Mass Timber Shafts and Shaft Wall Solutions for Mass Timber Buildings

Presented by

Jeff Spiritos  
*Spiritos Properties*

Andrew Ruff  
*Gray Organschi Architecture*

Michael Scancarello  
*Odeh Engineers*

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
## ACME Timber Lofts

### Design + Development Team

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developer</td>
<td>ACME Timber LLC / Spiritos Properties LLC</td>
</tr>
<tr>
<td>Architect</td>
<td>Gray Organschi Architecture</td>
</tr>
<tr>
<td>Structural Engineer</td>
<td>Odeh Engineers</td>
</tr>
<tr>
<td>MEP Engineer</td>
<td>Acorn Engineers</td>
</tr>
<tr>
<td>Fire Engineer</td>
<td>Arup</td>
</tr>
<tr>
<td>Construction Manager</td>
<td>LaRosa Building Group</td>
</tr>
</tbody>
</table>

*Special thanks to the USDA Forest Service Wood Innovations Program for their support*
### Project Information

<table>
<thead>
<tr>
<th>Location</th>
<th>New Haven, Connecticut, USA</th>
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<tbody>
<tr>
<td>Building Type</td>
<td>Mixed-use Multifamily (R-2)</td>
</tr>
<tr>
<td>Construction Type</td>
<td>Type III – B (Existing)</td>
</tr>
<tr>
<td></td>
<td>Type IV-HT (Vertical Addition)</td>
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<tr>
<td></td>
<td>2021 IBC Code Modification</td>
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<tr>
<td>Existing Height</td>
<td>3.5 Stories +35’ Above Grade</td>
</tr>
<tr>
<td>New Height</td>
<td>5 Stories + Basement + Roof +73’-7” Above Grade</td>
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</tbody>
</table>
ACME Timber Lofts
Building Construction Type

**2021 IBC: 602.4.4 Type IV-HT**
Type IV-HT (Heavy Timber) construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid wood, laminated heavy timber or structural composite lumber (SCL), without concealed spaces or with concealed spaces complying with Section 602.4.4.3.

The minimum dimensions for permitted materials including solid timber, glued-laminated timber, SCL and cross-laminated timber (CLT) and the details of Type IV construction shall comply with the provisions of this section and Section 2304.11.

Exterior walls complying with Section 602.4.4.1 or 602.4.4.2 shall be permitted. Interior walls and partitions not less than 1-hour fire-resistance rated or heavy timber conforming with Section 2304.11.2.2 shall be permitted.

**2015 IBC: 602.3 Type III**
Type III construction is that type of construction in which the exterior walls are of noncombustible material and the interior building elements are of any material permitted by this code. Fire-retardant-treated wood framing and sheathing complying with Section 2303.2 shall be permitted within exterior wall assemblies of a 2-hour rating or less.
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Level 04

CLT Walls

CLT Core
Section 722.6 Wood Assemblies
This section contains procedures for calculating the fire-resistance ratings of walls, floor/ceiling and roof/ceiling assemblies based in part on the standard method of testing referenced in Section 703.2.

722.6.1.1 Maximum Fire-Resistance Rating
Fire-resistance ratings calculated for assemblies using the methods in Section 722.6 shall be limited to a maximum of 1 hour.

722.6.2.1 Fire-Resistance Rating of Wood Frame Assemblies
The fire-resistance rating of a wood frame assembly is equal to the sum of the time assigned to the membrane on the fire-exposed side, the time assigned to the framing members and the time assigned for additional contribution by other protective measures such as insulation. The membrane on the unexposed side shall not be included in determining the fire resistance of the assembly.
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Case Study   I   ACME Timber Lofts   I   December 15, 2022

2021 IBC

722.7 Fire-Resistance Rating for Mass Timber
The required fire resistance of mass timber elements in Section 602.4 shall be determined in accordance with Section 703.2. The fire-resistance rating of building elements shall be as required in Tables 601 and 705.5 and as specified elsewhere in this code. The fire-resistance rating of the mass timber elements shall consist of the fire resistance of the unprotected element added to the protection time of the noncombustible protection.

722.7.1 Minimum Required Protection
Where required by Sections 602.4.1 through 602.4.3, noncombustible protection shall be provided for mass timber building elements in accordance with Table 722.7.1(1). The rating, in minutes, contributed by the noncombustible protection of mass timber building elements, components or assemblies, shall be established in accordance with Section 703.6. The protection contributions indicated in Table 722.7.1(2) shall be deemed to comply with this requirement where installed and fastened in accordance with Section 722.7.2.
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The required fire resistance of mass timber elements in Section 602.4 shall be determined in accordance with Section 703.2. The fire-resistance rating of building elements shall be as required in Tables 601 and 705.5 and as specified elsewhere in this code. The fire-resistance rating of the mass timber elements shall consist of the fire resistance of the unprotected element added to the protection time of the noncombustible protection.

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ACME Timber Lofts
Shaft Conditions
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Structural System Overview

Existing Conditions

New Construction
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Structural System Overview

Existing Conditions

New Construction
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Code Path

2015 IEBC

[BS] 1103.3 Lateral force-resisting system. The lateral force-resisting system of existing buildings to which additions are made shall comply with Sections 1103.3.1, 1103.3.2 and 1103.3.3.

Exceptions:

1. Buildings of Group R occupancy with no more than five dwelling or sleeping units used solely for residential purposes where the existing building and the addition comply with the conventional light-frame construction methods of the International Building Code or the provisions of the International Residential Code.

2. Any existing lateral load-carrying structural element whose demand-capacity ratio with the addition considered is not more than 10 percent greater than its demand-capacity ratio with the addition ignored shall be permitted to remain unaltered. For purposes of this exception, comparisons of demand-capacity ratios and calculation of design lateral loads, forces and capacities shall account for the cumulative effects of additions and alterations since original construction. For purposes of calculating demand-capacity ratios, the demand shall consider applicable load combinations involving International Building Code-level seismic forces in accordance with Section 301.1.4.1.

ASCE 7-10

12.2.3 Combinations of Framing Systems in the Same Direction

Where different seismic force-resisting systems are used in combination to resist seismic forces in the same direction, other than those combinations considered as dual systems, the most stringent applicable structural system limitations contained in Table 12.2-1 shall apply and the design shall comply with the requirements of this section.

Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

<table>
<thead>
<tr>
<th>Seismic Force-Resisting System</th>
<th>ASCE 7 Section</th>
<th>Response Modification Coefficient, $R$</th>
<th>Overstrength Factor, $\Omega$</th>
<th>Deflection Amplification Factor, $C_d$</th>
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</thead>
<tbody>
<tr>
<td>BEARING WALL SYSTEMS</td>
<td>11</td>
<td>$1 \frac{1}{2}$</td>
<td>$2 \frac{1}{2}$</td>
<td>$1 \frac{1}{4}$</td>
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<tr>
<td>Ordinary plain masonry shear walls</td>
<td>14.4</td>
<td>$1 \frac{1}{2}$</td>
<td>$2 \frac{1}{2}$</td>
<td>$1 \frac{1}{4}$</td>
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</table>
ACME Timber Lofts
Structural System Overview
ACME Timber Lofts
Structural System Overview

**Existing Construction**
Exterior unreinforced masonry shear wall

Interior unreinforced masonry shear wall

**New Construction**
Existing unreinforced masonry shear walls

New light-framed wood shear walls

New CLT shear walls
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Attachment to Existing Structure

TYPICAL CLT ATTACHMENT AT TOP OF EXISTING BRICK MASONRY WALL

NO SCALE
ACME Timber Lofts
CLT Panel Connections
ACME Timber Lofts
Elevator Shaft Considerations
This concludes The American Institute of Architects Continuing Education Systems Course

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QUESTIONS?