AIA Conference on Architecture
WoodWorks Learning Lounge

Presented by WoodWorks
June 8 and 9, 2023
Regional Directors: One-on-One Project Support

Visit us at Booth 2136
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WoodWorks is your go-to resource for commercial and multi-family wood building design, engineering, and construction. We’re here to support you with free one-on-one consultations, educational resources, and a network of experts. Our experts can help—ask us anything. Get Free Project Support.

On Demand Education
Find over 140 continuing education courses on wood topics for architects, engineers, general contractors, and code officials.

WoodWorks Innovation Network
Discover mass timber projects across the US and connect with their teams.
Funding Partners

SLB
SOFTWOOD LUMBER BOARD

FOREST SERVICE
DEPARTMENT OF AGRICULTURE

Forestry Innovation Investment®
Mass Timber: Making the Case to Developers and Owners for Mid-rise and Tall Wood

Course Number LL904
Thursday, June 8, 2023, 3:00pm - 4:00pm
Learning Units 1.00 LU/RIBA
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Questions related to specific products and services may be addressed at the conclusion of this presentation.
Would you like to pitch sustainable mass timber to a client? If so, attend this session to learn how to complete the value proposition for developers and owners. The aesthetic differentiation and biophilic benefits of mass timber have broad appeal to a wide range of stakeholders, from end users to ESG-investors. Architects hoping to influence decisions to use mass timber will learn how this appeal can translate to return on investment in an overview of initial findings from WoodWorks’ Mass Timber Business Case Study series, written for the developer/ owner/ investor audience. Then we’ll take a deep dive on Ascent, the world’s tallest timber tower, and discuss the challenges, lessons learned, and successes the team experienced taking timber innovations to a new height in the US. Leading engineers, Thornton Tomasetti will share some insight from their explorations of mass timber and tall wood.
Learning Objectives

1. Understand how the biophilic benefits of wood can contribute to occupant health, tenant appeal and the financial value of a real estate development.

2. Discuss the environmental benefits of mass timber and how they resonate with a wide range of stakeholders from occupants to project teams, investors and communities.

3. Through case study examples, explore code-compliant design of mass timber structures, including those pushing beyond the code-prescribed tall wood building height and exposure allowances.

4. Explore the engineering considerations for tall wood buildings as they relate to developer/ owner concerns such as cost, sustainability and impact on floor plans.
Mass Timber: Making the Case to Developers and Owners for Mid-rise and Tall Wood

Chelsea Drenick, PE, SE
WoodWorks Regional Director

Jordan Komp, PE, SE
Thornton Tomasetti Associate Principal
Resources for Developers/Owners

www.woodworks.org/learn/mass-timber-clt/mass-timber-business-case/
“Mass timber is a category of framing styles typically characterized by the use of large solid wood panels for wall, floor, and roof construction.”

American Wood Council (AWC)
Glue Laminated Timber (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo: StructureCraft

Photo: LendLease

Photo: LEVER Architecture
As of December 2022, in the US, 1,667 multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.
11 tall wood projects already under construction or built.

- **Carbon 12**
  - Portland, OR
  - 8 stories mass timber

- **Heartwood**
  - Seattle, WA
  - 8 stories mass timber

- **Minnesota Places**
  - Portland, OR
  - 8 stories – 7 mass timber

- **TimberView**
  - Portland, OR
  - 8 stories mass timber

- **1510 Webster**
  - Oakland, CA
  - 18 stories – 16 mass timber

- **Ascent**
  - Milwaukee, WI
  - 25 stories – 19 mass timber

- **Bakers Place**
  - Madison, WI
  - 15 stories – 12 mass timber

- **INTRO**
  - Cleveland, OH
  - 9 stories – 8 mass timber

- **11 E Lenox**
  - Boston, MA
  - 7 stories mass timber

- **80 M Street**
  - Washington DC
  - 10 stories – 3-story mass timber vertical addition

- **Apex Plaza**
  - Charlottesville, VA
  - 8 stories – 6 mass timber

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WoodWorks is supporting 208 tall wood projects.
Mass Timber Business Case Studies
TALL MASS TIMBER
UNDERSTANDING THE WHY
Buildings generate nearly 40% of annual global greenhouse gas emissions (building operations + embodied energy).

Embodied Energy (11%): Concrete, iron + steel produce approximately 9% of this (Architecture 2030).

Embodied vs. Operational Energy

Traditional Non-Wood Building

% Energy

YEAR

2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070

Embodied

Operational

17 years

50%

50%

75%

25%

Image Credit: Gray Organschi Architecture
Carbon Storage
Wood ≈ 50% Carbon (dry weight)
U.S. Forest Land: Forest Area in the United States 1630 – 2017

Forest Area has been stable for more than 100 years

State of our Forests: US Timber Volume on Timberland

<table>
<thead>
<tr>
<th>Year</th>
<th>North</th>
<th>South</th>
<th>West</th>
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<tbody>
<tr>
<td>1953</td>
<td>148</td>
<td>104</td>
<td>364</td>
</tr>
<tr>
<td>1977</td>
<td>163</td>
<td>163</td>
<td>347</td>
</tr>
<tr>
<td>1987</td>
<td>190</td>
<td>190</td>
<td>347</td>
</tr>
<tr>
<td>1997</td>
<td>214</td>
<td>214</td>
<td>365</td>
</tr>
<tr>
<td>2007</td>
<td>248</td>
<td>248</td>
<td>396</td>
</tr>
<tr>
<td>2017</td>
<td>270</td>
<td>270</td>
<td>396</td>
</tr>
</tbody>
</table>

Volume of Trees has been growing for 60+ years!

This map displays the basic vegetation (forest vs. non-forest) of the conterminous United States as well as ownership (private vs. public). The lands displayed as "public" include Federal and State lands but do not generally include lands owned by local governments and municipalities.
Biophilia - Structural Warmth is a Value-Add
Study of Wood vs. Non-wood Finishes
Wood and Human Health

- Univ. of British Colombia & FP Innovations study
- 4 rooms: white furnishings vs. wood furnishings; plants vs. no plants

“Stress, as measured by sympathetic nervous system activation, was lower in the wood room in all periods of the study.”

Source: Wood and Human Health
**Workplaces: Wellness + Wood = Productivity**

Healthy Buildings/ Biophilia

“Those in workplaces with a higher proportion of **visible wood feel more connected to nature** and rate their working environment far more positively.”

These people report:

- lower stress levels
- higher concentration
- improved overall mood

“**Wood in the workplace is associated with higher productivity and reduced sick leave.**”

Report based on survey of 1,000 typical Australians working indoors
Material Mass
75% Lighter weight than concrete

- smaller cranes
- more efficient seismic systems
Construction Impacts: Labor Availability
Construction Impacts: Schedule
Up to 25% Faster

Compressing the Typical Schedule | Fast Construction

[Diagram showing construction phases with notations on schedule compression and potential schedule savings.]

Look for these potential $$ schedule savings with mass timber in comparison to steel and concrete.

Up to 25% schedule savings
- Less carrying costs
- Less GC overhead
- Ability to lease/occupy sooner
WHY MASS TIMBER?

• Sustainability
  o Renewable resource
  o Low Fabrication Emissions

• Aesthetics
  o Connection to nature / biophilia
  o Intrinsic Beauty and Appeal

• Construction
  o Increased Speed of Construction
  o Prefabrication
  o Fit-Out
  o Smaller Crew Sizes
  o Reduced Weight
  o Lighter Foundations
Mass Timber Business Case Studies: Value Creation Analysis

Ascent
Clay Creative
The Canyons
1 De Haro
INTRO Cleveland
District Office

Scan to download

WoodWorks

Investment Management
Mass Timber Business Case Studies: Value Creation Analysis

**Development Overview**
- Property Information
- Product Strategy
- Investment Highlights

**Qualitative Discussion**
- Challenges
- Lessons Learned
- Successes

**Quantitative Overview**
- Development Timeline
- Costs
- Rents
- Lease up

**Comparative Return Analysis**

<table>
<thead>
<tr>
<th></th>
<th>Market</th>
<th>Pro Forma</th>
<th>Realized</th>
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</thead>
<tbody>
<tr>
<td>Yield on cost</td>
<td>6.25%</td>
<td>7.00%</td>
<td>7.35%</td>
</tr>
<tr>
<td>Cap rate</td>
<td>4.75%</td>
<td>4.50%</td>
<td>TBD</td>
</tr>
<tr>
<td>Value/rentable SF</td>
<td>$550/ RSF</td>
<td>$717/ RSF</td>
<td>TBD ($800+/ RSF)</td>
</tr>
<tr>
<td>Leverage</td>
<td>65%</td>
<td>65%</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Multifamily | Office | Industrial | Student Housing
Contributors

Contributing Developers/Owners & Investors

We are grateful to the developers, owners and investors who have publicly shared their stories and financial data in these case studies.

Lead Analysis Team

We are grateful to the developers, owners and investors who have publicly shared their stories and financial data in these case studies.
Analysis

The study uses simple, industry standard means of understanding economic viability

- Net Income (cashflows)
- Cost to develop (purchase price)
- Cap rate (initial return, excluding loans)

Levers for Value Creation

\[
\frac{\text{A}}{\text{C}} = \text{B} \\
\frac{\text{NET INCOME}}{\text{RETURN or CAP RATE}} = \frac{\text{COST or PURCHASE PRICE or VALUE}}{\text{A}}
\]
Initial Findings: General

Office & Multifamily Tend to:

Lease up faster than submarket norms; which translates to:
• Higher net income
• Lower income volatility
• Better IRR
• Lower risk via quicker to refinance/ sell

Attract quality tenants; which translates to:
• Better rent collection
• Better (lower) cap rates
• Better (stable) occupancy
Initial Findings: Residential

Residents respond to "look & feel"

- Aesthetics seem to be broadly appealing; wider target markets = better market demand
- Robust pre-leasing = lower costs & risks
  - More income sooner = lowers operating & interest budgets
  - Faster to stabilization = faster to refinance
- Tangible distinction = mitigates future supply risk
- Tangible realization of desired brand identities
Initial Findings: Office

Firms Attracted for Myriad Reasons

• Most tenants are "creditworthy"
• Desire intangible stakeholder benefits
  o Workforce Desires
  o Regulatory Perceptions
  o Brand Position
• Tend to see impressive pre-leasing
  o Enables better construction debt
  o Sets perceptions of desirable development
• Seeing sustained occupancy via subleasing
  o Tested by COVID disruptions
Ascent
MILWAUKEE, WI

Mass Timber Business Case Study
Ascent: Project Team

Development Team:
New Land Enterprises
Wiechmann Enterprises

Lenders
Mezzanine: Hines Realty
Income Fund
Senior: Bank OZK

Investors:
Local high net worth +
Crowd funding
(Realty Mogul)

Architect
Korb + Associates Architects

Structural Engineer
Thornton Tomasetti

Contractors
C.D. Smith Construction
Catalyst Construction

Mass Timber Business Case Study
Milwaukee’s East Town Market

- **East Town**: Revitalizing the northern edge of downtown, where cultural institutions, lakefront parks and water access bridge to desired residential areas
- **Neighborhood**: Large corporations and healthcare drive employment for Milwaukee.
The building will sequester approximately 7,200 metric tons of CO2. It will take approximately 25 minutes to grow this volume of wood in North American forests.

This CO2 benefit is also equivalent to taking approximately 2400 cars off the road for a year or the energy to operate over 1100 homes for a year.
Development Overview

- 284’ tall, 25-story apartment tower; world’s tallest timber structure at the time of construction
- 19 stories of mass timber over 6 story parking podium
- Strategy: reset Milwaukee standard for luxury high-rise living while appealing to a broad market segment
- Approval pursued under WBCB Section 361 (similar to 2015 IBC’s “Alternate Materials, Design and Methods”)
- ~50% of Mass Timber Exposed

<table>
<thead>
<tr>
<th>Property Information</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Property timing</td>
<td>Delivered July &amp; August 2022</td>
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<tr>
<td>Submarket</td>
<td>Milwaukee’s East Town</td>
</tr>
<tr>
<td>Construction Type</td>
<td>4 (w/ fire ratings for high-rise)</td>
</tr>
<tr>
<td>Site size</td>
<td>28,504 SF / .65 acres</td>
</tr>
<tr>
<td>Gross building area</td>
<td>493,000 SF</td>
</tr>
<tr>
<td></td>
<td>273,000 SF mass timber</td>
</tr>
<tr>
<td>Net rentable/saleable area</td>
<td>279,475 SF</td>
</tr>
</tbody>
</table>
ASCENT:

Typical Floor Plans:

TYPICAL PARKING LEVEL

TYPICAL RESIDENTIAL LEVEL

AMENITIES LEVEL (L25)

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
ASCENT STRUCTURE

Foundation

- Light weight superstructure
- Static Load Test: 450 Tons (Geotechnical)
  - Limited by reaction frame!
Podium Framing

Transfer Slab

Typical Parking Slab
ASCENT STRUCTURE

Typical Residential
ASCENT STRUCTURE

Systems

- SLABS (CLT)
- BEAMS + COLUMNS (GLULAM)
- PODIUM AND LATERAL SYSTEM (CONCRETE)
ASCENT CONNECTIONS

Exposed

- “Framework” Connector
ASCENT CONNECTIONS

Concealed

- Wood-Wood Bearing
MASS TIMBER

Material Considerations

• Visual Appearance vs. Material Properties
• Design Methodology
• Code Compliance (NDS vs. Eurocode)
# Mass Timber: Sound and Vibration Considerations

<table>
<thead>
<tr>
<th>Category</th>
<th>Range of Damping (% critical)</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightly damped</td>
<td>1-2%</td>
<td>The lower end includes bare floors without topping and with minimal furnishing. The higher end includes floors with concrete topping and furnishings.</td>
</tr>
<tr>
<td>Moderately damped</td>
<td>2-4%</td>
<td>Lower end includes bare timber-concrete composite floors, or timber floors with a floating concrete layer and full furnishings. The higher end includes floors with floating floor layers, resilient foam, full furnishings and mechanical systems. Floors with both furnishings and permanent partitions, not otherwise accounted for, could also be represented at the higher end of this damping range.</td>
</tr>
<tr>
<td>Heavily damped</td>
<td>4-8%</td>
<td>Floors in this range represent the upper limit of inherent damping. These floors nearly include floating topings, resilient floors, suspended ceilings, furnishings, finishes and other permanent partitions not otherwise taken into account.</td>
</tr>
<tr>
<td>Exposed, stamping control</td>
<td>8-10%</td>
<td>Generally, mass timber floors do not have more than 5% damping, unless explicit damping control (e.g., a layered mass damped slab) is added. These systems are beyond the scope of this guide.</td>
</tr>
</tbody>
</table>

---

**Typical Mass Timber Floor Assembly**

**Section View**

- Finish Floor if applicable
- Concrete/Gypsum Based Topping Slab
- Acoustical Mat/Product
- Mass Timber Floor Panel
- Partitions and/or Ceilings as applicable
- Finish Floor as applicable
- Concrete/Gypsum Topping
- Joint Strip Topping - Align with Partition
- Acoustical Mat/Products
- Mass Timber Floor Panel

---

Richard McLain - Woodworks
MASS TIMBER

Vertical Compensation and Surveying
MASS TIMBER

Modeling
MASS TIMBER

Coordination
MASS TIMBER

Fire Rating

- Char
  - Calculations (Char Method)
  - Full Scale (Global) Testing
  - Element (Member) Testing
  - Connection Testing
- Product Certificates
- Concealment
- Intumescent Paint (connections only)

<table>
<thead>
<tr>
<th>Required Fire Endurance (hr.)</th>
<th>Effective Char Rate, $\beta_{ef}$ (in./hr.)</th>
<th>Effective Char Depth, $a_{char}$ (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Hour</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>1½-Hour</td>
<td>1.67</td>
<td>2.5</td>
</tr>
<tr>
<td>2-Hour</td>
<td>1.58</td>
<td>3.2</td>
</tr>
</tbody>
</table>

**Table 16.2.2 Adjustment Factors for Fire Design**

<table>
<thead>
<tr>
<th>ASD</th>
<th>Design Stress to Member Strength Factor</th>
<th>Size Factor $^2$</th>
<th>Volume Factor $^2$</th>
<th>Flat Use Factor $^2$</th>
<th>Beam Stability Factor $^2$</th>
<th>Column Stability Factor $^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>Fb</td>
<td>2.85</td>
<td>C_F</td>
<td>C_V</td>
<td>C_fu</td>
<td>C_L</td>
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<td>x</td>
<td>F_{be}</td>
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<td>-</td>
<td>-</td>
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<td>C_F</td>
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<td>F_{ce}</td>
<td>2.03</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1. See 4.3, 5.3, 8.3, and 10.3 for applicability of adjustment factors for specific products.
2. Factor shall be based on initial cross-section dimensions.
3. Factor shall be based on reduced cross-section dimensions.
MASS TIMBER

Fire Performance

BEAMS

COLUMNS

CLT

© TT

© TT

© TT
PERMITTING

IBC 2015-2018

602.2 Types I and II. Types I and II construction are those types of construction in which the building elements listed in Table 601 are of noncombustible materials, except as permitted in Section 603 and elsewhere in this code.

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.

602.4 Type IV. Type IV construction (Heavy Timber, HT) is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid or laminated wood without concealed spaces. The details of Type IV construction shall comply with the provisions of this section and Section 2304.11. Exterior walls complying with Section 602.4.1 or 602.4.2 shall be permitted.

602.5 Type V. Type V construction is that type of construction in which the structural elements, exterior walls and interior walls are of any materials permitted by this code.

<table>
<thead>
<tr>
<th>Type</th>
<th>Interior Material</th>
<th>Exterior Material</th>
<th>Façade exceptions</th>
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</thead>
<tbody>
<tr>
<td>Types I &amp; II</td>
<td>Non Combustible</td>
<td>Non Combustible</td>
<td>None</td>
</tr>
<tr>
<td>Type III</td>
<td>Any</td>
<td>Non Combustible</td>
<td>Fire-retardant-treated wood (FRTW)</td>
</tr>
<tr>
<td>Type IV</td>
<td>Solid or laminated wood</td>
<td>Non Combustible</td>
<td>FRTW CLT</td>
</tr>
<tr>
<td>Type V</td>
<td>Any</td>
<td>Any</td>
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</table>
## TABLE 504.3*
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE

<table>
<thead>
<tr>
<th>OCCUPANCY CLASSIFICATION</th>
<th>TYPE OF CONSTRUCTION</th>
<th>SEE FOOTNOTES</th>
<th>TYPE I</th>
<th>TYPE II</th>
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<th>TYPE IV</th>
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<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>HT</td>
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<td>A, B, E, F, M, S, U</td>
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<td>160</td>
<td>65</td>
<td>55</td>
<td>65</td>
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<tr>
<td></td>
<td></td>
<td>S</td>
<td>UL</td>
<td>180</td>
<td>85</td>
<td>75</td>
<td>85</td>
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<tr>
<td>H-1, H-2, H-3, H-5</td>
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<td>UL</td>
<td>180</td>
<td>85</td>
<td>75</td>
<td>85</td>
</tr>
</tbody>
</table>

### Footnotes:

3. Not more than one story above grade plane.
4. Not more than two stories above grade plane.
## IBC 2015-2018

### PERMITTING

<table>
<thead>
<tr>
<th>OCCUPANCY CLASSIFICATION</th>
<th>TYPE OF CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TYPE I</td>
</tr>
<tr>
<td></td>
<td>TYPE</td>
</tr>
<tr>
<td>B</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>R-1</td>
<td>NS&lt;sup&gt;d,b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>S13R</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>R-2</td>
<td>NS&lt;sup&gt;d,b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>S13R</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>R-3</td>
<td>NS&lt;sup&gt;d,b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>S13R</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>R-4</td>
<td>NS&lt;sup&gt;d,b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>S13R</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
</tbody>
</table>

---

**OFFICE**

**RESIDENTIAL**
PERMITTING

UNITED STATES APPROVALS

Framework (2017)
Portland, OR
12 stories

Ascent (2020)
Milwaukee, WI
25 stories
CODE DEVELOPMENT

IBC (2021 and Beyond)

- TYPE IV-C
  - 9 Stories
  - Fully Exposed

- TYPE IV-B
  - 12 Stories
  - Limited exposure (20% ceilings, 40% walls)

- TYPE IV-A
  - 18 Stories
  - Fully Concealed

IBC 2015

IBC 2021 (approved)

Images From American Wood Council (https://awc.org/tallmasstimber)

IBC 2024 currently approving 100% exposed ceilings

FUTURE CODES?
PERMITTING

Alternate Materials

[A] 104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety. Where the alternative material, design or method of construction is not approved, the building official shall respond in writing, stating the reasons why the alternative was not approved.

[A] 104.11.1 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.

[A] 104.11.2 Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the building official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the building official for the period required for retention of public records.
### FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Primary structural frame (see Section 202)</td>
<td>3'</td>
<td>2'</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>3'</td>
<td>2'</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3'</td>
<td>2'</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions Interior</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor construction and associated secondary members (see Section 202)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Roof construction and associated secondary members (see Section 202)</td>
<td>1'</td>
<td>0'</td>
<td>1'</td>
<td>0'</td>
<td>0'</td>
</tr>
</tbody>
</table>

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.

Chapter SPS 361

**ADMINISTRATION AND ENFORCEMENT**

Subchapter I — Scope and Application

(6) Alternatives: Nothing in chs. SPS 361 to 366 is intended to prohibit or discourage the design and utilization of new building products, systems, components, or alternate practices, provided written approval from the department is obtained first.

Note: Chapter SPS 361, subch. VI contains requirements for approval of building products and alternate standards.

Subchapter VI — Product and Standard Review and Approval

**SPS 361.50 Building product approvals.**

1. **Voluntary approval.**
   - (a) Materials, equipment, and products regulated under chs. SPS 361 to 366 may receive a written approval from the department indicating code compliance.
   - (b) 1. Approval of materials, equipment, and products shall be based on sufficient data, tests, and other evidence that prove the material, equipment, or product is in compliance with the standards specified in chs. SPS 361 to 366.
   - 2. Tests, compilation of data, and calculations shall be conducted by a qualified independent third party.

2. **Alternate approval.**
   - (a) Materials, equipment, and products that meet the intent of chs. SPS 361 to 366 and which are not approved under sub. (1) shall be permitted if approved in writing by the department.
   - (b) 1. Approval of materials, equipment, and products shall be based on sufficient data, tests, and other evidence that prove the material, equipment, or product meets the intent of the standards specified in chs. SPS 361 to 366.
   - 2. Tests, compilation of data, and calculations shall be conducted by a qualified independent third party.

IBC 2015

WISCONSIN COMMERCIAL BUILDING CODE
PERMITTING

Fire Rating

- Char
  - Calculations (Char Method)
  - Element (Member) Testing
    - 1st Ever 3 Hour Test!
  - Connection Testing
PERMITTING

Fire Rating (Members)
PERMITTING

Fire Rating (Connections)

- “Framework Connector”
- Encapsulation
PERMITTING

Ascent – AHJ Agreements

- SPECIAL INSPECTIONS
  - (not required in WI)
  - Concrete cores
  - Automatic sprinkler system
  - Dual Water Supply to Fire Pump
  - Standpipe in Each Stair
  - Smoke detection
  - FD Vehicle Access on Two Roads
  - Electronically Supervised Valves
  - Fire Command Center
  - Fire Dept Communications Support
  - Voice Communications
  - Stair Pressurization
ASCENT

Construction Progress

Start of Timber Construction
(June 2021)

Level 17 Complete
(September 2021)

Level 26 (Roof) Topped Out
(December 2021)
Primary Mass Timber Structural Components
Primary Mass Timber Connections

- COL-COL (EPOXY)
- COL-COL (INTERIOR)
- BEAM-COL (HANGER)
- BEAM-COL (BEARING)

CORE-CLT/GLB
## Quantitative Overview

### Costs

<table>
<thead>
<tr>
<th></th>
<th>Market Standard**</th>
<th>Pro Forma**</th>
<th>Realized***</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total project cost</strong></td>
<td>$130,000,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$501,930/unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Land</strong></td>
<td>$6,250,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ appraised value</td>
<td>$6,250,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Construction costs</strong></td>
<td>$200 / GSF</td>
<td>$190 / GSF</td>
<td>$190 / GSF **</td>
</tr>
</tbody>
</table>

### NOI

<table>
<thead>
<tr>
<th></th>
<th>Market</th>
<th>Pro Forma**</th>
<th>Realized***</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rental rates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-BR</td>
<td>$1,850</td>
<td>$2,046</td>
<td>~11% higher</td>
</tr>
<tr>
<td>2-BR</td>
<td>$3,500</td>
<td>$3,956</td>
<td>~13% higher</td>
</tr>
<tr>
<td>3-BR</td>
<td>$5,500</td>
<td>$5,551</td>
<td>~55% higher</td>
</tr>
<tr>
<td><strong>Occupancy at stabilization</strong></td>
<td>95%</td>
<td>54%</td>
<td>Property still in lease up</td>
</tr>
<tr>
<td><strong>Parking Revenue</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In addition to lease</td>
<td>$175</td>
<td>$185</td>
<td>$175</td>
</tr>
<tr>
<td><strong>Retail rentals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Gross Rent</td>
<td>$25 / RSF/YR</td>
<td>$21 / RSF/YR</td>
<td>TBD / COVID</td>
</tr>
<tr>
<td>NNN</td>
<td>$21 / RSF/YR</td>
<td>$185</td>
<td>$175</td>
</tr>
<tr>
<td><strong>Tenant improvement allowance</strong></td>
<td>Varies</td>
<td>$86 / SF</td>
<td>TBD / SF</td>
</tr>
<tr>
<td><strong>Occupancy after 12 months</strong></td>
<td>Varies</td>
<td>100%</td>
<td>TBD%</td>
</tr>
</tbody>
</table>

*Market standard costs refer to normal cost to build for subject's use, irrespective of structural approach
**Pro forma dated early 2020
***Realized metrics as of October 2022
****Average unit size is larger than the market contributing to lower cost per square foot. Mass timber was a slight premium. A longer iterative design process proved beneficial in maximizing efficiencies, thereby driving down costs to make mass timber competitive.

### Return Performance

<table>
<thead>
<tr>
<th></th>
<th>Market</th>
<th>Pro Forma**</th>
<th>Realized***</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield on cost – untrended</strong></td>
<td>6.00%</td>
<td>5.85%</td>
<td>TBD / on track</td>
</tr>
<tr>
<td><strong>Cap rate (mkt vs. appraisal subject conclusion)</strong></td>
<td>5.00%</td>
<td>4.70%</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Value per unit</strong></td>
<td>$500,000</td>
<td>$594,000</td>
<td>TBD / on track</td>
</tr>
<tr>
<td><strong>Leverage</strong></td>
<td>65%</td>
<td>79%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Mezzanine leverage</strong></td>
<td>15%</td>
<td>15%</td>
<td>20%</td>
</tr>
</tbody>
</table>

### Timeline

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>Context/Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of conception</td>
<td>April 2018</td>
<td>Mid cycle</td>
</tr>
<tr>
<td>Date underwriting</td>
<td>May 2020</td>
<td>Mid cycle</td>
</tr>
<tr>
<td>Equity capital</td>
<td>June 2020</td>
<td>Late cycle</td>
</tr>
<tr>
<td>Permitting duration</td>
<td>6 months</td>
<td>Longer (started early &amp; ran concurrent w/design)</td>
</tr>
<tr>
<td>GMP in place</td>
<td>July 2020</td>
<td></td>
</tr>
<tr>
<td>Construction start</td>
<td>Aug 2020</td>
<td></td>
</tr>
<tr>
<td>Duration of construction (anticipated without delays)</td>
<td>22 months</td>
<td>Faster (by 4 months)</td>
</tr>
<tr>
<td>Duration of construction (realized w/ delays)</td>
<td>24 months</td>
<td>Delays due to COVID + Suez Canal obstruction</td>
</tr>
<tr>
<td>Construction completed</td>
<td>Aug 2022</td>
<td>Two phases of completion: July 15 &amp; Aug 31</td>
</tr>
<tr>
<td>Date stabilized (80% occupancy, NOI, or at pro forma or refinanced)</td>
<td>TBD</td>
<td>Projected June 2023</td>
</tr>
</tbody>
</table>

### Project Context

- Economic case made by demand
  - Lease up velocity averaging 20 units/month is better than the market’s typical average of 14 units/month (per the appraisal) and better than the pro forma expectations
  - Superior luxury product with minimal comps in Milwaukee market

---

Mass Timber Business Case Study

**Above-market absorption**
Good Design is a Good Investment for all Stakeholders

**Lessons Learned**

- **Intensive coordination**: Bldg scale and performance-based code approach required extraordinary coordination + precise MEPF design
- **Fire Testing**: AHJ required fire ratings for a high-rise; glulam columns passed 3-hr fire-resistance ratings

**Challenges**

- **Insurance**: More costly, (3x) standard rate
- **Extra considerations**: For developers on a variety of technical A/E/C topics

**Successes**

- **Cost**: Slight premium for optimized mass timber system over market rates for similar apartment towers
- **Lease-up**: Amazing pre-leasing w/ ~45% pre-leased at construction completion
CODE DEVELOPMENT

IBC (2021 and Beyond)

IBC 2015
- 6 Stories
- Fully Exposed

TYPE IV-C
- 9 Stories
- Fully Exposed

TYPE IV-B
- 12 Stories
- Limited exposure (20% ceilings, 40% walls)

TYPE IV-A
- 18 Stories
- Fully Concealed

IBC 2024 currently approving 100% exposed ceilings

FUTURE CODES?

Images From American Wood Council (https://awc.org/tallmasstimber)
FIRE TESTING

IBC 2021 - 2024
COMPOSITE MASS TIMBER

Panel Composite Action
CONNECTIONS

2-hour Fire Rating

**MTC**
Double Ricon/Megan: 16.6 kips (1.5 hours)

**Simpson Strong-Tie**
CBH2.37x9.97: 36kips (2 hours)
HYBRID STRUCTURES

Mass Timber - Steel
HYBRID STRUCTURES
Mass Timber - Concrete

2. Advancement in codes and permitting allow for tall timber, with more advances on the horizon.

3. Advances in engineering – additional research and testing, hybrid structures and composite structures.

4. WoodWorks Resources are available for free to assist architects, engineers and developers. Scan code to right to download business case studies!
This concludes The American Institute of Architects Continuing Education Systems Course

QUESTIONS?

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