# 1430 Q: Engineering the First 6-over-2 Podium Building in the US

## Sacramento, CA

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#### **Course Description**

While five-story wood buildings are increasingly common, 1430 Q in Sacramento is the first building in the U.S. to include six stories of wood-frame construction over a two-level concrete podium. Intended primarily for engineers, this presentation will explore the structural design challenges associated with this unique mixed-use project including connection of the wood structure to the concrete podium, and lateral system design. It will also provide insight into the alternate means process that was necessary for project approval, including questions and concerns raised by the City of Sacramento and how they were resolved.

## Learning Objectives

- 1. Discuss the successful navigation of the Alternate Means and Methods process with the City of Sacramento.
- 2. Examine the structural design considerations associated with a 6-over-2 building, including connection of the wood structure to the concrete podium.
- 3. Review the building's lateral system and relevant design considerations.
- 4. Describe how the 1430 Q project meets fire life safety objectives.

## Alternate Means and Methods Request (AMMR)



## The Vision

- Location
- Building Overview
- Code Limitations
- AMMR Process

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#### Location



 1430 Q Street, Sacramento, CA

- Fremont Park
- Light Rail
- R Street Redevelopment

## **Building Overview**







- 6-1/2 stories wood-frame construction
- 2 story concrete podium
- 1 story concrete basement
- 121 ft x 161 ft overall plan dimension
- 163,000 square feet
- 95ft tall above grade to roof
- 74ft to level 8
- 10 ft basement

## **Code Limitations | Podium**

		CODE REFERENCE
CONSTRUCTION TYPE	Type 1A	601
OCCUPANCY TYPES	A-2, B, S-1 & S-2	301
BASIC ALLOWABLE AREA	A - Unlimited B - Unlimited S-2 Unlimited	TABLE 503
MAX. HEIGHT	Unlimited	504.2
MAX. STORIES	Unlimited	504.2
SPRINKLERS	Yes	901

- 2013 CBC / 2012 IBC
- Type I-A concrete podium
- Unlimited height and area
- Sprinklers
- CBC 510.2 limits height of podium to one story

## **Code Limitations | Superstructure**

		CODE REFERENCE
CONSTRUCTION TYPE	Type IIIA	601
OCCUPANCY TYPE	R-2	301
BASIC ALLOWABLE AREA	24,000 sf	TABLE 503
MAX. HEIGHT	65	504.2
MAX. STORIES	4	504.2
SPRINKLERS	Yes	901

- 2013 CBC / 2012 IBC
- Type III-A wood framed superstructure
- 65ft max height or 4 stories
- Sprinklers
- 504.2 allows height increase of 20ft and/or one story if sprinklers installed.
  - 85ft Max Height (to roof)
  - 5 stories

## **Code Limitations | Structural Lateral System**

	Stru	Structural System Limitations Including Structural Height, h <sub>e</sub> (ft) Limits <sup>4</sup>				
	s	eismic	Design	Catego	ary	
Seismic Force-Resisting System	в	с	Dŕ	Ed	F*	
A. BEARING WALL SYSTEMS				5.4.03		
15. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance	NL	NL	65	65	65	

ASCE 7-10 Table 12.1-1

 65ft max height for wood shear walls

#### **Code Limitations | Structural Lateral System**



- Two-stage analysis per ASCE 7-10 12.2.3.2
- Stiffness and period requirements to be considered two-stage

## **Code Limitations | Summary**



- 85ft max height above grade
- 5 stories max height for woodframe portion
- 65ft max height for wood shear walls
- Single-story podium



#### **AMMR Process**

- Study options to go taller
- Allowed by CBC 104.11 and CFC 104.9
- Authority having jurisdiction needs to approve

## **AMMR Process**

#### City of Sacramento Code

d. 104.9 Alternate means and methods. The provisions of this code are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by this code, provided that any such alternative has been approved. The fire code official is authorized to approve an alternate material or method of construction where the fire code official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code and these local amendments, and that the material, method or work offered is, for the purpose intended, at least 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 fire code official shall respond in writing, stating the reasons why the alternative was not approved.

- Woodworks helped with AMMR application
- Fire Marshall decision
  - 2-hour rated walls

- Unit separation walls
- Corridor walls/systems
- Bearing walls
- Two roof-access stairwells

## **AMMR Process**



No structural AMMR

- Seismic base is at level 4
  - Level 4 is wood framed with the exception of the shear walls, which are concrete

## **Structural Design Considerations**



- Overall Building Layout
- Concrete Shear Walls
- Podium
- Concrete Columns
- Connection of Wood Structure to Podium
- Wood Framing System



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- 33" Basement Mat Slab Foundation
  - Perimeter Concrete Retaining and Shear Walls





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- Level 3 Podium
- 15" Post-tensioned twoway concrete slab
- Slab transfer beams
- Concrete shear walls





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- Typical Wood Floors
- Pre-fabricated floor trusses
- Wood shear walls





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- Roof
- Pre-fabricated roof trusses
- Solar panels



### **Concrete Shear Walls**



- Seismic base at level 4
- Discontinuous shear walls at level 3 and level 1

## **Podium Design**



- Reduced thickness at center courtyard
- Punching shear uses drop caps and studrails in some locations

## **Podium Design**



- Slab beams
- Column capitals where needed





**Podium Design** 

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- Soffit elevation plan to clarify the height of:
  - Slab beams
  - Drop caps
  - Column capitals
  - Depressed areas
  - Sloped thickness transitions

#### **Concrete Columns**



- Constrained by parking layout
- 18x40 largest



# HOLDOWN TENSION ROD BEARING PLATE BOLT THROUGH SLAB

## **Connection of Wood Structure to Podium**

- Holdown system bolt through podium
  - Holdown rod developed into concrete shear wall where occurs
  - Sill bolts cast-in-place into concrete podium slab

## **Wood Framing System**



- Wood stud bearing walls
- 3x6 @ 12"cc at lowest level wall
  - Some local areas of 3x6 @ 8"cc
- Top floor double height wall where mezzanine does not occur

### **Wood Framing System**



- Type IIIA construction
- Fire retardant treated wood in exterior wall
  - 2-hour exterior walls

- Woodworks assistance on detailing options
- A discussion with the building department regarding detailing is necessary

#### **Wood Framing System**



Proprietary joist hangers to span over gyp board layers

## Shrinkage



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## Flexible coupling for gas pipes

Estimated Building Shrinkage/Settling				
Lavai	Level '8'	<u>Cumulative '8'</u>		
Roof	0.8'	1.70"		
Mezz	0.8'	1.845*		
øm	0.30'	1.40*		
799	0.30'	1101		
øm.	0.27	0.8'		
810	0.26*	0.83*		
410	0.27	0.27		

1. 'B' indicates combined shrink age and setting in.

- Betingled enrinkage and setting in values assume all unbe in all framing has NC ≤rkh at the time of installation.
- These value have been provided for consideration in the design and defailing of building expleme errelive to enrink age such as he down take up devices, purping systems, etc.

- Shrinkage considerations due to extra level of wood framing
- Specify wood with <19% moisture content
  - Other building systems such as plumbing pipes also need to consider shrinkage effects

## **Plumbing in Walls**



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 Plumbing in walls required study and repairs

### **Exterior Building Maintenance**



 Tieback and davit anchors on wood framing



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## **Structural Lateral System**



- Transfer 'Slab Beams'
- Wood Shear Walls

Wood Diaphragms

#### **Transfer Slab Beams**



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## Wood Shear Walls



44'-0"

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- Both walls in the double party wall are shear walls
- Some walls near the bottom are double sided shear
- Continuous tie-down rod system is used for holdowns

#### **Wood Shear Walls**



- Concrete walls extend up to level 4
  - Concrete shear wall at 4<sup>th</sup> floor takes full load

#### **Wood Shear Walls**



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 Large compression post sizes at bottom of wall

## **Wood Diaphragms**

**Exception:** Where calculations show that diaphragm deflections can be tolerated, the length, L, (normal to the open side) shall be permitted to be increased to an L/W ratio not greater than 1.5:1 when sheathed in conformance with 4.2.7.1 or 4.2.7.3, or not greater than 1:1 when sheathed in conformance with 4.2.7.2.

- 2008 SDPWS 4.2.5
  - Deflections checked to allow 1.5:1 ratio of L/W
- Note: 2015 SDPWS requirements are different – consult current code

## Wood Diaphragms



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- Envelope rigid and flexible analysis
- Strap for collectors to shear walls



## **Fire Life Safety Objectives**



- Wall Assemblies
- Floor Assemblies
- Corridor Systems
- Fire Separations
- Sprinkler System
- Compartments

#### **Wall Assemblies**



- 2-hour structural walls
- 2-hour exterior walls

#### **Floor Assemblies**



2-hour rated

- 3 layers 5/8" Type 'X' gypsum board ceiling
- 1 ¼" gypsum concrete floor topping

#### **Corridor Systems**



- 2-hour rated
  - 2 layers 5/8" Type 'X' gypsum board at floor joists
- 1 layer 5/8" Type 'X' gypsum board with plaster at ceiling joists



- 3-hour separation
- 2" autoclaved aerated concrete (AAC) panels

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#### **Fire Separations**



 Melt away clips on each side



#### **Fire Separations**



3-hour separation wall where double sided shear walls occur required two AAC panels for constructability

## **Exiting Routes**



- Horizontal exit through fire separation wall
- Door frame attached to concrete wall panel
- Two communication devices in corridor per level

## **Fire Sprinklers**



 Automatic sprinklers per NFPA 13



#### **Compartments & Access**

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This approval is specific to this project.	and this request, and is not transferable
AMMR has been all elements pr is included in t	approved pending that aposed in pris decoment the project drawings.

 Compartments facilitate in fire fighting

 Additional stair access to roof

when planning fire control in buildings. Due to the inherent design of apartments, residential occupancies have a high degree of compartmentalization. This includes floors, corridors and unit separation walls which define a fire area significantly less than the allowable building area. These small compartments limit fire size and maintain structural integrity of the building. Providing 2-hour fire-resistance-rated separation walls throughout the Type IIIA building will create smaller fire areas and help to reduce the spread of fire throughout the building.









## **Questions?**

This concludes The American Institute of Architects Continuing Education Systems Course

Owner: D&S Development Architect: HRGA

#### **Structural Engineer:**

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ideas engineered | visions realized