All-wood Podiums in Mid-rise Construction

Karyn Beebe, PE, LEED AP

Learning Objectives

At the end of this program, participants will have:

1. Participants will analyze the code study including the opportunities and challenges for wood use in this project and be able use that knowledge to specify this type of system in the future.

2. Attendees will learn the motivational drivers associated with the use of wood for this project and why they may consider it on future projects vs. typically specified systems.

3. Participants will discover the structural challenges associated with a wood podium as designed in this project and gain a better understanding of the collaboration necessary with the structural engineer.

4. Participants will understand how the building was designed for durability and longevity using non-traditional systems and methods.

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Podium Construction Defined

- Traditional Podium Construction
  Residential + Nonresidential concrete podium
- Wood Podium Construction
  Residential + Nonresidential wood podium
History Wood Podiums

Outcomes:

- Podium Construction Defined
- Project Overviews
- Design Challenges and Solutions
- Features and Benefits

Oceano at Warner Center:

- Luxury apartments, 244 units
- 4 stories above grade, one story below, 55'
- 2008 LABC based on 2007 CBC based on 2006 IBC

Galt Place:

- Affordable seniors’ housing, 88 units
- 3 stories, 47'
- 2007 CBC based on 2006 IBC

Oceano at Warner Center

- Project Team:
- Owner: TDI California Construction & Oceano Partners
- General Contractor: TDI California Construction
- Architect: RC Alley III, NCARB, Architects Orange
- Structural Engineer: Tom VanDorpe, SE, VanDorpe Chou Associates, Inc. (VCA)
- Framer: Brian Larrabure, Larrabure Framing

- Construction Timeline:
- January 2011 to occupancy in July 2012
Oceano at Warner Center

Architectural Components:
- Construction Type: VA
- Occupancies: Below Grade: S-2 Enclosed semi-subterranean parking below grade
- Levels 1-4: R-2 Building 1 – 116 units (146,847 sf) and Building 2 – 128 units (163,468 sf)
- Sprinklers: NFPA 13 sprinkler system.

Galt Place

- Project Team:
- Owner: City of Galt and CFY Development Inc.
- General Contractor: CFY Development Inc.
- Structural Engineer: Mike Baker, SE, Baker Guptil Structural Designs, Inc.
- Framer: Becker General Contractors

- Construction Timeline:
- March 2011 to occupancy in June 2012
Structural Specifications

- Light-framed shear walls all levels
- Wood Podium: Engineered Wood System
  - Wood Structural Panels with gypcrete topping
  - I-joists
  - Glulaminated Beams (Glulams)

Structural Components

- Light-framed shear walls
  - Superstructure
    - Shear wall design methods
    - Architectural Gingerbread
  - Wood Podium
    - Focus on Continuity
    - Detailing
Structural Components

**Engineered Wood System**
- Wood Structural Panels
  - Oriented Strand Board (OSB)
- Plywood for balconies
- I-joists and Sawn Lumber

**Glulam Beams**
- **2 Stress Classes**
  - Bending Stress, Modulus of Elasticity
    - 24F-1.8E (2400 psi, 1.8x10^6 psi)
    - 30F-2.1E LVL (3000 psi, 2.1x10^6 psi)
- **Variety Sizes**
  - 5-1/8 inches to 12-1/4 inches wide
  - 10-3/4 inches to 45 inches deep

**LVL Laminations**
- High Strength Composite (HSC) Beams
  - Hybrid Glulam with LVL Outer Laminations
  - Full length with no finger joints required
  - LVL has greater tensile strength compared to lumber
  - 30F-2.1E stress level achieved
  - Direct substitute for many SCL products

**Structural Steel**
- Steel Columns & Connections
- Price Steel Beams > Glulams
OUTLINE:

- Podium Construction Defined
- Project Overviews
- Design Challenges and Solutions
- Features and Benefits

2007 California Building Code (CBC)

Governing Codes for Engineered Wood Design

2008 City of Los Angeles Building Code
Heights and Areas

What factors into determining allowable heights and areas?

- Occupancy
- Construction Types
- Protected or Unprotected
- Open Frontage
- Sprinklers
- Fire Walls/Barriers

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2009 Special Provisions – 509

509.2 Horizontal building separation allowance.

Considered separate buildings above and below for purposes of area calculations if:

- 3hr horizontal assembly
- One story above grade of Type 1A with sprinklers below separation
- Occupancy above is A, B, M, R or S
- Occupancy below is A, B, M, R or S-2
- Overall height is still limited

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2009 Special Provisions – 509

509.4 Parking beneath Group R.

Possibility of a Type IV podium where number of stories starts above parking:

- Horizontal assembly
- One story above grade of Type IV open with sprinklers below separation
- Occupancy above is A, B, M, R or S
- Occupancy below is A, B, M, R or S-2
- Overall height is still limited
Considering a Conventional Code “Podium”
Will the parking work?

509.7 *Open* parking below Group R
Height and area above the open parking garage per section 503; height measured from grade plane including both the garage and the building above the garage.
Garage area / height per 406.3

Enclosed Garages: 406.4
Height and area as per table 503 as modified by sections 504, 506, and 507

Type V is OK for S2 Occupancy per table 503

*Parking Garage is OK in Type VA construction if it is enclosed*

For enclosed garage: Ventilation must be provided per Mechanical Code

### Enclosed Parking Garage

**Ventilation Systems required for Enclosed Garages**

- **Mech Code: 403.8 Exhaust Ventilation for Enclosed Parking Garages.**
  - Exhaust airflow for enclosed parking garages shall be provided in accordance with the requirements in Table 4-4 and this Section.
  - Exhaust makeup air shall be permitted to be any combination of outdoor air or transfer air.

  *Table 4-4 Parking garages 0.75 cfm / sq ft*

- **403.8.2 Alternative Exhaust Ventilation for Enclosed Parking Garages.**
  - Mechanical ventilation systems used for enclosed parking garages shall be permitted to operate intermittently where the system is arranged to operate automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices.

- Part natural and part mechanical ventilation permitted by code

  - **Final result: 10,000 cfm system ...cost 10K**

### Code Area Analysis

#### Automatic Sprinkler Increase for Height

**CBC 504.2** Where a building is equipped throughout with an approved sprinkler system...

- Maximum height is increased by 20 feet
- Maximum number of stories is increased by one.

Can be combined with frontage area increase - 506.2
Can be combined with sprinkler area increase - 506.3

- **EXCEPT for high-rise buildings, Group A, E, H, I, L and R (not including R-2 Type VA) occupancies**
**Area Modification – CBC 506**

\[ A_a = A_t + [A_t \times l_f] + [A_t \times l_s] \]  
(Equation 5-1)

- \( A_a \) = Allowable area per story (sq. ft.)
- \( A_t \) = Tabular area per story (Table 503) (sq. ft.)
- \( l_f \) = Area increase factor due to frontage (CBC 506.2)
- \( l_s \) = Area increase factor due to sprinkler protection (CBC 506.3)

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**506.2.1 “Frontage Increases”**

Calculation of “W” for allowable area increases due to open perimeter (“open frontage”) has been clarified for building on the same lot.

\[ W = \text{exterior wall to exterior wall} \]

Equation 5-2 of the 2009 IBC:

\[ l_f = \left[ \frac{F/P - 0.25}{30} \right] W / 30 \]  
(.75 max)

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**Frontage Increase for Area**

- **CBC 506.2** - Allowable size of building may increase where open frontage is provided.

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**506.3 Automatic Sprinkler System Increase**

- **IBC 506.3** - The area limitation in Table 503 is permitted to be increased by an additional:
  - 200 percent \( l_f = 2 \) for buildings with more than one story above grade plane
  - 300 percent \( l_f = 3 \) for buildings with no more than one story above grade plane.
  - These increases are permitted in addition to the height and story increases in accordance with Section 504.2

- California Exceptions for **Group A, E, H, I, L, R (not including R-2 VA) and Highrise**
Why incorporate fire walls?

- **705.1 General** - Each portion of a building separated by one or more fire walls that comply with the provisions of this section shall be considered a separate building.
- For example if an 18,000 sf building is desired using type VB the maximum square footage is 9,000sf.

<table>
<thead>
<tr>
<th>Max Size Type VB</th>
<th>Max Size Type VB w/firewall</th>
</tr>
</thead>
<tbody>
<tr>
<td>9,000sf</td>
<td>9,000sf 9,000sf</td>
</tr>
</tbody>
</table>

Fire Walls

- What is a Fire Wall as defined in the CBC?
  - CBC 705.4 Fire-resistance rating (hours) of walls as specified in Table 705.4 (Depends on Group occupancy)
  - Section 705.3 requires that fire walls shall be of any approved noncombustible materials.
    - Exception: Buildings of Type V construction.
  - CBC 705.2 Collapse of construction on either side to not affect structural integrity of wall for the duration of fire-resistance rating.
Fire Walls

- A Fire Wall effectively defines the boundaries for a new building.
- In many cases 2 hour walls are acceptable for Type V construction with untreated wood.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FIRE-RESISTANCE RATING (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, E, H-4, I, R-1, R-2, U</td>
<td>3a</td>
</tr>
<tr>
<td>F-1, H-3b, H-5, M, S-1</td>
<td>3b</td>
</tr>
<tr>
<td>H-1, H-2</td>
<td>4b</td>
</tr>
<tr>
<td>F-2, S-2, R-3, R-4</td>
<td>2b</td>
</tr>
</tbody>
</table>

a. Walls shall be not less than 2-hour fire-resistance rated where separating buildings of Type II or V construction.

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Oceano at Warner Center

**Architectural Components:**
- **Construction Type: VA**
- **Areas & Occupancies:**
  - Below Grade: S-2 Enclosed semi-subterranean parking below grade with 353 parking stalls (78,650 square feet)
  - Levels 1-4: R-2 with a total of 244 units (310,195 square feet)
  - Building 1 has – 116 units (146,847 square feet) and Building 2 has –128 units (163,468 square feet)
- **Sprinklers:** NFPA 13 sprinkler system.

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Oceano Wood Podium

- R-2 & S-2 Enclosed Occupancies
- Type V Construction
- CBC 508.3.3 – Mixed Use Occupancy
  - **Section 711.2** for the requirements of the horizontal assembly states the floor and roof assemblies shall be of materials permitted by the building type of construction.
  - **Table 508.3.3** specifies a fire separation between occupancies to have a 1-hour fire resistive rating.

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Galt Place

- **Architectural Components:**
- **Construction Type: VA**
- **Areas & Occupancies:**
  - Level 1: S-2 70 covered and open air parking stalls (24,633 square feet), A2, M and B– Retail/Restaurant/Office and Residential Administration (14,356 sf)
  - Levels 2 and 3: R-2– 88 Units (62,480 square feet)
  - Separated Occupancies: 1 hour maximum fire resistive rating per Table 508.3.3
- **Sprinklers:** NFPA 13 sprinkler system.
Galt Wood Podium

- R-2 & S-2 Enclosed Occupancies
- Type V Construction
- CBC 508.3.3 – Mixed Use Occupancy
  - Section 711.2 for the requirements of the horizontal assembly states the floor and roof assemblies shall be of materials permitted by the building type of construction.
  - Table 508.3.3 specifies a fire separation between occupancies to have a 1-hour fire resistive rating.

Design Challenges and Solutions

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Ara Sargsyan, PE, CBO, LEED AP

Engineer at City of Los Angeles
Greater Los Angeles Area - Government Administration

Current: Supervising Plan Check Engineer City of Los Angeles
Past: Project Leader at LG Design, Inc.; Assistant Professor at Yerevan Polytechnic Institute
Education: Yerevan Polytechnic Institute
Connections: 115 connections

Ara Sargsyan, PE, CBO, LEED AP's Experience

- Supervising Plan Check Engineer
- City of Los Angeles (Government Agency, Government Administration Industry)
- January 2003 – Present (10 years 4 months)
- Planning/Design/Supervision

- Project Leader
- LG Design, Inc.
- Civil Engineering-Master
- December 1997 – April 2003 (6 years 5 months)
- Detailing of Precast, Prestressed Concrete Elements

- Assistant Professor
- Yerevan Polytechnic Institute
- Master of Science
- 2000 – 2005 (5 years)

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Check Height & Area (Cha-Cha) for 2007/2010 CBC

Type of Construction: XA
Max Permitted Height: Virtual Permitted Height: 50
Sprinklers Throughput per 500 ft. L (not applicable for M construction):

- 1st floor: Occup. Area A (sq ft)
- 2nd floor: Occup. Area B (sq ft)
- 3rd floor: Occup. Area C (sq ft)
- Total Building Area (sq ft)

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Code Check Resources
Design Challenges & Solutions

**Durability:**
- Protected building envelope
- Different approaches
  - Oceano
  - Galt

Design Challenges & Solutions

**Exposed Conditions**
- Preservative treatment
- Naturally durable wood species
  - Alaskan Yellow Cedar
  - Port Orford Cedar

Design Challenges & Solutions

Two accepted fire rating methods recognized in the U.S.
- IBC Empirical Method
- NDS Mechanics Based Model

FRT

Design Challenges & Solutions

*Calculating Fire Resistance of Glulam Beams and Columns*, Technical Note Y245
Design Challenges & Solutions

**Communication:**
- Project team
  - Subconsultants
  - Single Engineering Firm
- BIM
- Glulam Manufacturers
- Emphasis on Stacking

**Field Modifications:**
- BIM
- Hole cutting
- Field Notching and Drilling of Glulam (APA Form S560)

**OUTLINE:**
- Podium Construction Defined
- Project Overviews
- Design Challenges and Solutions
- Features and Benefits
Benefits

Enhanced constructability:
- Fewer trades on job
- Less mobilization time
- Fewer construction delays

Enhanced constructability:
- Improved framing efficiency
- Large pool experienced and competitive labor
- Easier field modifications

Structural:
- Decreased mass for lateral design
- Continuity of lateral system
- Fewer design team members

Improved sustainability:
- Wood as a building material
- LEED-HMR Silver (Oceano)
- LCA
- Sawn lumber products have a negative net CO₂ contribution.
- Wood industry often contributes biomass energy to the grid.

Galt Place is a great example of **Smart Growth**:
- **Mixed Use**
- **Infill and Urban**
- **Encourages transportation choice - car, bus, walk, bicycle**
- **High in Resource Efficiency**
  - low energy and land use
  - supports existing infrastructure
- **Quality Design that creates a sense of place**

### Wood Structures = Long Term Storage

- 2,400 sf home = 32 m³ structural = 29 metric tons CO₂ = 5.7 passenger annual emissions

**Features and Benefits**

*Source: FP Innovations*
Benefits

More economical building:
- Motivating factor to build wood podiums for both projects
- Oceano - wood podium estimated to be 2/3 cost of concrete podium
- Galt – change order - received $2 million credit primarily due to use of wood

Public Partner Perspective

- Affordable housing requires Public-Private Partnerships
- C.F.Y. Development financed this $20 million project with a combination of partnership equity, conventional mortgage, deferred profit and a loan from the City of Galt Redevelopment Agency

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partnership Equity</td>
<td>$ 13.4</td>
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<tr>
<td>Mortgage 1st TD</td>
<td>$ 3.4</td>
</tr>
<tr>
<td>City RDA Loan 2nd TD</td>
<td>$ 2.5</td>
</tr>
<tr>
<td>Deferred Profit</td>
<td>$ 0.8</td>
</tr>
</tbody>
</table>

Resources

- APA Case Study, Form No. N110
- [www.apawood.org](http://www.apawood.org)
- [www.woodworks.org](http://www.woodworks.org)
Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

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