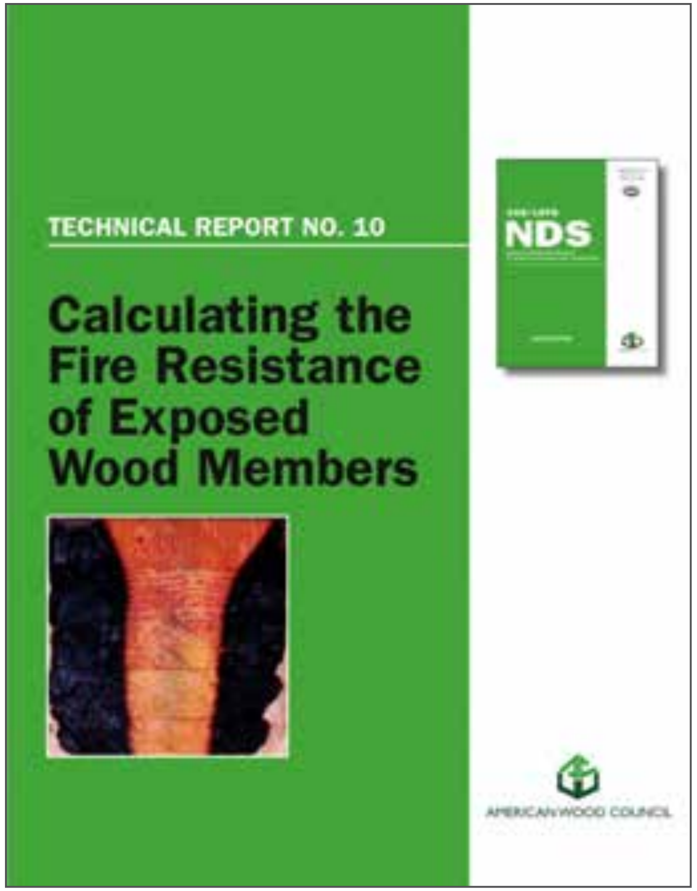
Source: AWC's TR 10

Mass Timber Design

Fire Resistance

For Exposed Wood Members: IBC 722.1 References AWC's NDS Chapter 16 (AWC's TR 10 is a design aid to NDS Chapter 16)





Mass Timber Design

Fire Resistance

Several successful CLT fire tests have been conducted, both with and without gypsum board protection

D.R. Johnson Passes Two Critical Tests for Safety of its Cross-Laminated Timber Panels – Flame Spread and Fire Resistance

Results are "a first" for CLT manufactured in North America, says expert

RIDDLE, Ore. (August 9, 2016) – D.R. Johnson Wood Innovations, the nation's first certified U.S. manufa
has become the first North American CLT manufacturer to achieve significant fire safety requirements
flame spread and fire resistance. No other manufacturer of CLT has been certified under the new APA
has subjected its panels to such rigorous tests.

"We're proud of our team and the quality of the CLT panels they're manufacturing," said Valerie Johnso
Innovations. "Our panels are manufactured to the highest possible standards and perform safely unde
prove you don't sacrifice safety when you build with CLT."

The flame spread test was performed by QAI Laboratories in California using the standard flame sprea
tests in accordance with ASTM Designation E84-15b, "*Standard Method of Test for Surface Burning Ch*
The test identifies the rate of the spread of fire across the building material, and it places the results in
with A being the highest rating and C being the lowest. D.R. Johnson's CLT panel achieved an A rating,
of fire across the building material over the test's standard time period.

NGC Testing Services — Fire Testing Laboratory — IAS ACCREDITED Testing Laboratory TL-216

TEST REPORT — Page 1 of 53

for

American Wood Council

222 Catoctin Circle SE, Suite 201
Leesburg, VA 20175

Standard Methods of
Fire Tests of Building Construction and Materials
ASTM E 119 – 11a

Test Report No: WP-1950
Assignment No: K-1069
Subject Material: Cross-Laminated Timber and Gypsum Board Wall Assembly (Load-Bearing)
Test Date: October 4, 2012
Report Date: October 15, 2012

Prepared by:
Michael J. Rizzo
Test Engineer

FPInnovations
NRC·CNRC

Project No. 301006155
Final Report 2012/13

Preliminary CLT Fire Resistance Testing Report

by

Lindsay Osborne, M.A.Sc.
Christian Dagenais, Eng., M.Sc.
Scientists
Advanced Building Systems – Serviceability and Fire Group

and

Noureddine Bénichou, Ph.D.
Senior Research Officer
tional Research Council of Canada – Fire Research Resource Centre

July 2012

sborne
eader

Noureddine Bénichou
Reviewer

Conroy Lum
Research Leader


And Then the Wave

Tall Wood Projects in the US

- Current Prescriptive Code Limit - 6 stories or 85 feet (B Occupancy)
- Based on the 1910 Heights and Areas Act
- Over 6 Stories - Alternate Means and Methods Request (AMMR) through performance based design

Photo credit: Alex Schreyer

6 Stories/85 ft

5 Stories

3 Stories/63 ft

5 Stories

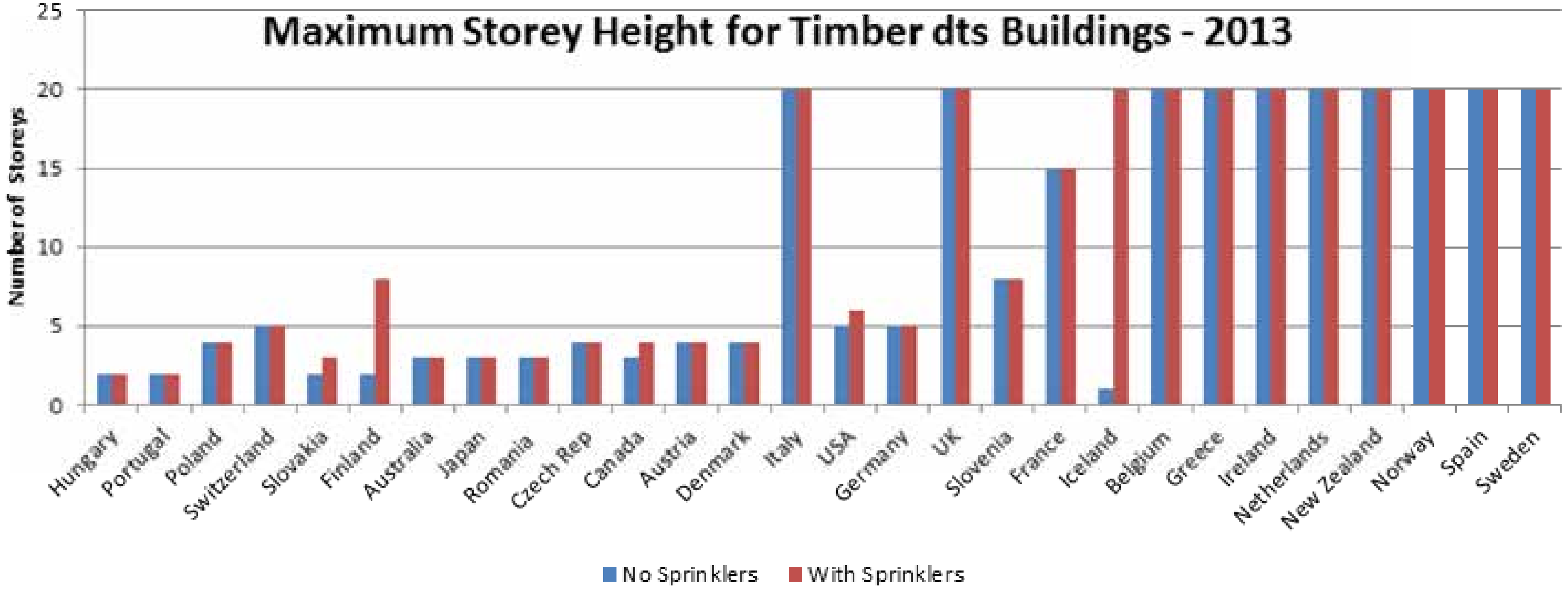
5 Stories

6 Stories/ 85 ft

4 Stories

7 Stories/ 85 ft

Building Height Limits in Timber



Source: Arup

In December 2015, the ICC Board established the ICC Ad Hoc Committee on Tall Wood Buildings. Objectives:

1. Explore the building science of tall wood buildings
2. Investigate the feasibility, and
3. Take action on developing code changes for tall wood buildings.

Modern Tall Wood: Carbon 12

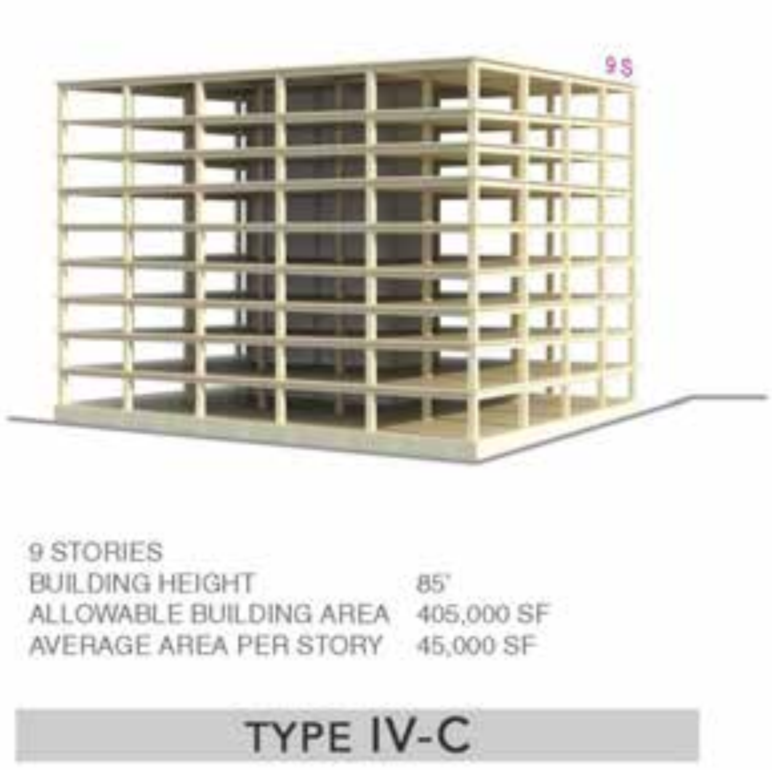
2017, 8 stories, 32,000 sf, CLT

Portland, OR

Photos:
Baumberger Studio/PATH Architecture/Marcus Kauffman

2021 IBC Tall Wood – Type IV Construction

Type IV-C



Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman

Type IV-C Height and Area Limits

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	6	85 ft	56,250 SF	168,750 SF
B	9	85 ft	135,000 SF	405,000 SF
M	6	85 ft	76,875 SF	230,625 SF
R-2	8	85 ft	76,875 SF	230,625 SF

Areas exclude potential frontage increase

In most cases, Type IV-C height allowances = Type IV-HT height allowances, but add'l stories permitted due to enhanced FRR

Type IV-C area = 1.25 * Type IV-HT area

Type IV-B

Credit: Susan Jones, atelierjones

Credit: LEVER Architecture

Type IV-B Height and Area Limits

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	12	180 ft	90,000 SF	270,000 SF
B	12	180 ft	216,000 SF	648,000 SF
M	8	180 ft	123,000 SF	369,000 SF
R-2	12	180 ft	123,000 SF	369,000 SF

Areas exclude potential frontage increase

In most cases, Type IV-B height & story allowances = Type I-B height & story allowances

Type IV-B area = 2 * Type IV-HT area

Type IV-A

Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp

Type IV-A Height and Area Limits

Credit: Susan Jones, atelierjones

Occupancy	# of Stories	Height	Area per Story	Building Area
A-2	18	270 ft	135,000 SF	405,000 SF
B	18	270 ft	324,000 SF	972,000 SF
M	12	270 ft	184,500 SF	553,500 SF
R-2	18	270 ft	184,500 SF	553,500 SF

Areas exclude potential frontage increase

In most cases, Type IV-A height & story allowances = 1.5 * Type I-B height & story allowances

Type IV-A area = 3 * Type IV-HT area

Tall Wood Fire Resistance Ratings (FRR)

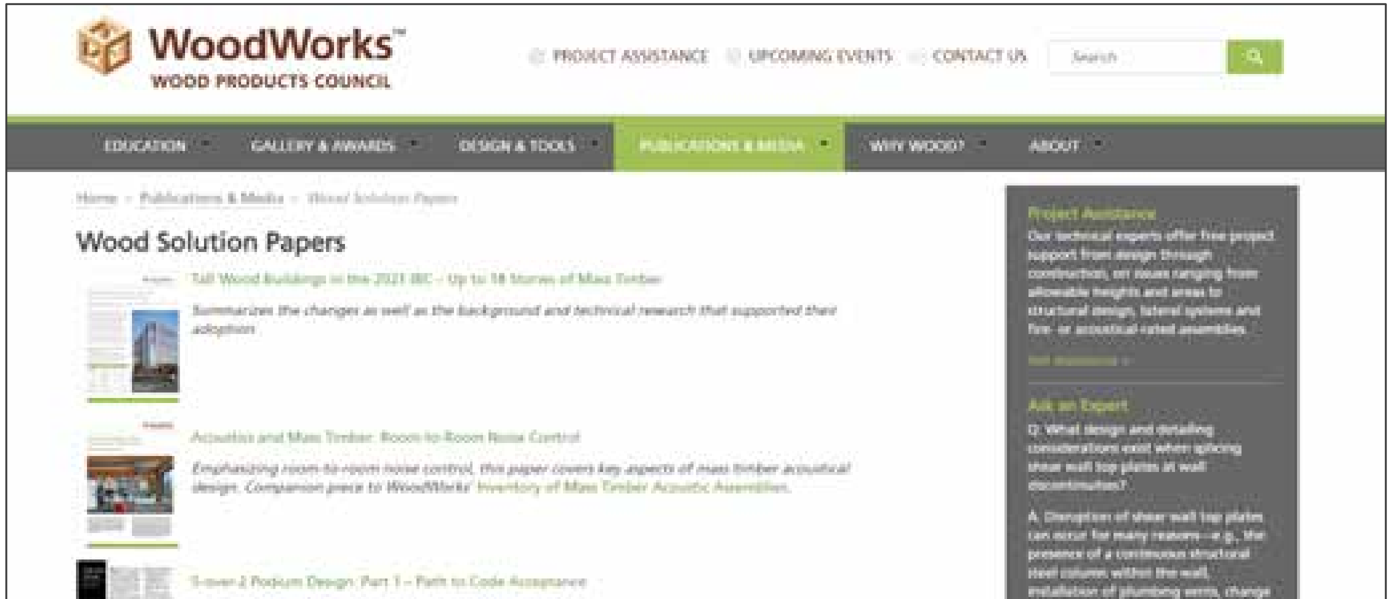
	IV-A	IV-B	IV-C
Primary Frame or Brng Wall FRR	3 HR (2 HR at Roof)	2 HR (1 HR at Roof)	2 HR (1 HR at Roof)
Floor Construction FRR	2 HR	2 HR	2 HR
Roof Construction FRR	1.5 HR	1 HR	1 HR
Floor Surface Protection	1 inch of NC protection	1 inch of NC protection	No protection req'd
Roof Construction Protection	2 layers 5/8" type X gyp on inside face	2 layers 5/8" type X gyp on inside face	No protection req'd unless concealed space

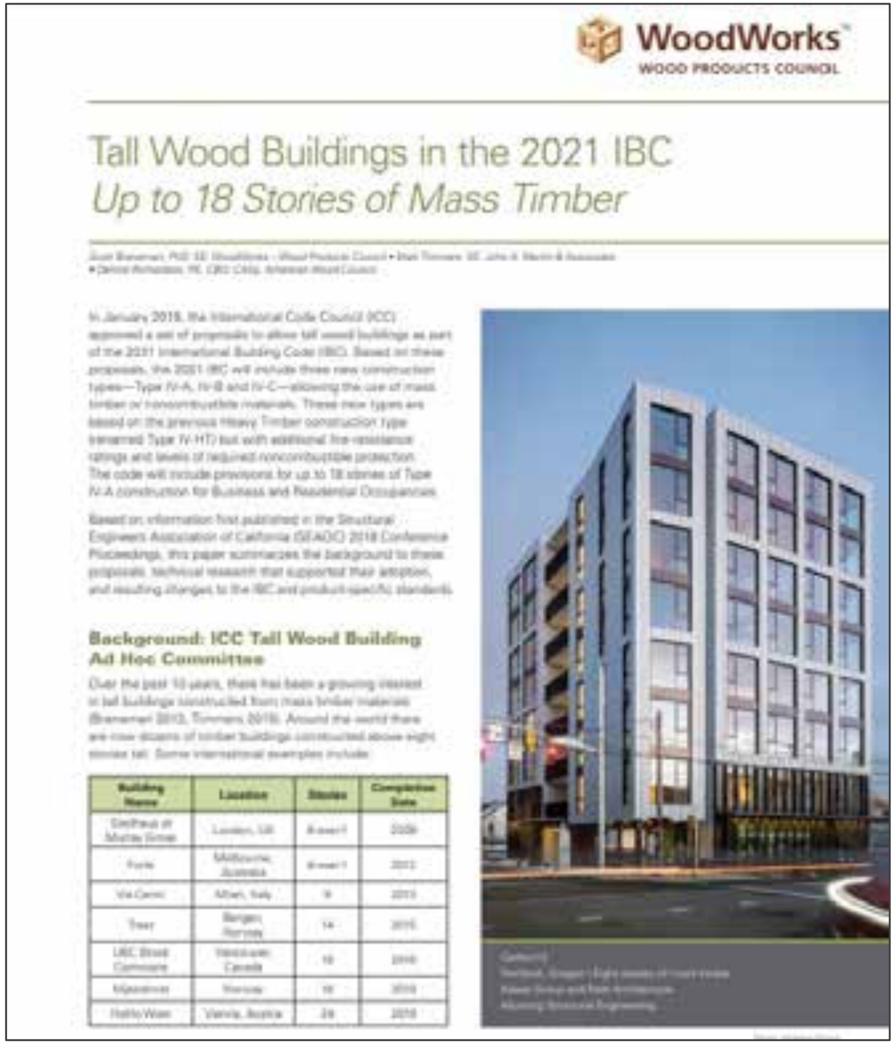
Tall Wood Materials & Protection

	IV-A	IV-B	IV-C
Exterior Walls	Mass Timber, exterior surface protected with 1 layer 5/8" type X gyp		
Structural Materials	Mass Timber or NC		
Concealed Spaces	Permitted, requires NC protection on MT surfaces		
Gypsum Protection	All MT is protected 3 HR: 3 layers 5/8" type X gyp 2 HR or less: 2 layers 5/8" type X gyp	Same as IV-A for protected MT. Limited exposed MT permitted, FRR still applies	All MT permitted may be exposed except as noted

2021 IBC Tall Wood – Type IV Construction

- Download at www.woodworks.org





Tall Wood – Not waiting for 2021

- Milwaukee, WI
- 21-stories / 238’
- 9-story concrete podium
- 12-stories of mass timber
- 410,000 sf
- 201 Apartments
- City has given preliminary approval to plans


Are you ready for the
Next Wave?

Questions?

This conclude The American Institute of Architects Continuing Education Systems Course

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