MASS TIMBER

in multi-family Housing, Is it a good fit?

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

TYPE
Urban Infill – Residential
Type III-B

SCALE
5 stories Existing / 4 stories New Construction
60 units (33 units Existing / 27 units New Construction)
68,400 square feet (33,000 sf Existing / 35,400 sf New Construction)

FEATURES
Ground-floor retail space – 4,000 square feet

PROJECT TEAM

Developer: Pieper Properties LLC
Contractor: Catalyst Construction
Historical Consultant: MacRostie Historic Advisors LLC
Structural: Pierce Engineering
CLT supplier: KLH
Civil: The Sigma Group
Lighting Consultant: Spectrum Lighting & Controls
Envelope Consultant: Brandt Enclosure Consulting Inc.
Architects: Engberg Anderson
The Louis Bass Building is historically significant because it is a contributing member to the Florida and Third Industrial Historic District as an Industrial Loft type building. The Industrial Loft is an important building type in Milwaukee's history and is distinguished by its long, narrow, multi-story load bearing brick exterior with heavy timber framing. Designed by Otto Strack and constructed in 1891, the building was initially built as a rental for the Pabst Brewing Company but later was occupied, for a short term, by the Lindemann & Hoverson Company, which manufactured stoves, ranges, and other like products. After that, the longest tenant was by Louis Bass, from 1947 until 1982.
EXISTING RE-USE + ADDITION
NPS Historic Tax Project requisite, one of which was the Louis Bass ghost sign dictated the height of the Addition as to not cover or obscure it.
P a i n t e d H e a v y T i m b e r S t r u c t u r e a n d B r i c k

E x i s t i n g ...
Cream City Brick

Extensively utilized in Milwaukee – made from local clay that yields a distinct texture and yellow/sepia color.

Stabilize...

Existing...

Preservation of Original Arched Window
EXISTING...

Louis Bass | timber lofts
Remove and re-use of existing wood floors

Implement...

Existing...
The existing Louis Bass building consisted of load bearing brick exterior walls and wood framing on the interior. The framing employed here was 12x12 heavy timber columns and mostly typically 3”x12” floor joists with the exception of one floor that used 2”x12” framing. The floor system is 3/4” t&g over a 2’x t&g sub-floor. Not meeting the dimensional requisites of HT and considering the existing with the new construction, construction type III-B was the best selection to code the project as a whole.

Due the historic nature of the building, we were allowed to keep the wood structure exposed because the historic finishes and the use of sprinklers.

**IEBC 2015 - 1203.5 Interior Finishes**

The existing finishes of walls and ceilings shall be accepted when it is demonstrated that they are the historic finishes.

**IEBC 2015 - 1203.12 Automatic Fire-Extinguishing Systems**

Every historical building that cannot be made to conform to the construction requirements specified in the International Building Code for the occupancy or use and that constitutes a distinct fire hazard shall be deemed to be in compliance if provided with an approved automatic fire-extinguishing system.
EXISTING RE-USE + ADDITION
EXISTING - Lateral Addition + Continuity

LEVEL THREE

LEVEL ONE

Louis Bass | timber lofts
DLT + NLT + CLT
NEW CONSTRUCTION
FLOOR/CEILING ASSEMBLY

FIRE RATED 1 1/2 HOUR
UL DESIGN L901*
AS NOTED IN CROSS-LAMINATED TIMBER
DESIGN & CONSTRUCTION GUIDE
CH 2.5.2 AND 2.3.1

ADDITION ... floor assembly
ADDITION... structure + module
Historic Tax Credits: Historic tax credits are available for Historically designated buildings that are rehabilitated according to the Secretary of Interior’s Standards for Rehabilitation. The Historic Tax Credit process is a three-part application process to garner the subsidy/income tax credit.

- Part I: Presents information about the significance and appearance of the building.
- Part II: Describes the condition of the building and the planned rehabilitation work.
- Part III: Submitted after the project is completed and documents that the work was completed as proposed.
Vision of Ownership. Sustainability was a key consideration and it started with the recycling/adaptive reuse of the Louis Bass building. Continuing that theme, the Owner was well versed in the advantages of CLT/Mass Timber and selected this as a system early on, not only for sustainability, but also because it offered aesthetic continuity of the interior structure from existing to new.
EXISTING...
o Questions?

o This concludes the American Institute of Architects Continuing Education System Course

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Mass Timber in Multi-Family Housing: Is It a Good Fit for Your Project?

Ricky McLain, PE, SE
WoodWorks
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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.
Course Description

Mass timber is often attached to the stigma of being more expensive than other building materials. Because of this, some people assume it only makes sense for one-off projects where innovation is celebrated but repeatability is not. Is this true, or do its other benefits result in overall cost efficiency? If it is true, how can we expect to build the number of new housing units needed across our country in a sustainable and affordable manner? Typical multi-family housing developments are in the range of 4-6 stories, often utilizing podium or pedestal construction with 1-2 stories of steel and concrete topped with 3-5 stories of light wood framing. Beyond these heights, building codes have historically required steel or concrete framing and, to justify the added costs of these materials, projects often go much taller. This has created a critical gap in housing developments in the range of 6-12 stories. Can mass timber multi-family projects make financial sense in the 4-6 story range, used in conjunction with light wood-frame systems? What new opportunities will the 2021 International Building Code create for mass timber housing in the 6-18 story range? This presentation will answer these questions and much more.
Learning Objectives

1. Evaluate the code opportunities for mass timber structures in residential mid-rise projects.

2. Discuss code-compliant options for exposing mass timber, where up to 2-hour fire-resistance ratings are required, and demonstrate design methodologies for achieving these ratings.

3. Review code requirements unique to hybrid mass timber and light-frame housing projects, and emphasize solutions for criteria such as construction type, fire-resistance ratings and acoustics design.

4. Highlight the unique benefits of using exposed mass timber in taller multi-family buildings.
Is Mass Timber a Good Fit for Your Multi-Family Project?

Ascent, Milwaukee, WI
Source: Korb & Associates Architects
Glue Laminated Timber (Glulam)
Beams & columns

Cross-Laminated Timber (CLT)
Solid sawn laminations

Cross-Laminated Timber (CLT)
SCL laminations

Photo: Freres Lumber

Photo: StructureCraft

Photo: Lend Lease

Photo: LEVER Architecture
Current State of Mass Timber Projects
As of March 2022, in the US, 1,384 multi-family, commercial, or institutional projects have been constructed with, or are in design with, mass timber.

600+ Built
700+ In Design

Source: WoodWorks, December 31, 2021
* This total includes modern mass timber and post-and-beam structures built since 2013

Multi-Housing Typologies

MT Floors & Roofs on LWF Bearing Walls

MT Floors & Roofs on Post & Beam Framing

MT Floors & Roofs on MT Bearing Walls

Credit: KL&A Engineers & Builders

Credit: ADX Creative and Engberg Anderson

Credit: Grey Organschi Architecture and Spiritos Properties
Low- and Mid-Rise Multi-Family
THE KIND PROJECT, SACRAMENTO, CA

Credit: Kalesnikoff Mass Timber
THE DUKE, AUSTIN, TX
Construction Types
When does the code allow mass timber to be used in low- and mid-rise multi-family projects?

IBC defines mass timber systems in IBC Chapter 2 and notes their acceptance and manufacturing standards in IBC Chapter 23.

Permitted anywhere that combustible materials and heavy timber are allowed, plus more.
Construction Types

All wood framed building options:

**Type III**
Exterior walls non-combustible (may be FRTW)
Interior elements any allowed by code, including mass timber

**Type V**
All building elements are any allowed by code, including mass timber

Types III and V are subdivided to A (protected) and B (unprotected)

**Type IV (Heavy Timber)**
Exterior walls non-combustible (may be FRTW OR CLT)
Interior elements qualify as Heavy Timber (min. sizes, no concealed spaces except in 2021 IBC)
PRESCRIPTIVE BUILDING CODES
Tall Mass Timber Multi-Family
INTRO, CLEVELAND

9 Stories | 115 ft
8 Timber Over 1 Podium

512,000 SF
297 Apartments, Mixed-Use

Photo: Harbor Bay Real Estate Advisors, Purple Film | Architect: Hartshorne Plunkard Architecture
ASCENT, MILWAUKEE

Tallest Mass Timber Building in the World

25 STORIES
19 TIMBER OVER 6 PODIUM
284 FT

Photo: CD Smith Construction | Architect: Korb & Associates Architects
PRESCRIPTIVE BUILDING CODES

Type IV-A
- Office Assembly Residential
- Mercantile (12 stories)
- 270 ft. (18 stories)

Type IV-B
- Office Assembly Residential
- Mercantile (8 stories)
- 180 ft. (12 stories)

Type IV-C
- Office (9 stories)
- Residential (8 stories)
- Assembly Mercantile (6 stories)
- 85 ft. (9 stories)
Type IV-C

9 STORIES
BUILDING HEIGHT 85'
ALLOWABLE BUILDING AREA 405,000 SF
AVERAGE AREA PER STORY 45,000 SF

Credit: Susan Jones, atelierjones

Photos: Baumberger Studio/PATH
Architecture/Marcus Kauffman
Type IV-C Protection vs. Exposed

All Mass Timber surfaces may be exposed

Exceptions: Shafts, concealed spaces, outside face of exterior walls

Credit: Susan Jones, atelierjones
Type IV-B

12 Stories
Building Height 180 FT
Allowable Building Area 648,000 SF
Average Area Per Story 54,000 SF

Credit: Susan Jones, atelierjones
Credit: LEVER Architecture
Type IV-B Protection vs. Exposed

NC protection on all surfaces of Mass Timber except limited exposed areas

~20% of Ceiling or ~40% of Wall can be exposed
Type IV-A

18 STORIES
BUILDING HEIGHT 270'
ALLOWABLE BUILDING AREA 972,000 SF
AVERAGE AREA PER STORY 54,000SF

Credit: Susan Jones, atelierjones

Photos: Structurlam, naturally:wood, Fast + Epp
Type IV-A Protection vs. Exposed

100% NC protection on all surfaces of Mass Timber

Credit: Susan Jones, atelierjones
Credit: Acton Ostry Architects, Fast + Epp
2024 IBC Changes
INTEGRATED SYSTEMS

Credit: John Klein, Generate Architecture

The Tellhouse building system prioritizes the integration of design, engineering, and construction. This results in a high-performance building finely tuned to meet energy, comfort, acoustic, and design criteria that has been vetted by constructability experts to ensure fast, efficient production.

Utilizing Pre-Fabricated Facade Panels and Bathroom Modules that are manufactured off-site in factories allows for reducing construction time on-site, higher quality control practices, and safer labor conditions for construction workers. Efficient routing of duct work conserves material, and associated embedded carbon, allowing more exposed timber while providing the air quality needed for healthy living. Water conserving fixtures reduce potable water use as a precious resource, while maintaining reliable performance.
Fire Design of MT

CLT structural capacity

CLT char depth

Original CLT depth

Credit: David Barber, ARUP
Key Early Design Decisions

Fire-Resistance Ratings (FRR)
- Thinner panels (i.e. 3-ply) generally difficult to achieve a 1+ hour FRR
- 5-ply CLT / 2x6 NLT & DLT panels can usually achieve a 1- or 2-hour FRR
- Construction Type | FRR | Member Size | Grid (or re-arrange that process but follow how one impacts the others)

<table>
<thead>
<tr>
<th>Panel</th>
<th>Example Floor Span Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-ply CLT (4-1/8&quot; thick)</td>
<td>Up to 12 ft</td>
</tr>
<tr>
<td>5-ply CLT (6-7/8&quot; thick)</td>
<td>14 to 17 ft</td>
</tr>
<tr>
<td>7-ply CLT (9-5/8&quot;)</td>
<td>17 to 21 ft</td>
</tr>
<tr>
<td>2x4 NLT</td>
<td>Up to 12 ft</td>
</tr>
<tr>
<td>2x6 NLT</td>
<td>10 to 17 ft</td>
</tr>
<tr>
<td>2x8 NLT</td>
<td>14 to 21 ft</td>
</tr>
<tr>
<td>5&quot; MPP</td>
<td>10 to 15 ft</td>
</tr>
</tbody>
</table>

Credit: David Barber, ARUP
### FRR Design of MT

**WoodWorks Inventory of Fire Tested MT Assemblies**

Table 1: North American Fire Resistance Tests of Mass Timber Floor / Roof Assemblies

<table>
<thead>
<tr>
<th>CLT Panel</th>
<th>Manufacturer</th>
<th>CLT Grade or Major x Minor Grade</th>
<th>Ceiling Protection</th>
<th>Panel Connection in Test</th>
<th>Floor Topping</th>
<th>Load Rating</th>
<th>Fire Resistance Achieved (Hours)</th>
<th>Source</th>
<th>Testing Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 ply CLT (114mm x 4.88 in)</td>
<td>Nordic</td>
<td>SPF 15/50 + 5/1 ESME x SPF 83</td>
<td>2 layers 1/2” Type X gypsum</td>
<td>Half-Lap</td>
<td>None</td>
<td>Reduced 34% Moment Capacity</td>
<td>1</td>
<td>1 (Test 1)</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>3 ply CLT (155mm x 5.13 in)</td>
<td>Structuram</td>
<td>SPF #1/2 x SPF #1/2</td>
<td>None</td>
<td>Topside Splice</td>
<td>2 staggered layers of 1/2” cement boards</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>2</td>
<td>NRC Fire Laboratory March 2016</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 5/8” Type X gypsum</td>
<td>Topside Splice</td>
<td>2 staggered layers of 1/2” cement boards</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>5</td>
<td>NRC Fire Laboratory Nov 2014</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 5/8” Type X gypsum</td>
<td>Topside Splice</td>
<td>2 staggered layers of 1/2” cement boards</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>5</td>
<td>NRC Fire Laboratory Nov 2014</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 5/8” normal gypsum</td>
<td>Topside Splice</td>
<td>3/4 in. proprietary gypsum over Mason acoustic mat</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>4</td>
<td>UL</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Nordic</td>
<td>EI</td>
<td>1 layer of 5/8” Type X gypsum under Z-channels and herring strips with 3 1/8” - 8” in.</td>
<td>Topside Splice</td>
<td>3/4 in. proprietary gypsum over Mason acoustic mat or proprietary sound board</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>21</td>
<td>Interlock 8/24/2012</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Structuram</td>
<td>SPF 1950 x SPF #2</td>
<td>None</td>
<td>Topside Splice</td>
<td>1 1/2” Masonite Type G4 2,000 over Mason Reinforcing Mesh</td>
<td>Reduced, See Manufacturer</td>
<td>2.5</td>
<td>6</td>
<td>Interlock, 2/22/2016</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>DR Johnson</td>
<td>E1</td>
<td>None</td>
<td>Half-Lap &amp; Topside Splice</td>
<td>2” gypsum plugging</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>7</td>
<td>SwRI (May 2016)</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Nordic</td>
<td>SPF 1450 x SPF #1/2</td>
<td>None</td>
<td>Topside Splice</td>
<td>2” gypsum plugging</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>5</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5 ply CLT (245mm x 6.95 in)</td>
<td>Structuram</td>
<td>SPF #1/2 x SPF #1/2</td>
<td>None</td>
<td>Half-Lap</td>
<td>None</td>
<td>Unreduced 100% Moment Capacity</td>
<td>2</td>
<td>5</td>
<td>NRC Fire Laboratory</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Smartlam</td>
<td>SL-34</td>
<td>None</td>
<td>Half-Lap</td>
<td>no metal 1/2” ply with 9d nails.</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>12</td>
<td>Western Fire Center 10/26/2016</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>Smartlam</td>
<td>VI</td>
<td>None</td>
<td>Half-Lap</td>
<td>no metal 1/2” ply with 9d nails.</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>12</td>
<td>Western Fire Center 10/28/2016</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>DR Johnson</td>
<td>VI</td>
<td>None</td>
<td>Half-Lap &amp; Topside Splice</td>
<td>no metal 1/2” ply with 9d nails.</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>12</td>
<td>Western Fire Center 11/1/2016</td>
</tr>
<tr>
<td>5 ply CLT (175mm x 5.13 in)</td>
<td>K-LH</td>
<td>CVIM</td>
<td>None</td>
<td>Half-Lap &amp; Topside Splice</td>
<td>no metal 1/2” ply with 9d nails.</td>
<td>Reduced, See Manufacturer</td>
<td>2</td>
<td>12</td>
<td>Western Fire Center 11/1/2016</td>
</tr>
</tbody>
</table>
Acoustics & Sound Control
Acoustics & Sound Control

MT: Structure Often is Finish

Photos: Baumberger Studio/PATH Architecture/Marcus Kauffman | Architect: Kaiser + PATH
Acoustics & Sound Control

But by Itself, Not Adequate for Acoustics
# Acoustics & Sound Control

## TABLE 1:
Examples of Acoustically-Tested Mass Timber Panels

<table>
<thead>
<tr>
<th>Mass Timber Panel</th>
<th>Thickness</th>
<th>STC Rating</th>
<th>IIC Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-ply CLT wall⁴</td>
<td>3.07&quot;</td>
<td>33</td>
<td>N/A</td>
</tr>
<tr>
<td>5-ply CLT wall⁴</td>
<td>6.875&quot;</td>
<td>38</td>
<td>N/A</td>
</tr>
<tr>
<td>5-ply CLT floor⁵</td>
<td>5.1875&quot;</td>
<td>39</td>
<td>22</td>
</tr>
<tr>
<td>5-ply CLT floor⁴</td>
<td>6.875&quot;</td>
<td>41</td>
<td>25</td>
</tr>
<tr>
<td>7-ply CLT floor⁴</td>
<td>9.65&quot;</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>2x4 NLT wall⁶</td>
<td>3-1/2&quot; bare NLT 4-1/4&quot; with 3/4&quot; plywood</td>
<td>24 bare NLT 29 with 3/4&quot; plywood</td>
<td>N/A</td>
</tr>
<tr>
<td>2x6 NLT wall⁶</td>
<td>5-1/2&quot; bare NLT 6-1/4&quot; with 3/4&quot; plywood</td>
<td>22 bare NLT 31 with 3/4&quot; plywood</td>
<td>N/A</td>
</tr>
<tr>
<td>2x6 NLT floor + 1/2&quot; plywood²</td>
<td>6&quot; with 1/2&quot; plywood</td>
<td>34</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: Inventory of Acoustically-Tested Mass Timber Assemblies, WoodWorks⁷
Acoustics & Sound Control

There are three main ways to improve an assembly’s acoustical performance:

1. Add mass
2. Add noise barriers
3. Add decouplers
# Acoustics & Sound Control

## Inventory of Tested Assemblies

### Table 1: CLT Floor Assemblies with Concrete/Gypsum Topping, Ceiling Side Exposed

<table>
<thead>
<tr>
<th>CLT Panel</th>
<th>Concrete/Gypsum Topping</th>
<th>Acoustical Mat Product Between CLT and Topping</th>
<th>Finish Floor</th>
<th>STC¹</th>
<th>IIC¹</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLT 5-ply (6.875&quot;)</td>
<td>1-1/2&quot; Gyp Crete®</td>
<td>Maxxon Acousti-Mat® 3/4</td>
<td>None</td>
<td>47² ASTC</td>
<td>47² AIIIC</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LVT</td>
<td>49² AIIIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maxxon Acousti-Mat® 1% Premium</td>
<td>Carpet + Pad</td>
<td>75² AIIIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LVT on Acousti Top®</td>
<td>52² AIIIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eng.Wood on Acousti-Top®</td>
<td>51² AIIIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td>45² ASTC</td>
<td>45² AIIIC</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maxxon Acousti-Mat® 3/4</td>
<td>LVT</td>
<td>47² AIIIC</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LVT on Acousti-Top®</td>
<td>49² AIIIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLT 5-ply (6.875&quot;)</td>
<td>1-1/2&quot; Lavelrock®</td>
<td>USG SAM N25 Ultra</td>
<td>None</td>
<td>45⁵</td>
<td>39⁶</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LVT</td>
<td>48⁵</td>
<td>47⁶</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LVT Plus</td>
<td>48⁵</td>
<td>49⁶</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eng.Wood</td>
<td>47⁶</td>
<td>47⁶</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Carpet + Pad</td>
<td>45⁶</td>
<td>67⁶</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ceramic Tile</td>
<td>50⁶</td>
<td>46⁶</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td>45⁶</td>
<td>42⁶</td>
<td>15</td>
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Questions?

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