Engineering the First 6-over-2 Podium Building in the US

Sacramento, CA

Presented by Ryan Miller, S.E., LEED AP

Associate Principal, BUEHLER

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

"The Wood Products Council" is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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.

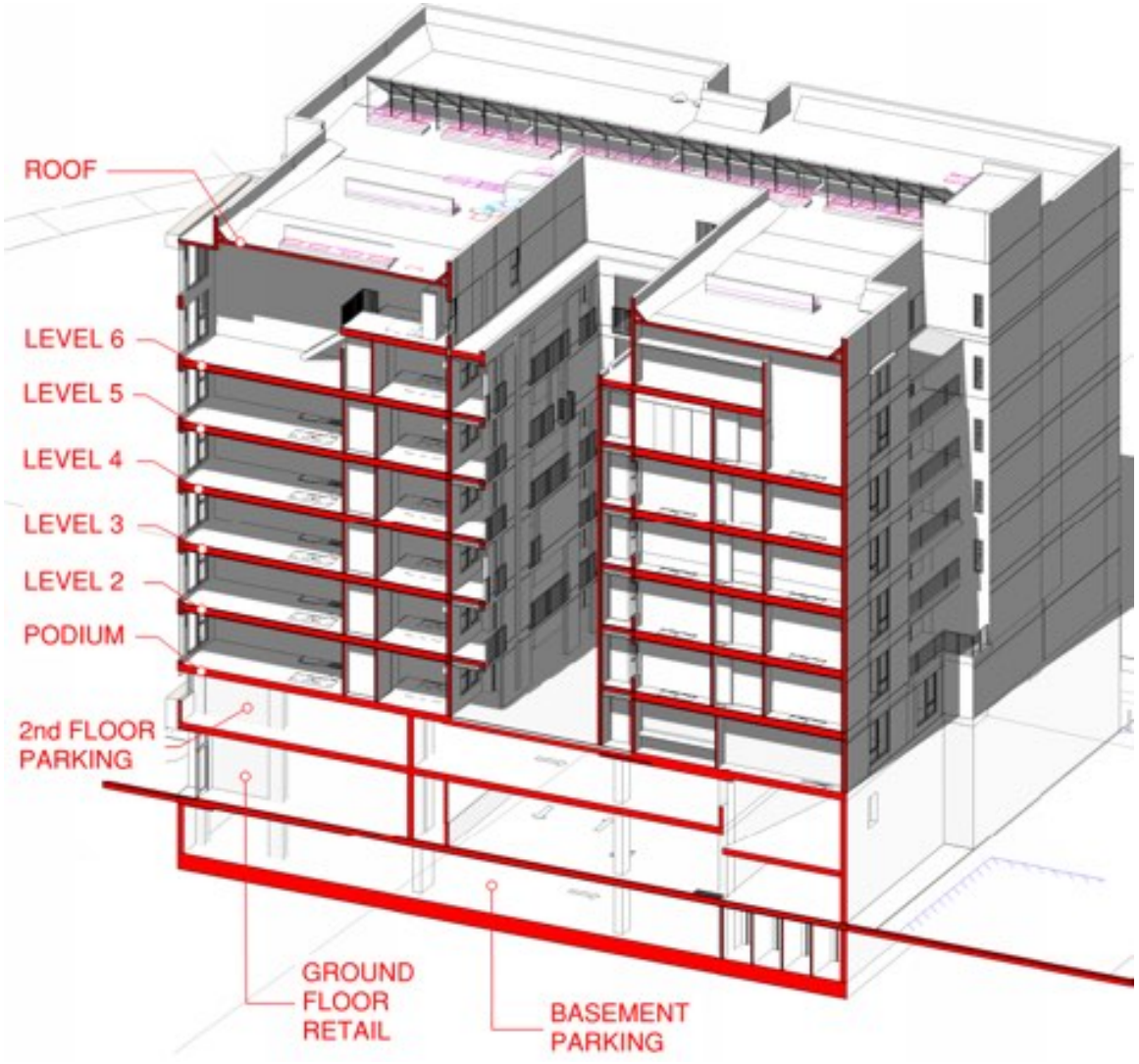
Alternate Means and Methods Request (AMMR)

- **The Vision**
  - Location
  - Building Overview
  - Code Limitations
  - AMMR Process

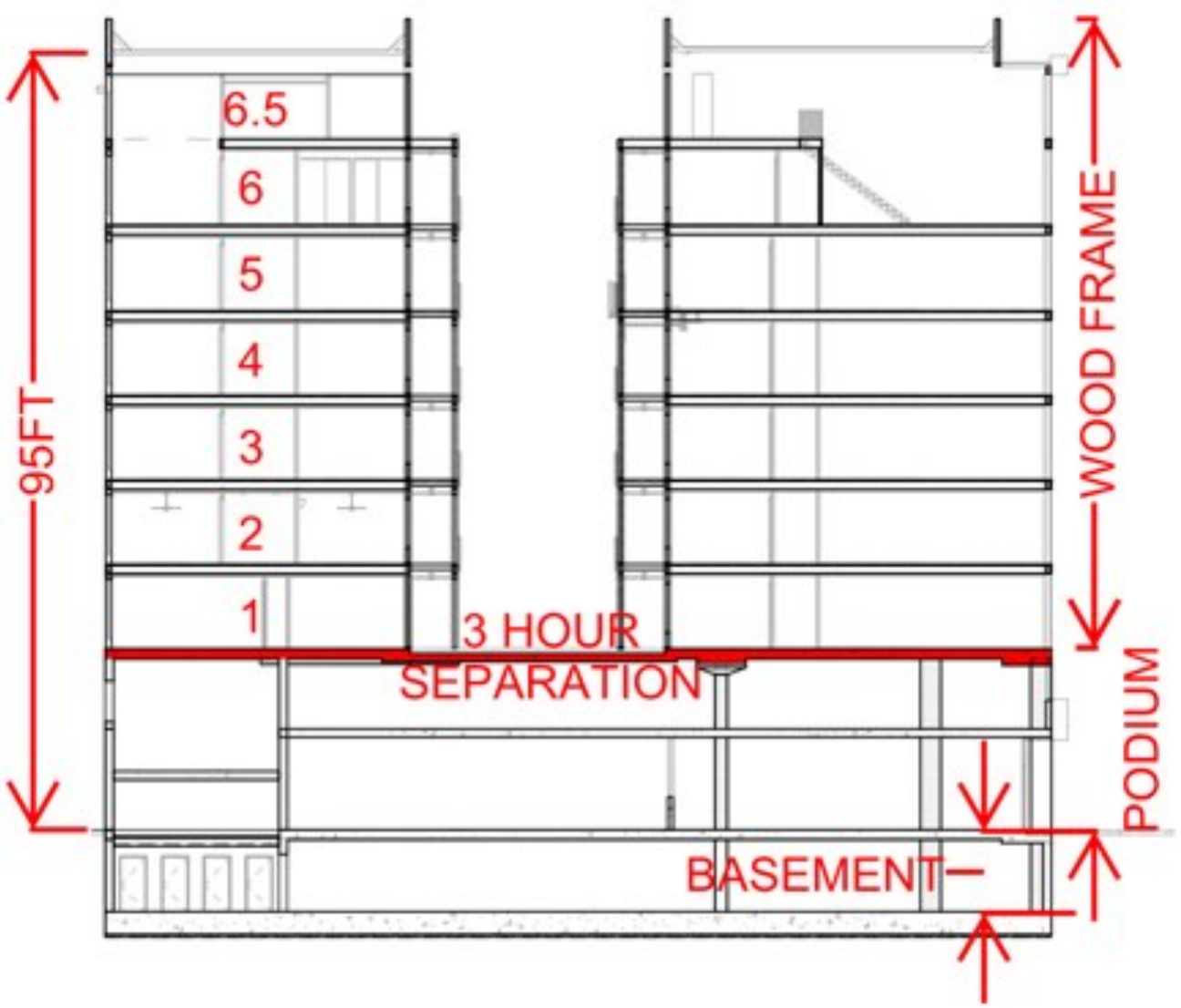
Location

- **1430 Q Street, Sacramento, CA**
  - Fremont Park
  - Light Rail
  - R Street Redevelopment

Building Overview



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

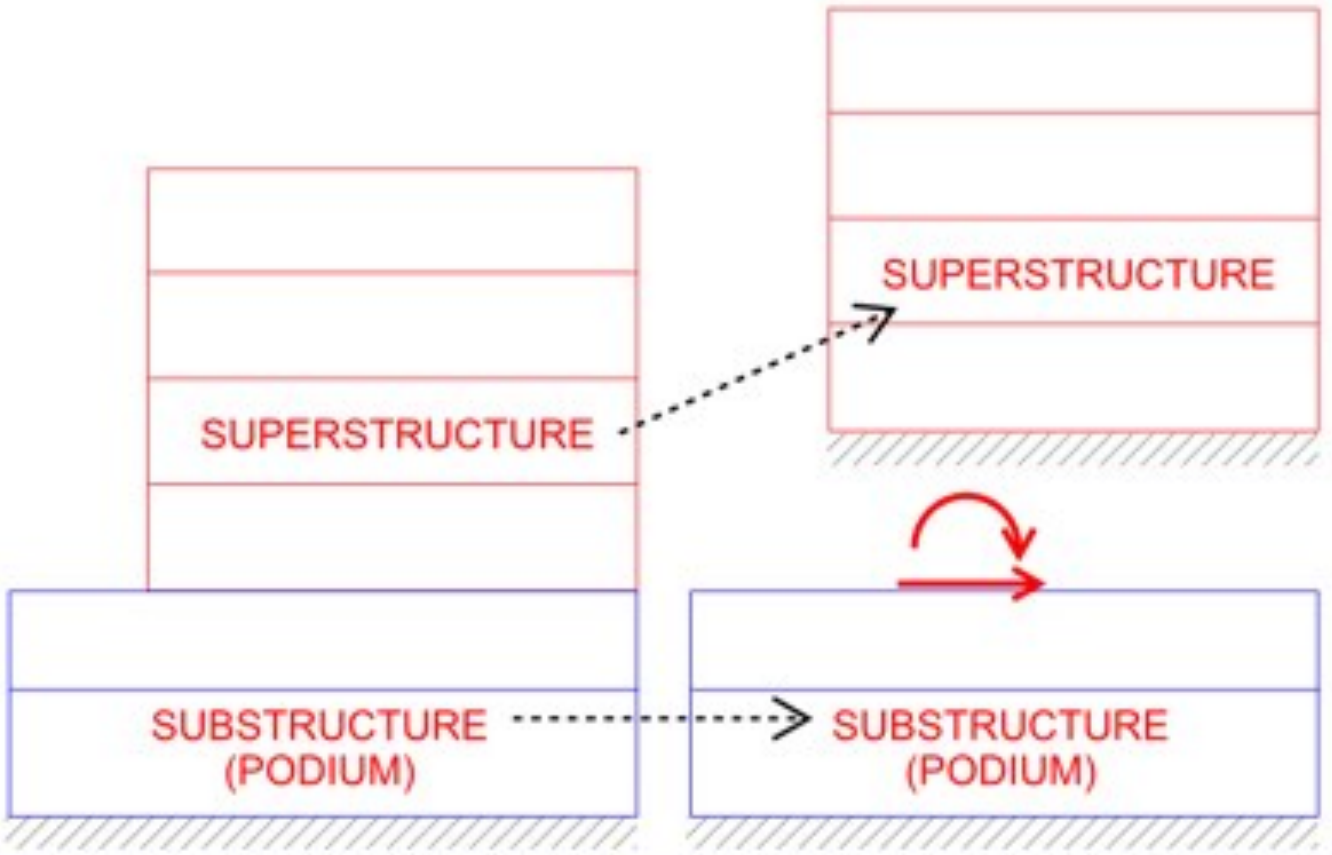
- 2013 CBC / 2012 IBC
- Type III-A wood framed superstructure
- 65ft max height or 4 stories
- Sprinklers
- 504.2 allows height increase of 20ft and/or one story if sprinklers installed.
  - 85ft Max Height (to roof)
  - 5 stories

Code Limitations | Structural Lateral System

Seismic Force-Resisting System	Structural System Limitations Including Structural Height, h_n (ft) Limits[c]				
	Seismic Design Category				
	B	C	D[d]	E[e]	F[e]
A. BEARING WALL SYSTEMS					
15. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance	NL	NL	65	65	65

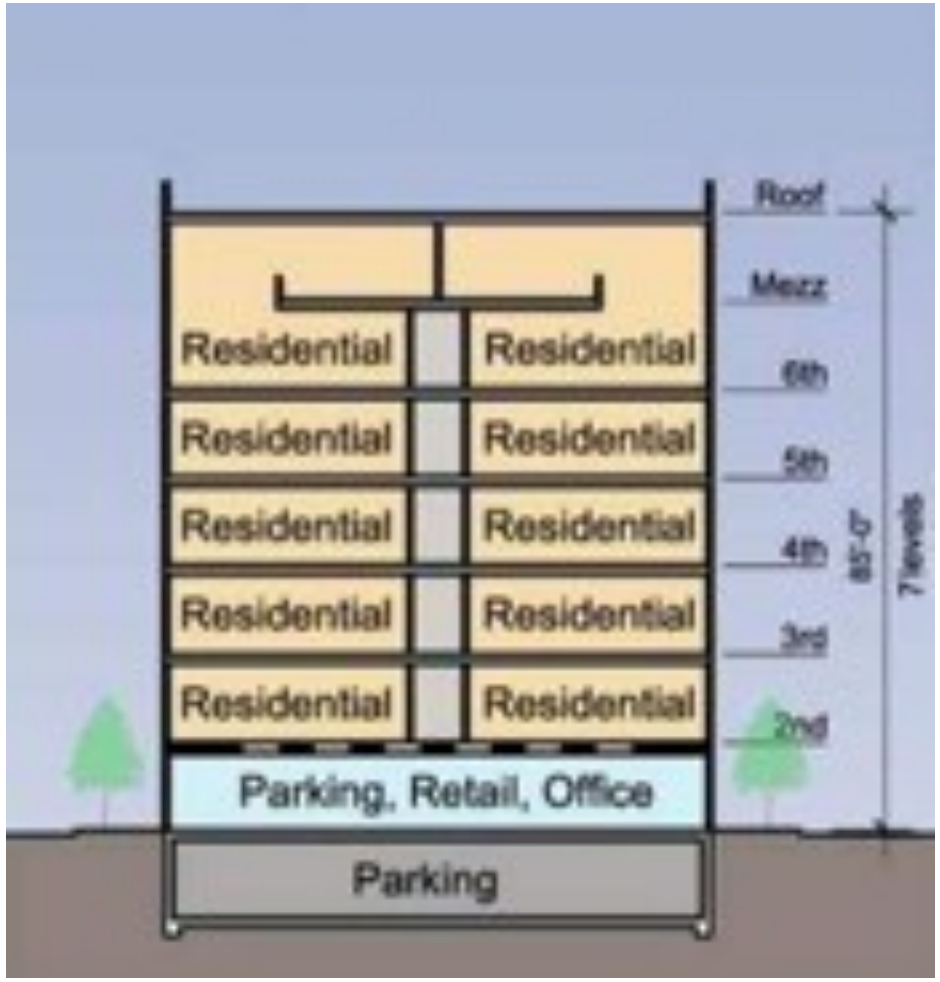
- ASCE 7-10 Table 12.1-1
- 65ft max height for wood shear walls

Code Limitations | Structural Lateral System



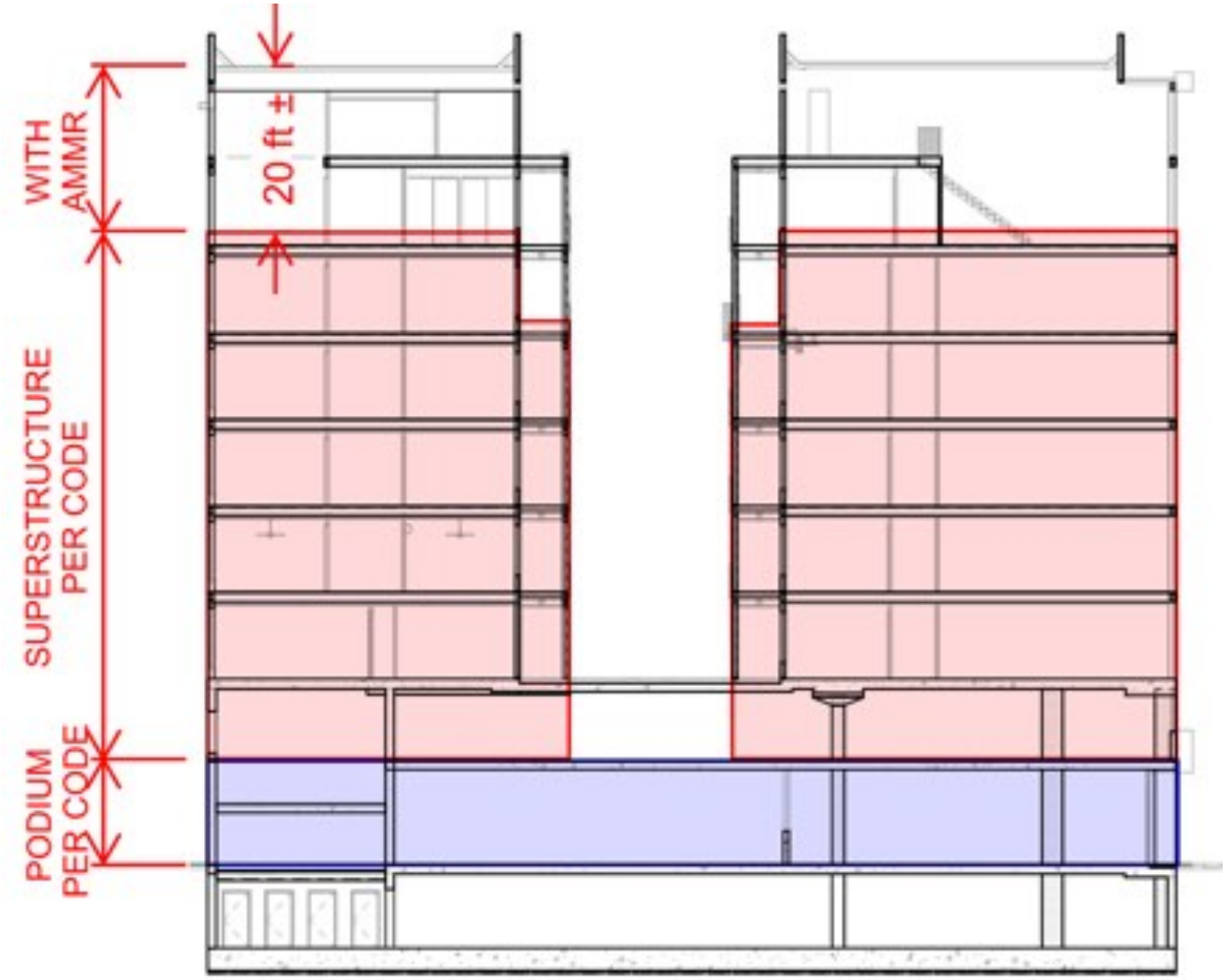
- Two-stage analysis per ASCE 7-10 12.2.3.2
- Stiffness and period requirements to be considered two-stage

Code Limitations | Summary



- 85ft max height above grade
- 5 stories max height for wood-frame 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

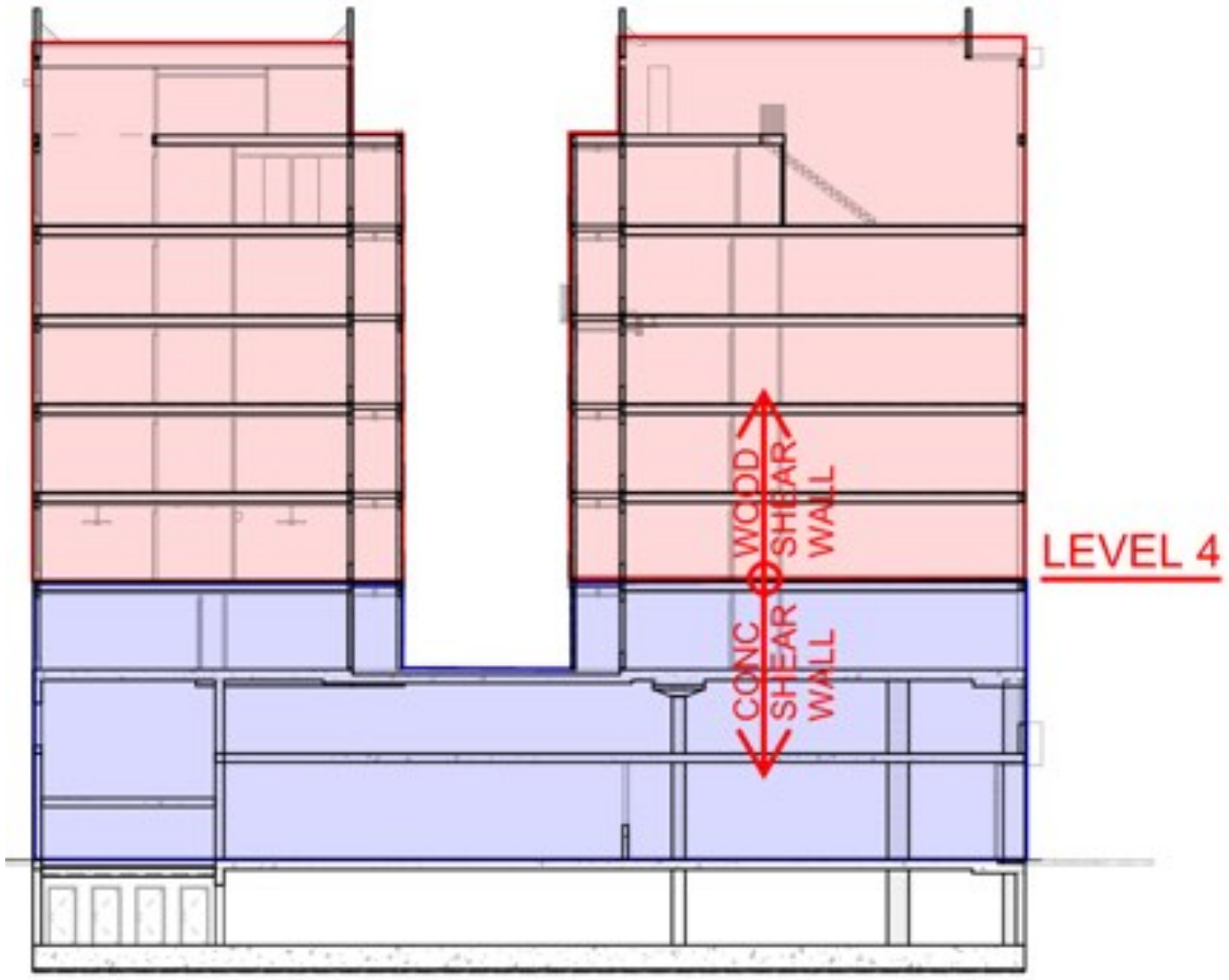
AMMR Process

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

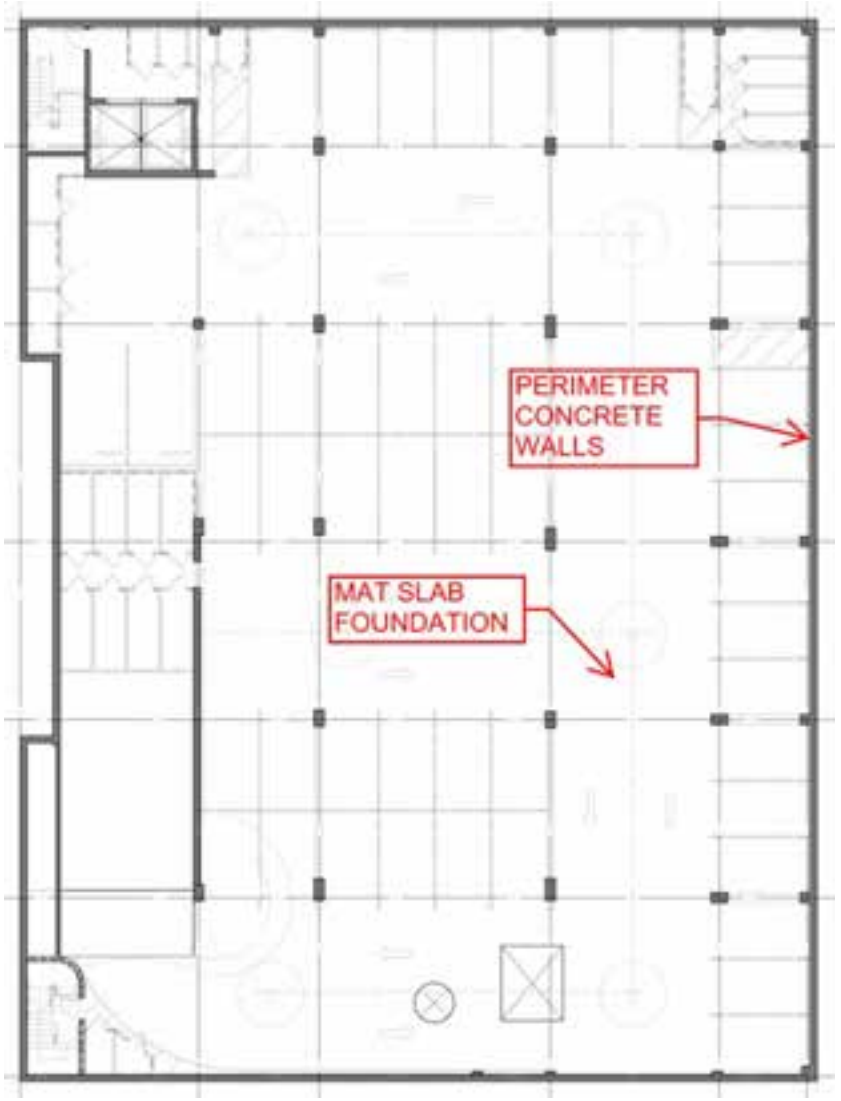


- No structural AMMR
- Seismic base is at level 4
- Level 4 is wood framed with the exception of the shear walls, which are concrete

Structural Design Considerations

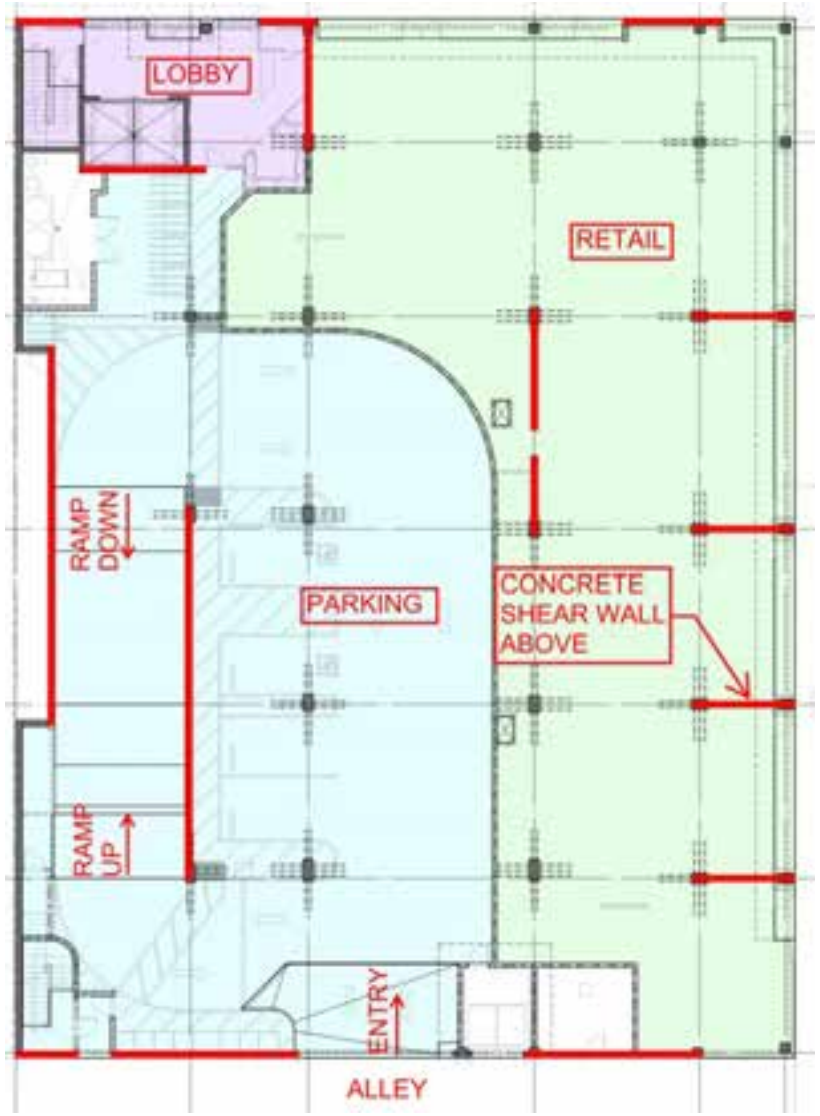
- Overall Building Layout
- Concrete Shear Walls
- Podium
- Concrete Columns
- Connection of Wood Structure to Podium
- Wood Framing System

Overall Building Layout



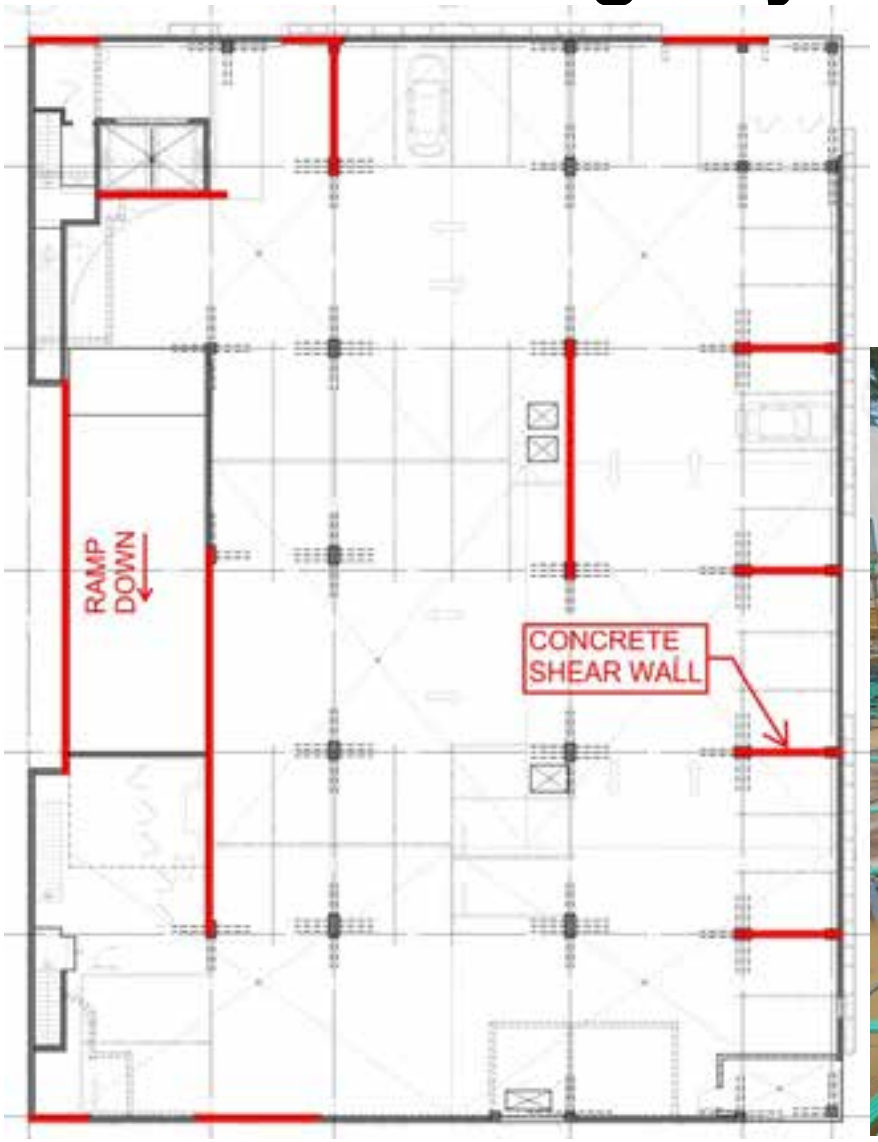
- 33” Basement Mat Slab Foundation
- Perimeter Concrete Retaining and Shear Walls

Overall Building Layout



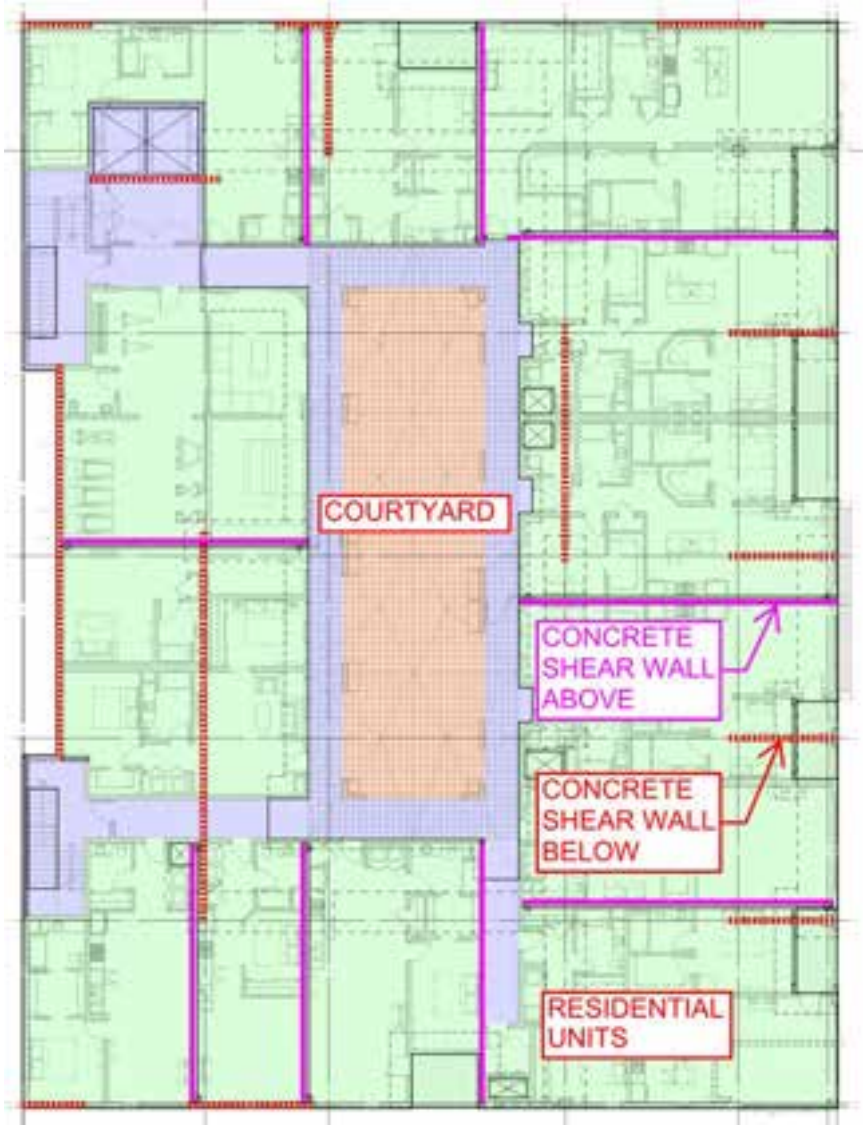
- Ground Level
- 14” Mild-reinforced two-way concrete slab
- Concrete shear walls

Overall Building Layout



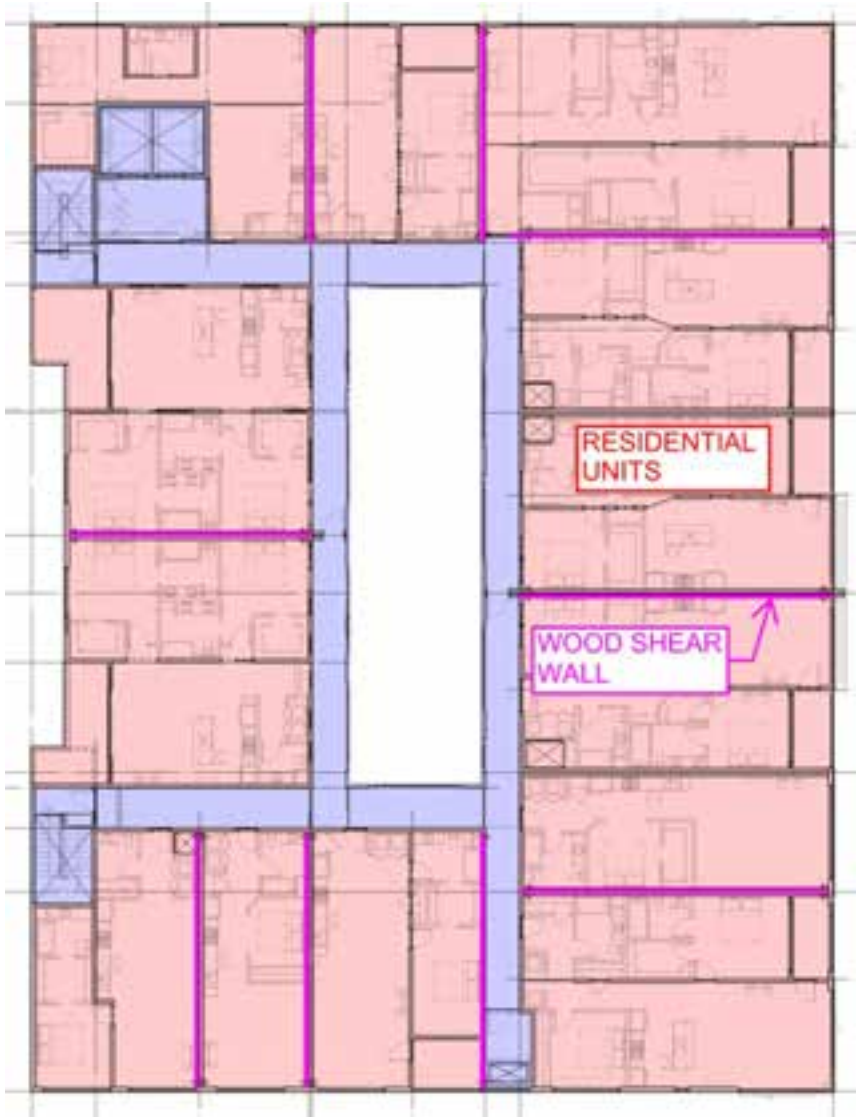
- Level 2 Parking
- 10” Post-tensioned two-way concrete slab
- Concrete shear walls

Overall Building Layout



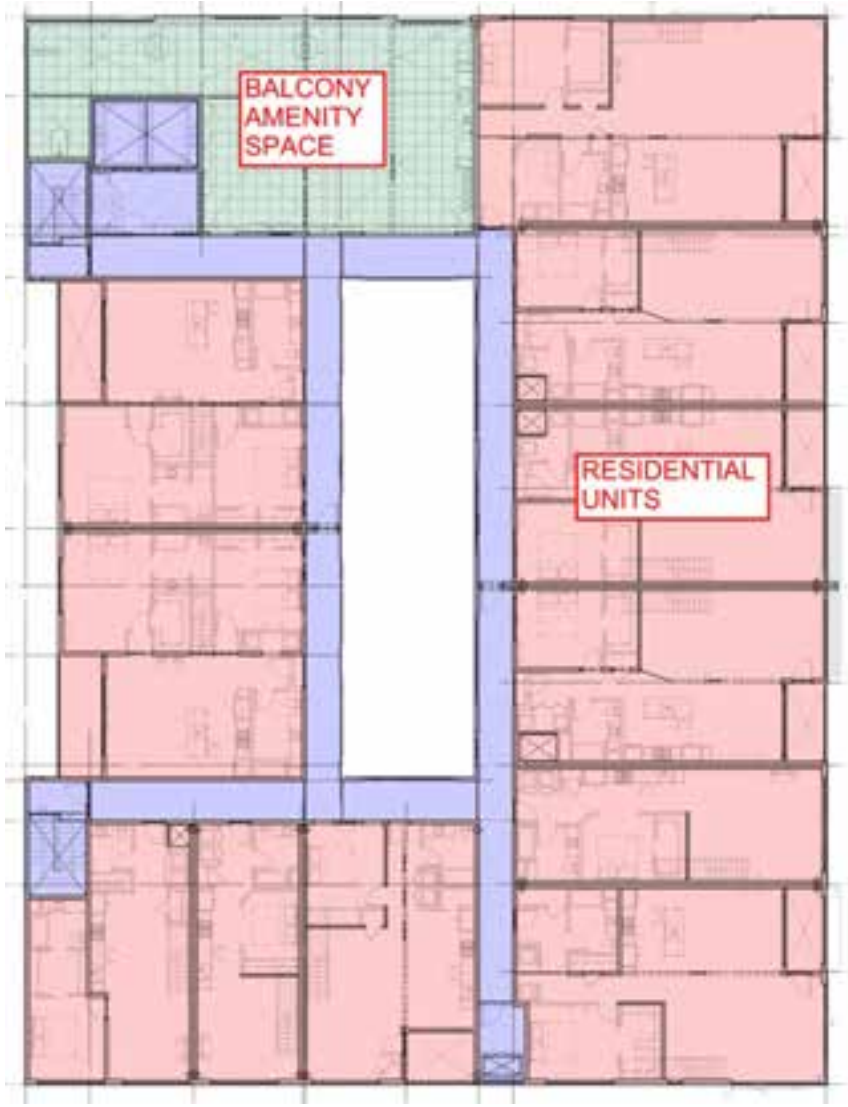
- Level 3 Podium
- 15” Post-tensioned two-way concrete slab
- Slab transfer beams
- Concrete shear walls

Overall Building Layout



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

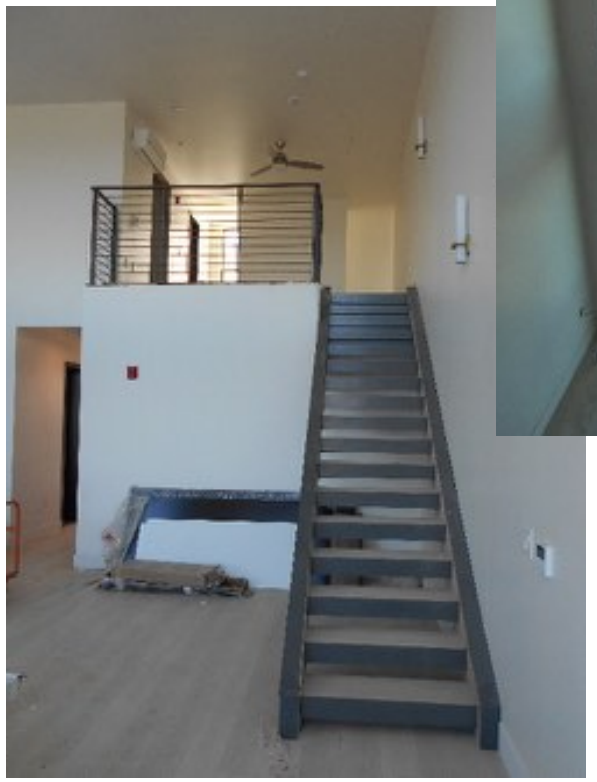
Overall Building Layout



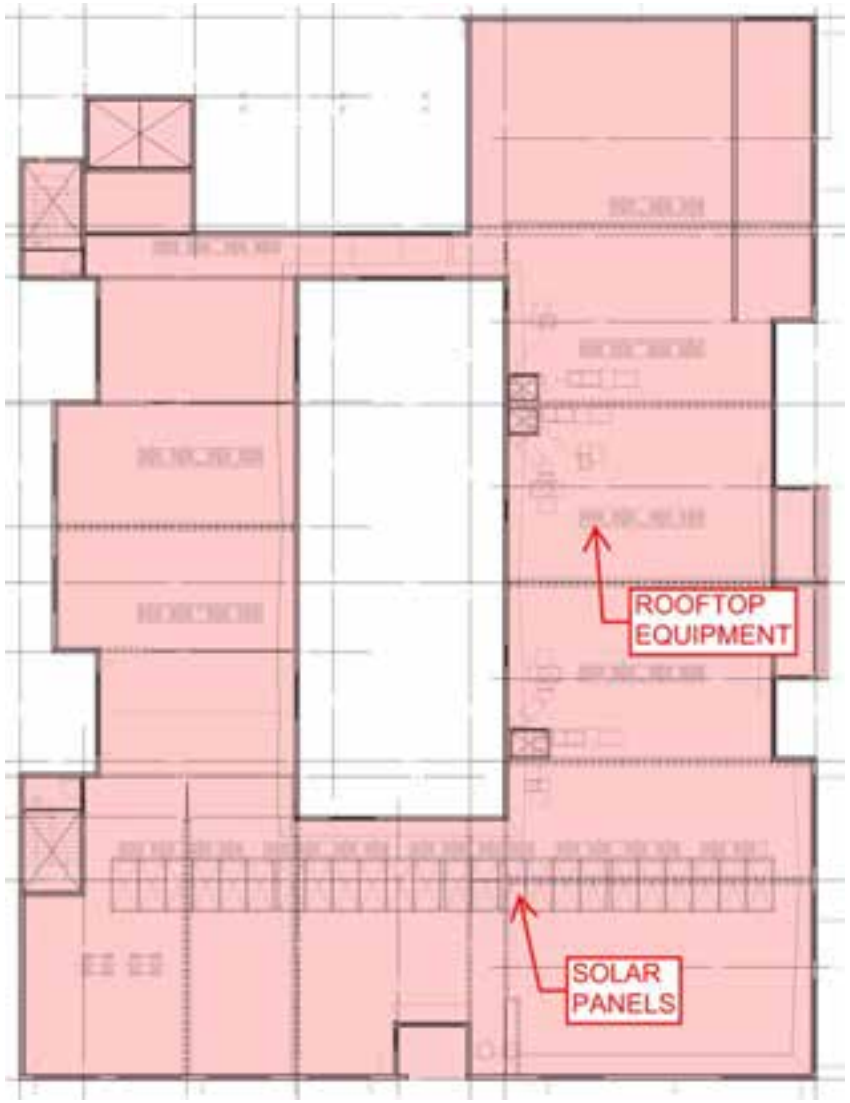
- 8th Floor
- Common area roof deck

Overall Building Layout

- Mezzanine

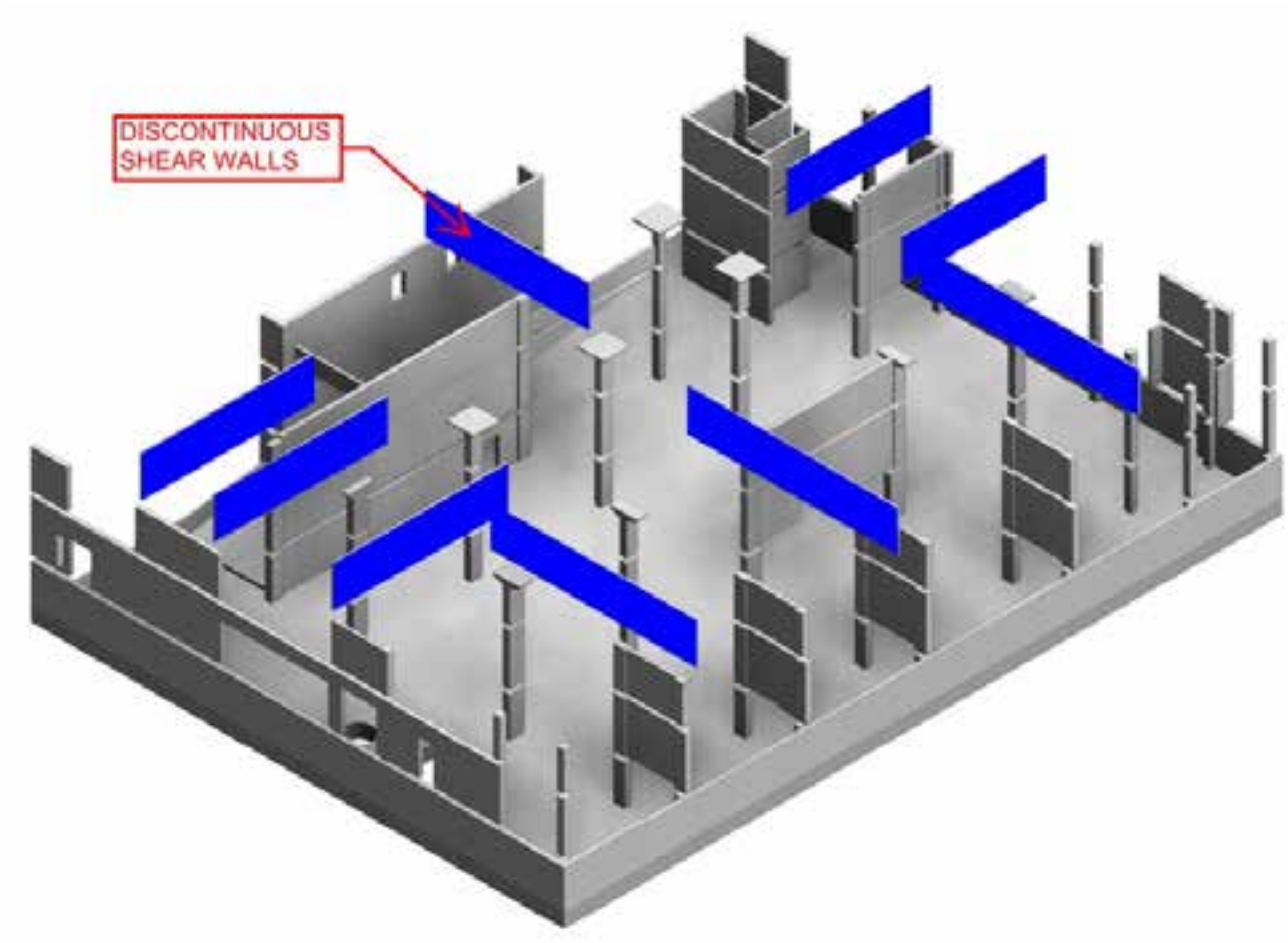


Overall Building Layout



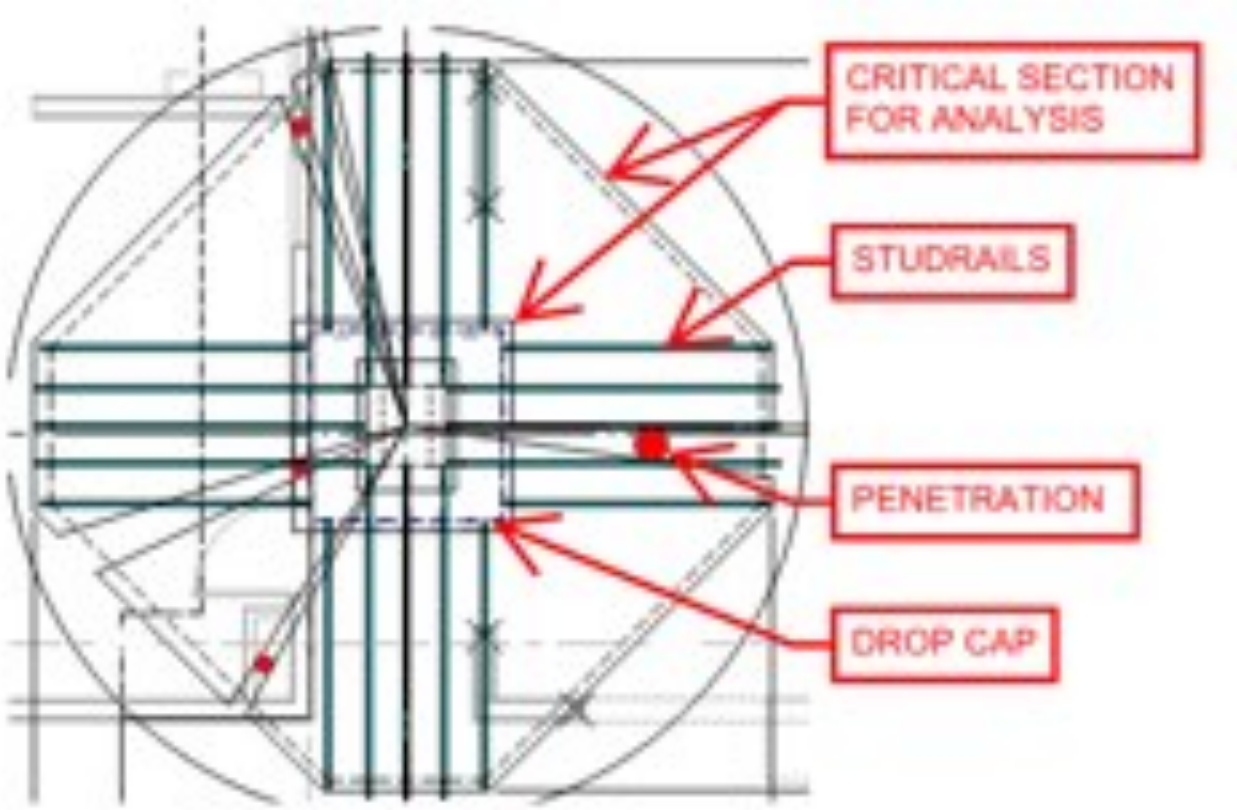
- Roof
- Pre-fabricated roof trusses
- Solar panels

Concrete Shear Walls



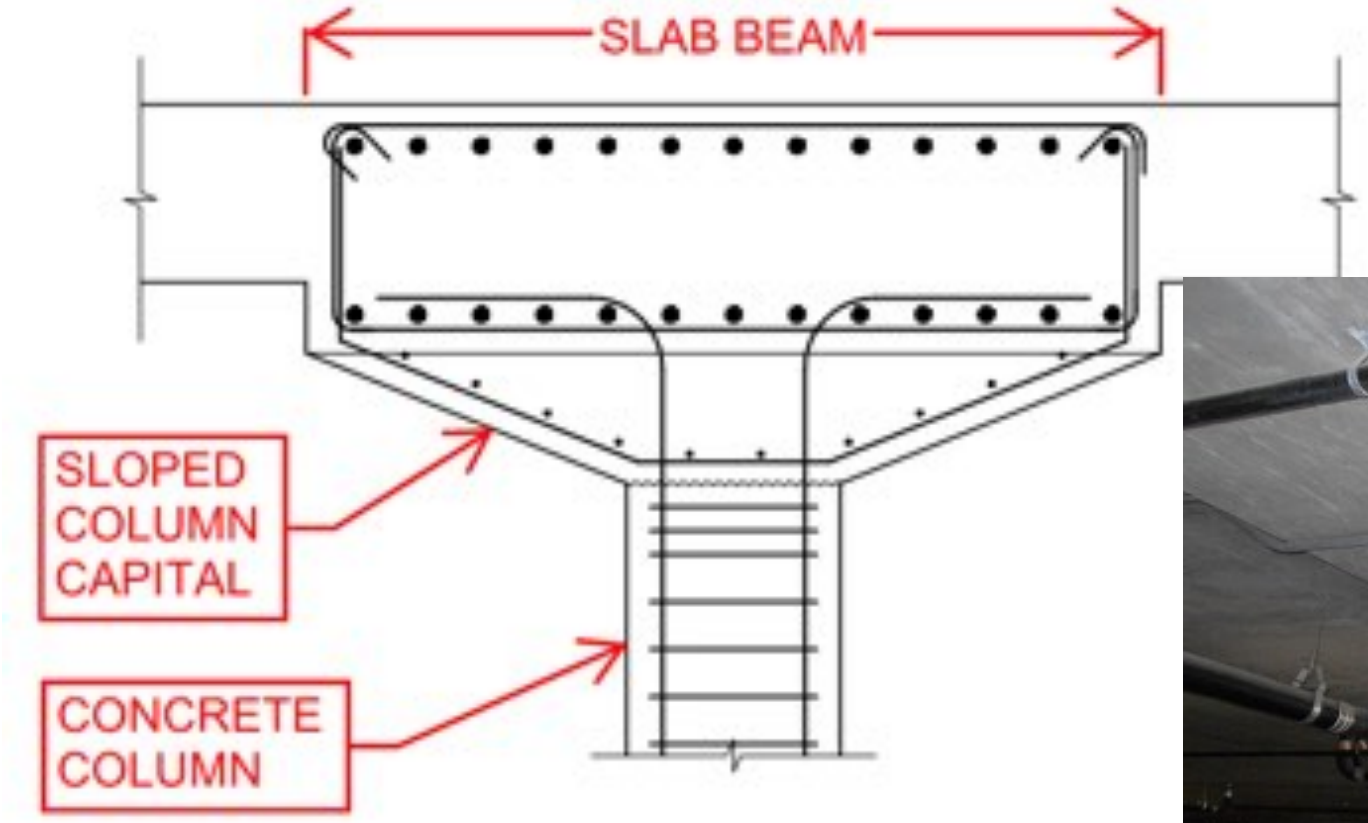
- Seismic base at level 4
- Discontinuous shear walls at level 3 and level 1

Podium Design



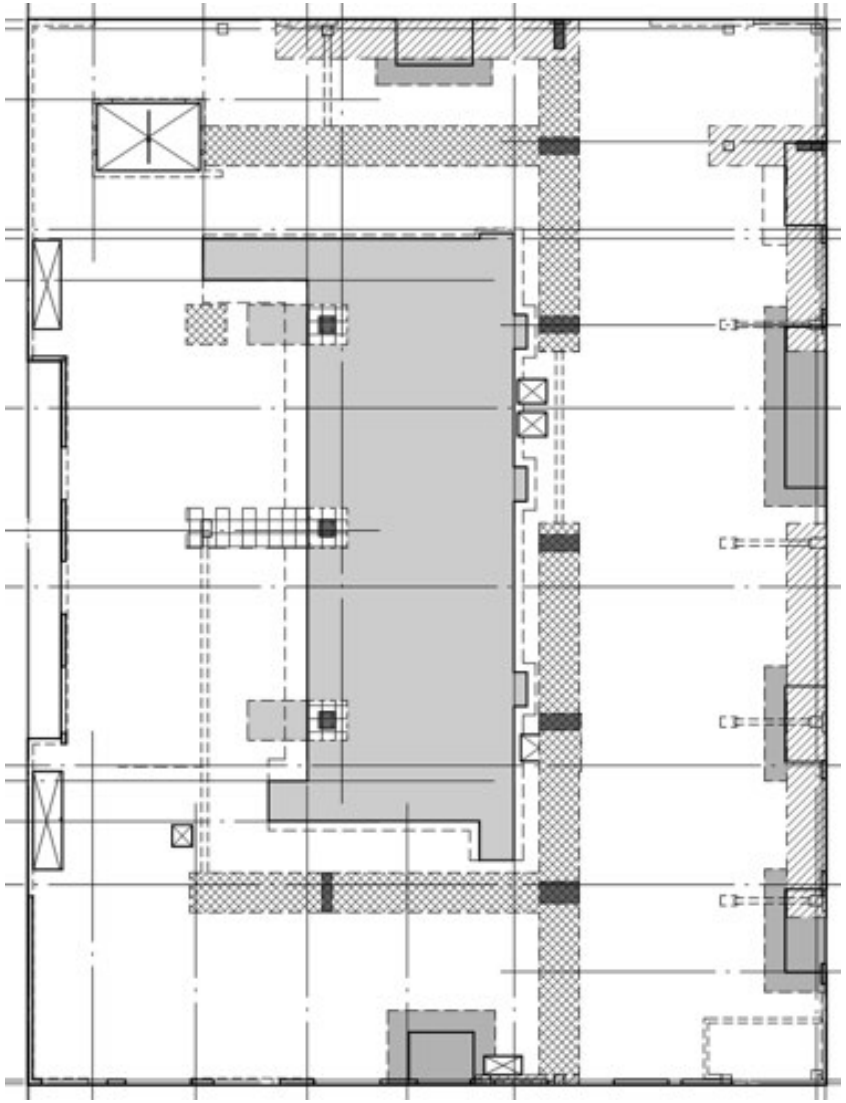
- Reduced thickness at center courtyard
- Punching shear uses drop caps and studrails in some locations

Podium Design



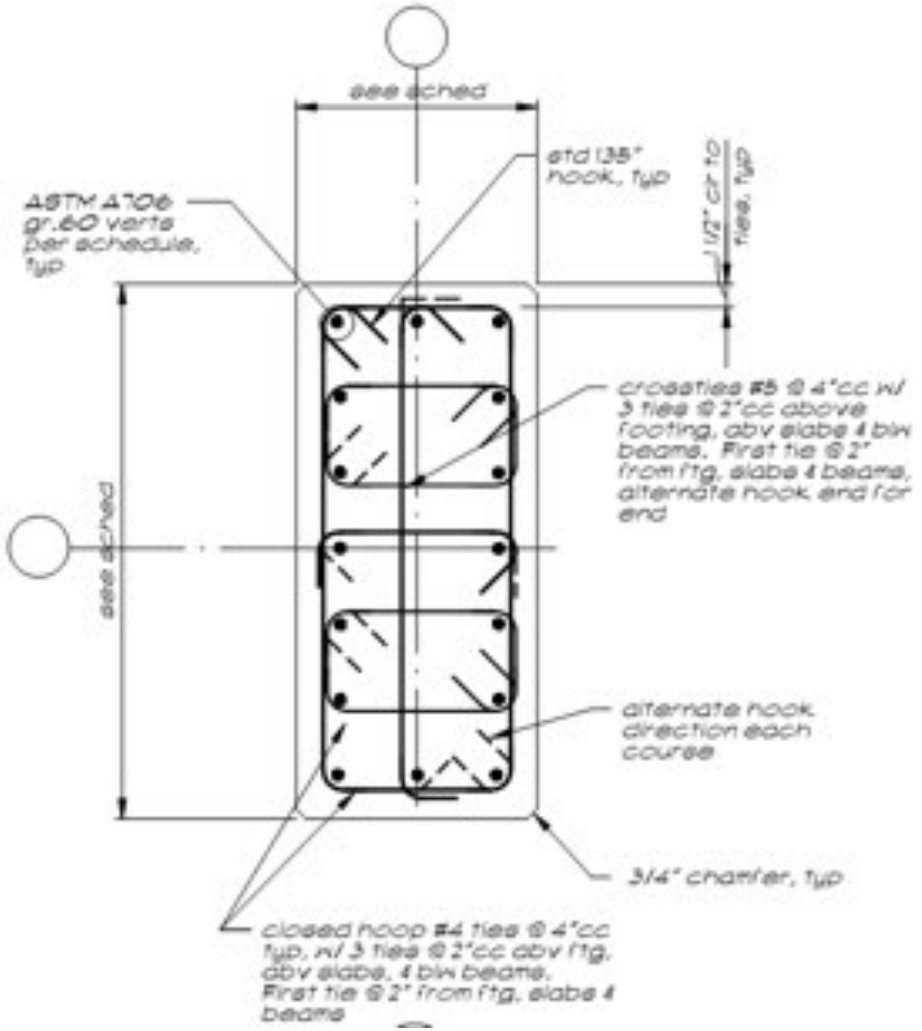
- Slab beams
- Column capitals where needed

Podium Design

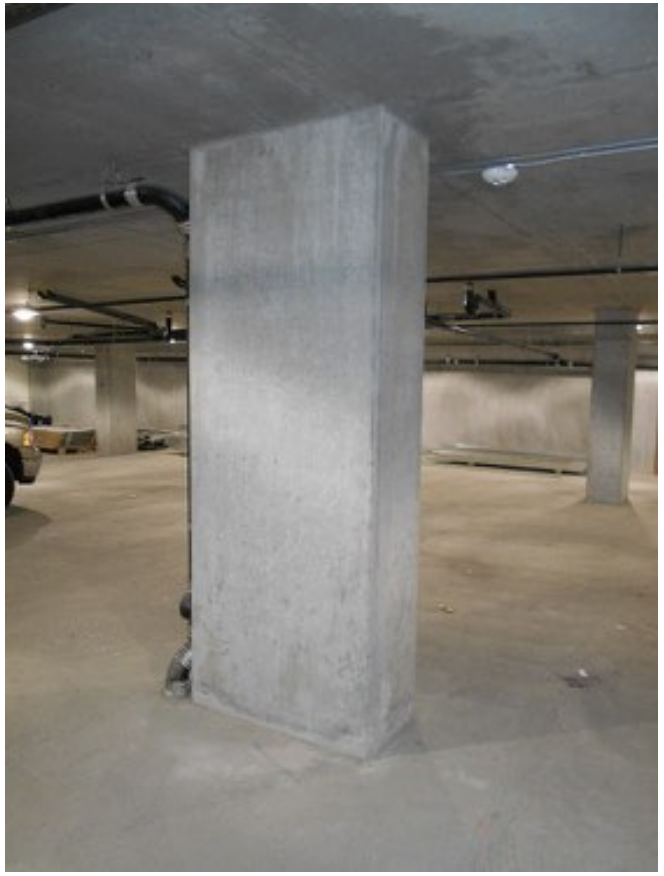


- Soffit elevation plan to clarify the height of:
  - Slab beams
  - Drop caps
  - Column capitals
  - Depressed areas
  - Sloped thickness transitions

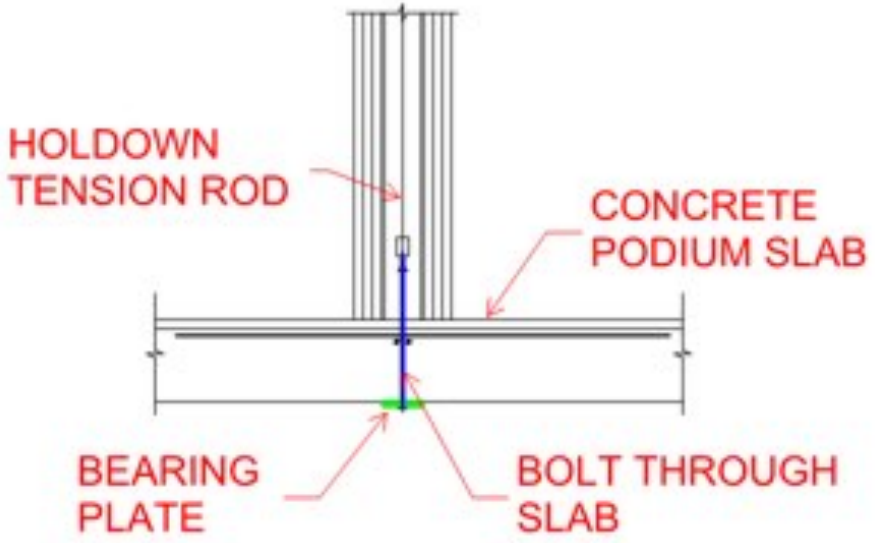
Concrete Columns



- Constrained by parking layout
- 18x40 largest

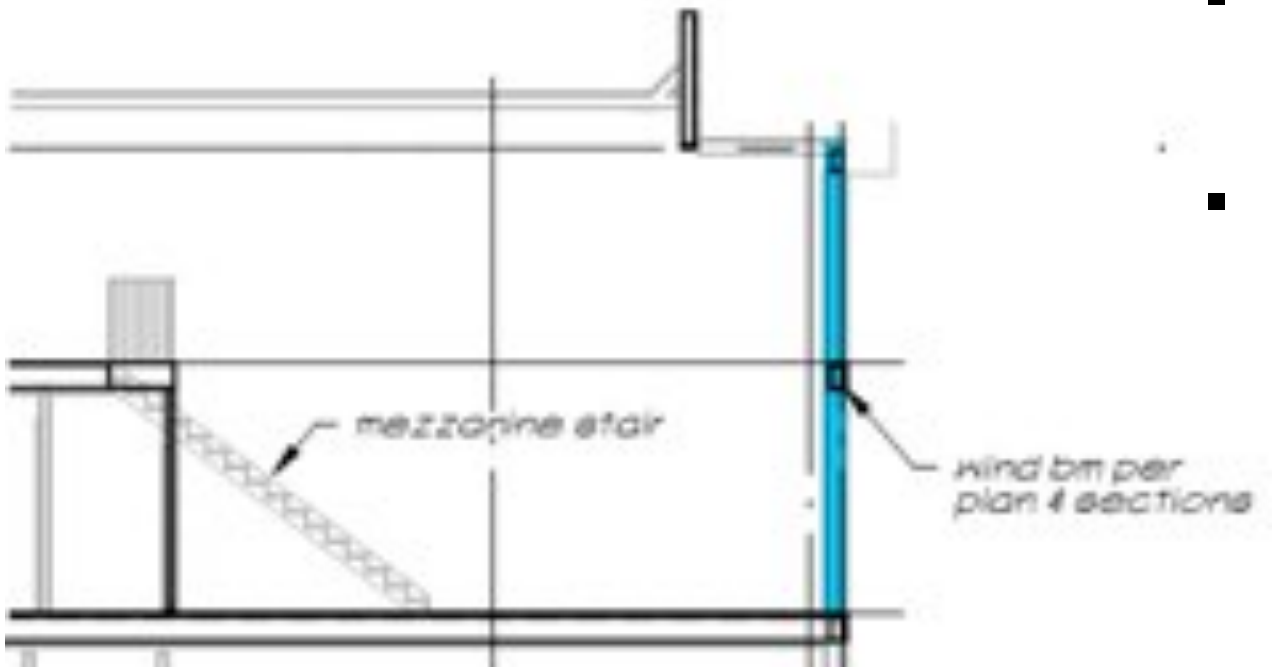


Connection of Wood Structure to Podium



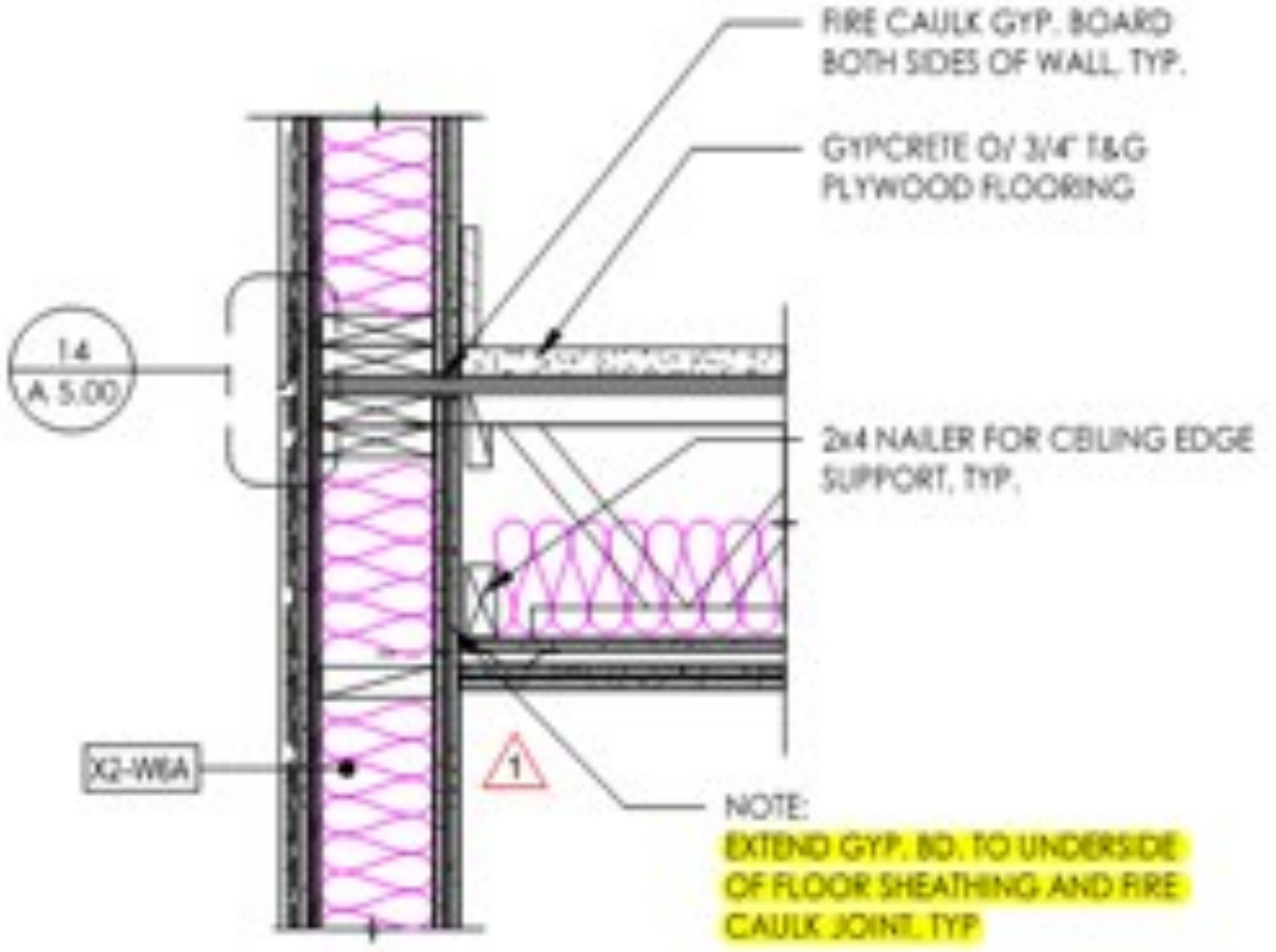
- Holdown system bolt through podium
- Holdown rod developed into concrete shear wall where occurs
- Sill bolts cast-in-place into concrete podium slab

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

Flexible coupling for gas pipes

A 5.0.02 Estimated Building Shrinkage/Settling

Level	Level 'S'	Cumulative 'S'
Roof	0.15"	1.70"
Mezz	0.15"	1.55"
8th	0.30"	1.40"
7th	0.30"	1.10"
6th	0.27"	0.8"
5th	0.26"	0.53"
4th	0.27"	0.27"

Notes:
1. 'S' indicates combined shrinkage and settling in.
2. Estimated shrinkage and settling in values assume all lumber in all framing has MC ≤ 19% at the time of installation.
3. These values have been provided for consideration in the design and detailing of building systems sensitive to shrinkage such as tie down take up devices, plumbing 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

- Plumbing in walls required study and repairs

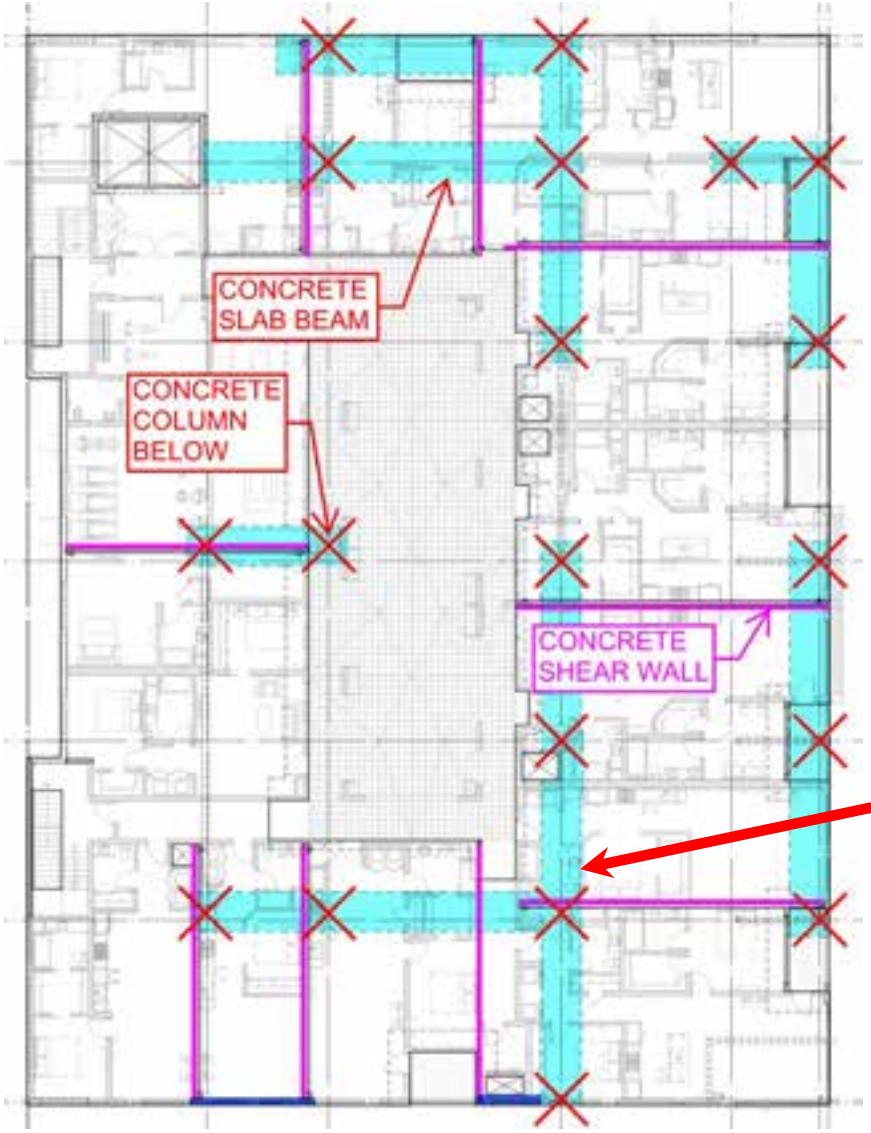
Exterior Building Maintenance

- Tieback and davit anchors on wood framing

Structural Lateral System

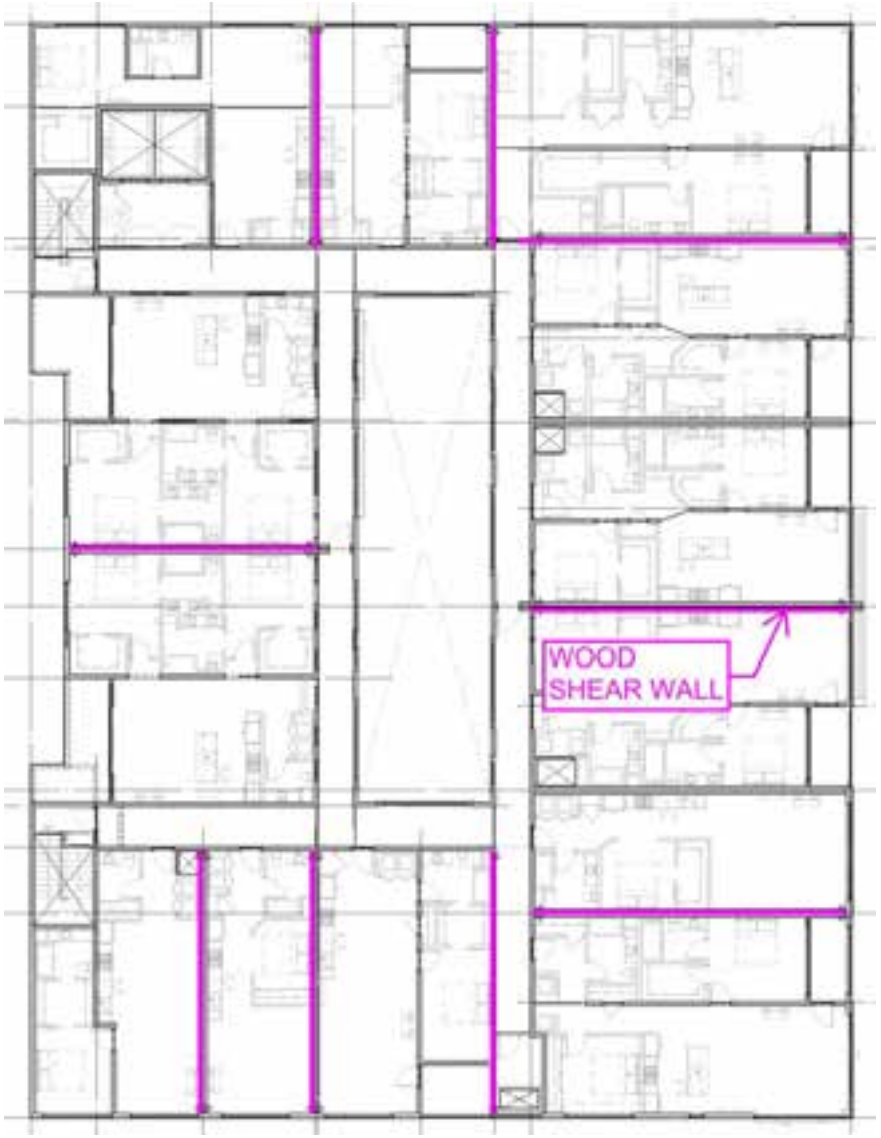
- Transfer ‘Slab Beams’
- Wood Shear Walls
- Wood Diaphragms

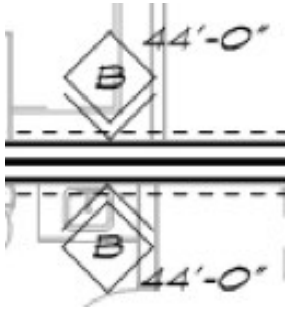
Transfer Slab Beams



- Ductile reinforced beams
- Design for overstrength loads from wall overturning
- 6” additional soffit depth and 6 ft wide

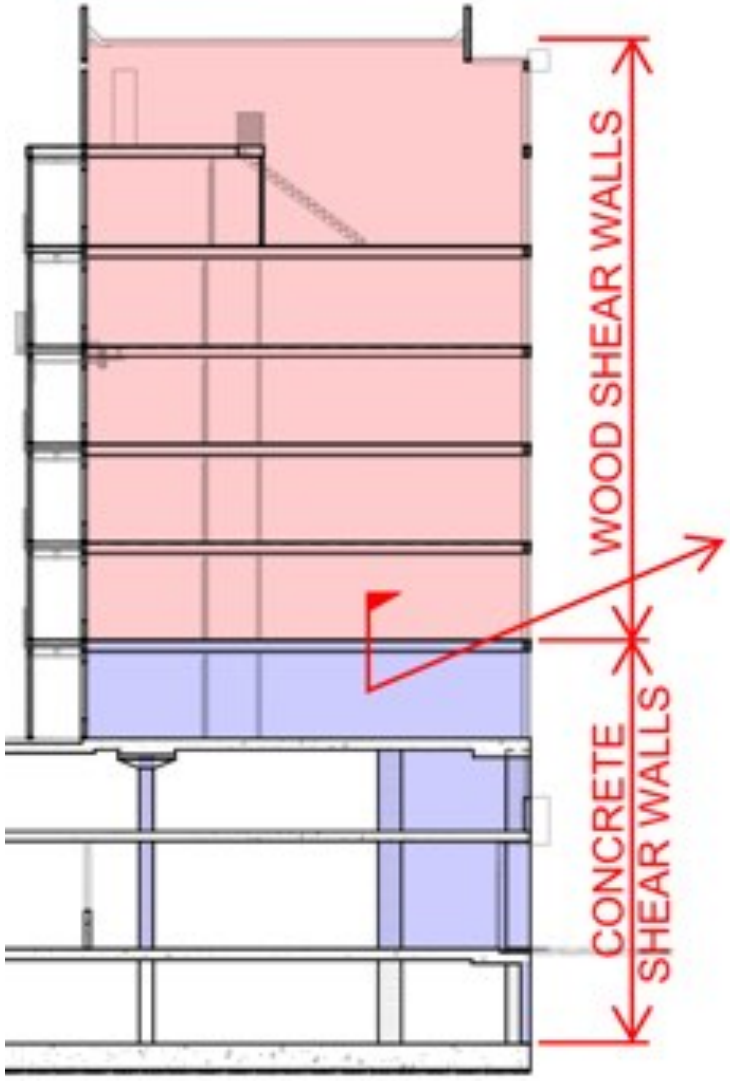
Wood Shear Walls

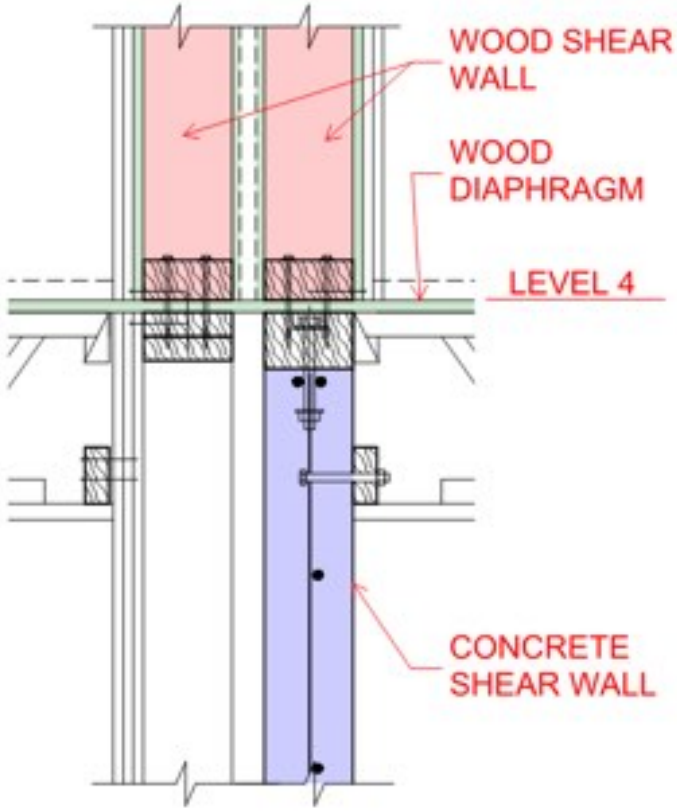




- Both walls in the double party wall are shear walls
- Some walls near the bottom are double sided shear
- Continuous tie-down rod system is used for holdowns

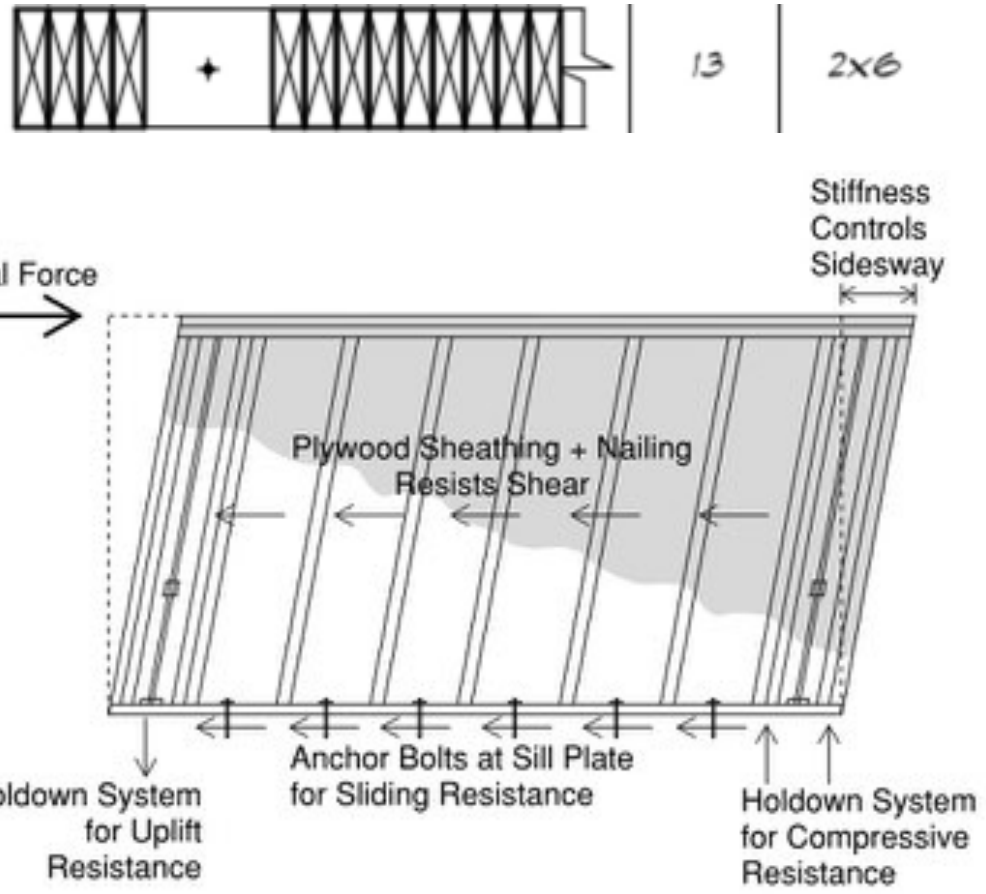
Wood Shear Walls





- Concrete walls extend up to level 4
- Concrete shear wall at 3rd floor takes full load of superstructure

Wood Shear Walls



- 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

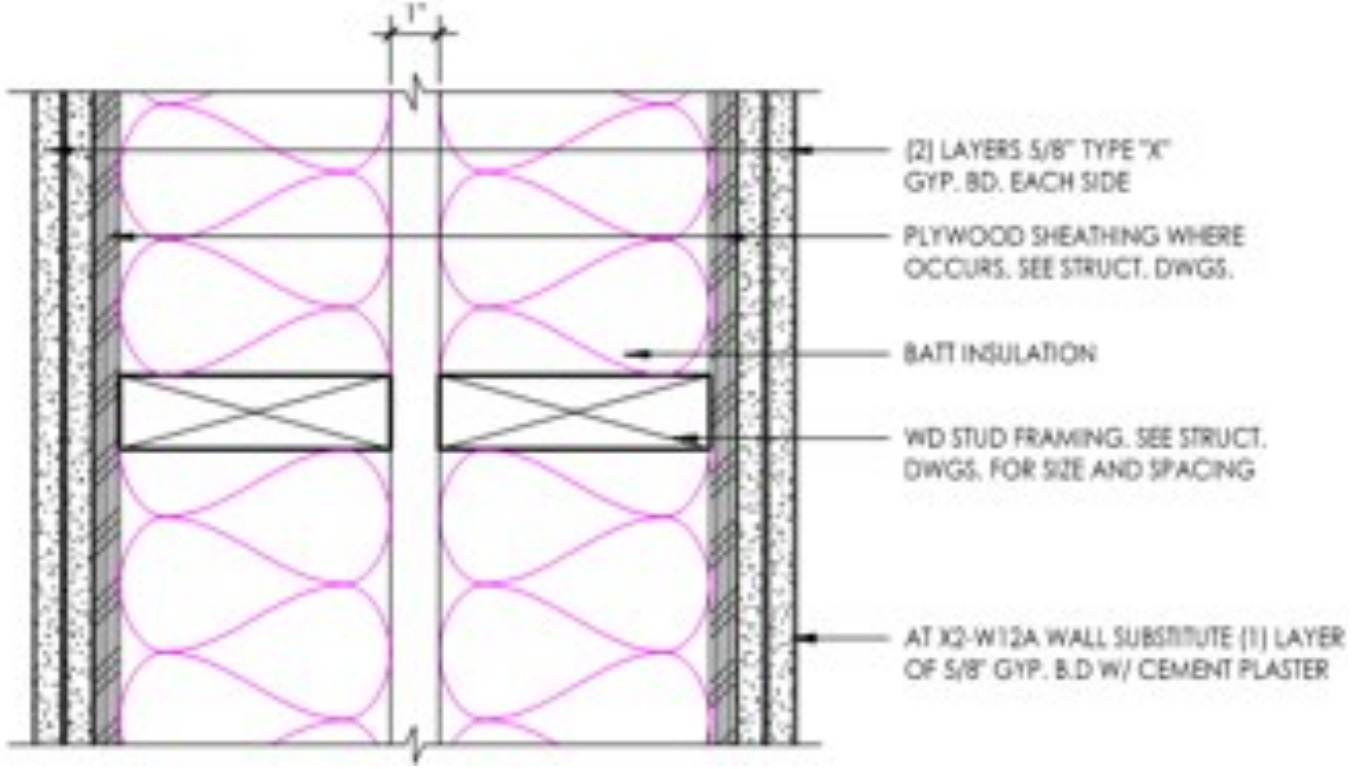
- Envelope rigid and flexible analysis
- Strap for collectors to shear walls

Fire Life Safety Objectives

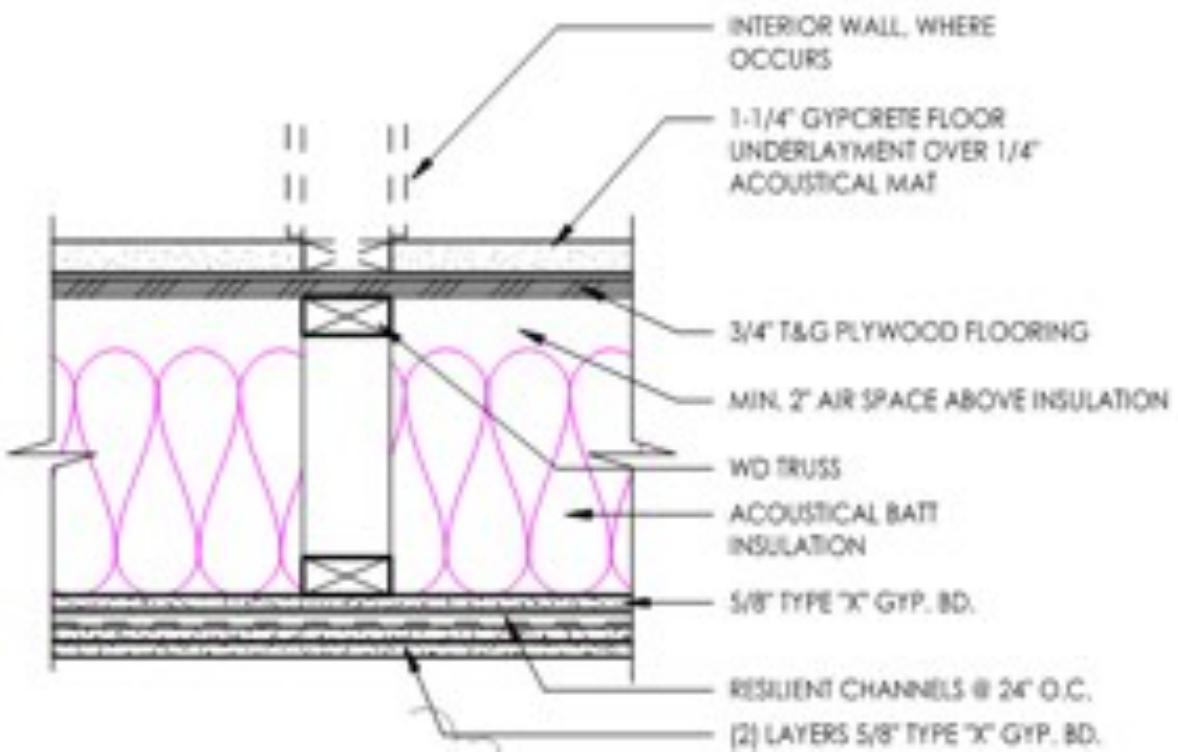
- Wall Assemblies
- Floor Assemblies
- Corridor Systems
- Fire Separations
- Sprinkler System
- Compartments

Wall Assemblies

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

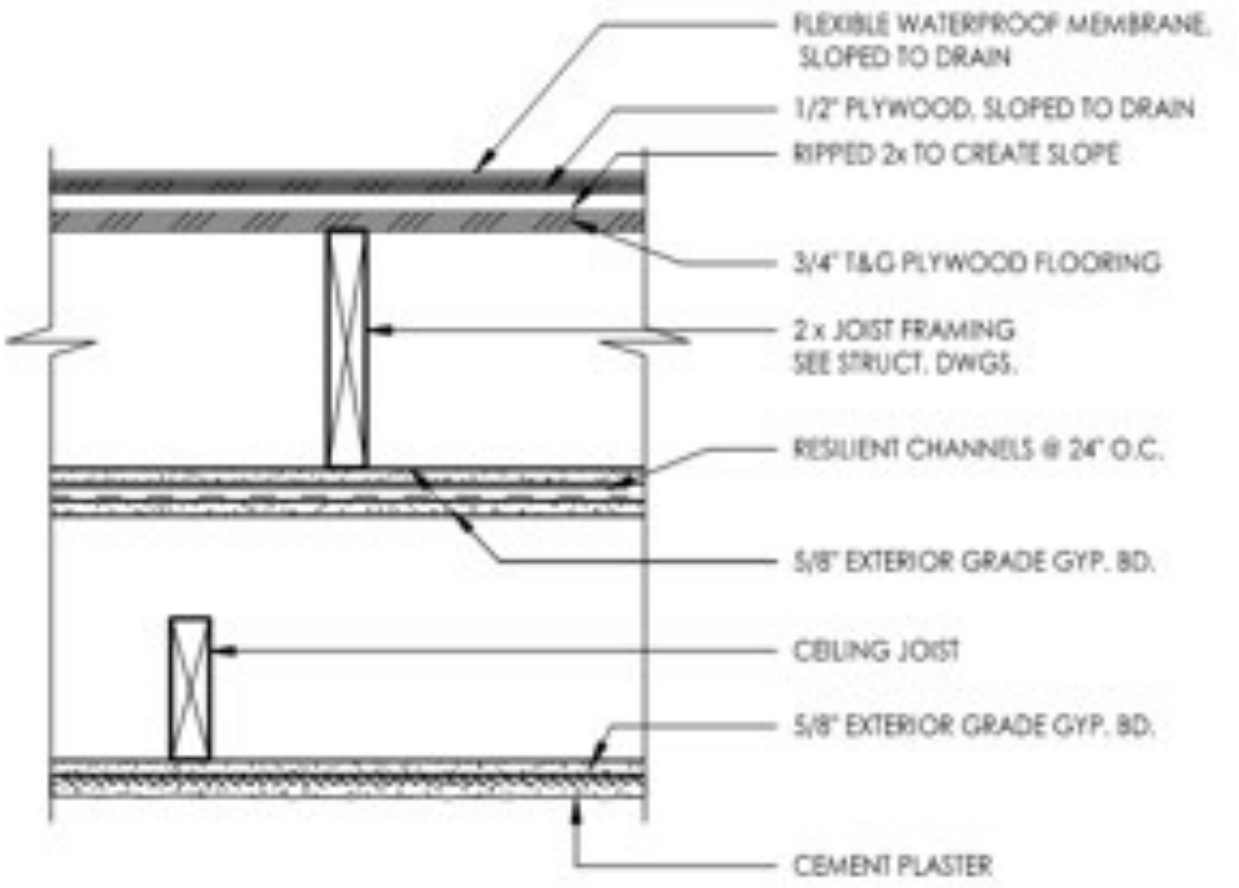


Floor Assemblies



- 2-hour rated
- 3 layers 5/8” Type ‘X’ gypsum board ceiling
- 1 ¼” gypsum concrete floor topping

Corridor Systems

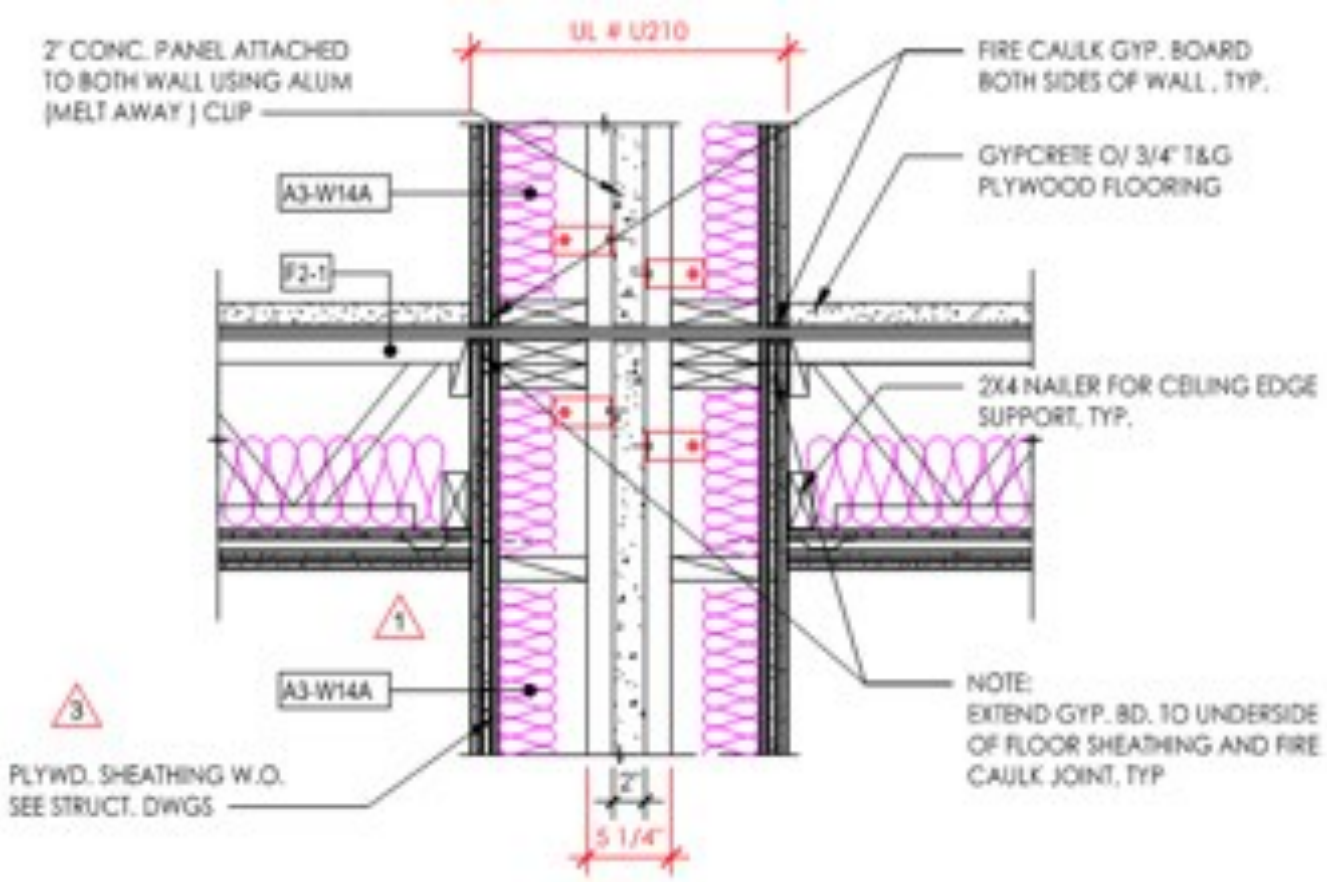


- 2-hour rated
- 2 layers 5/8” Type ‘X’ gypsum board at floor joists
- 1 layer 5/8” Type ‘X’ gypsum board with plaster at ceiling joists

Fire Separations

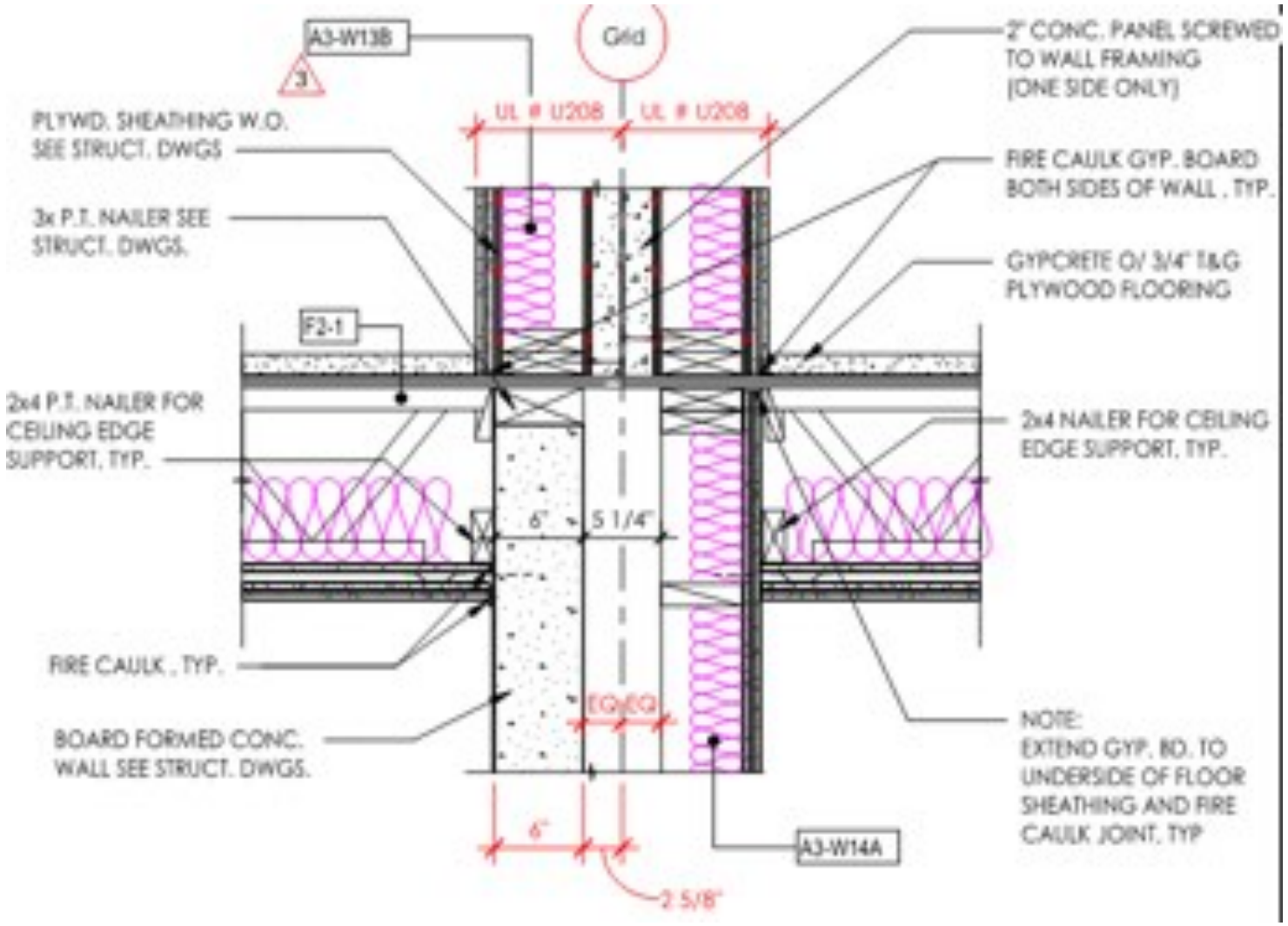
- 3-hour separation
- 2” autoclaved aerated concrete (AAC) panels

Fire Separations



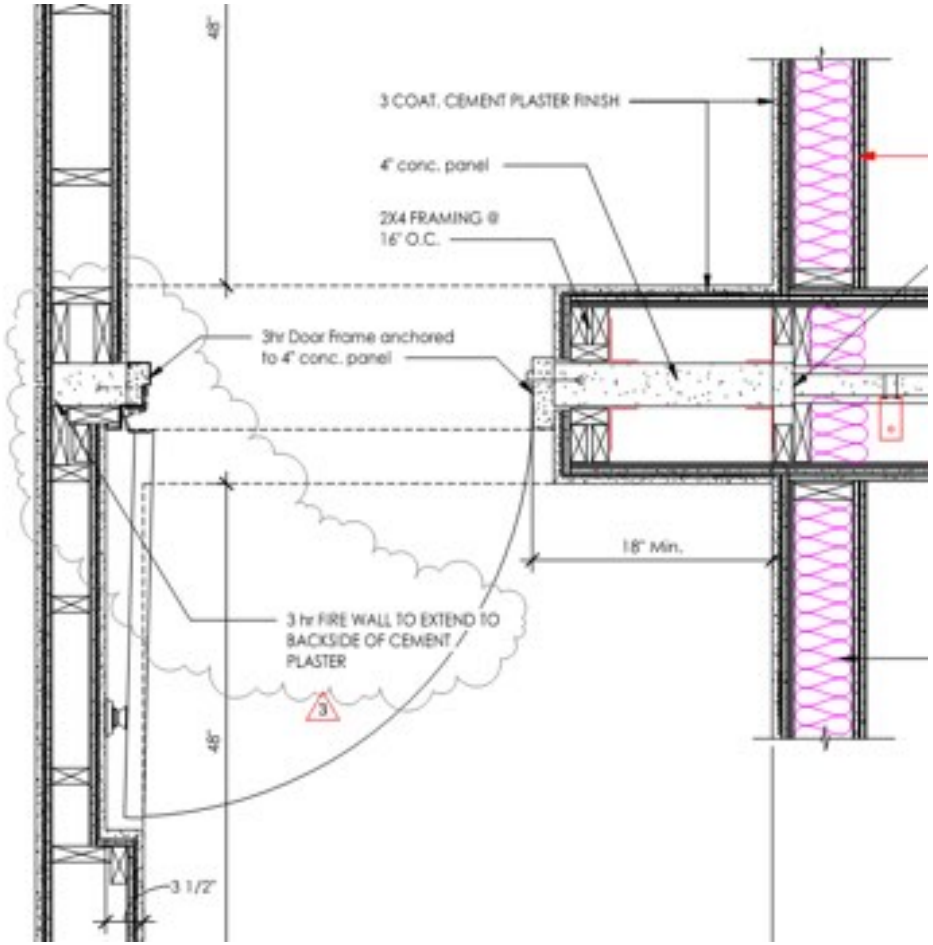
- Melt away clips on each side

Fire Separations



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

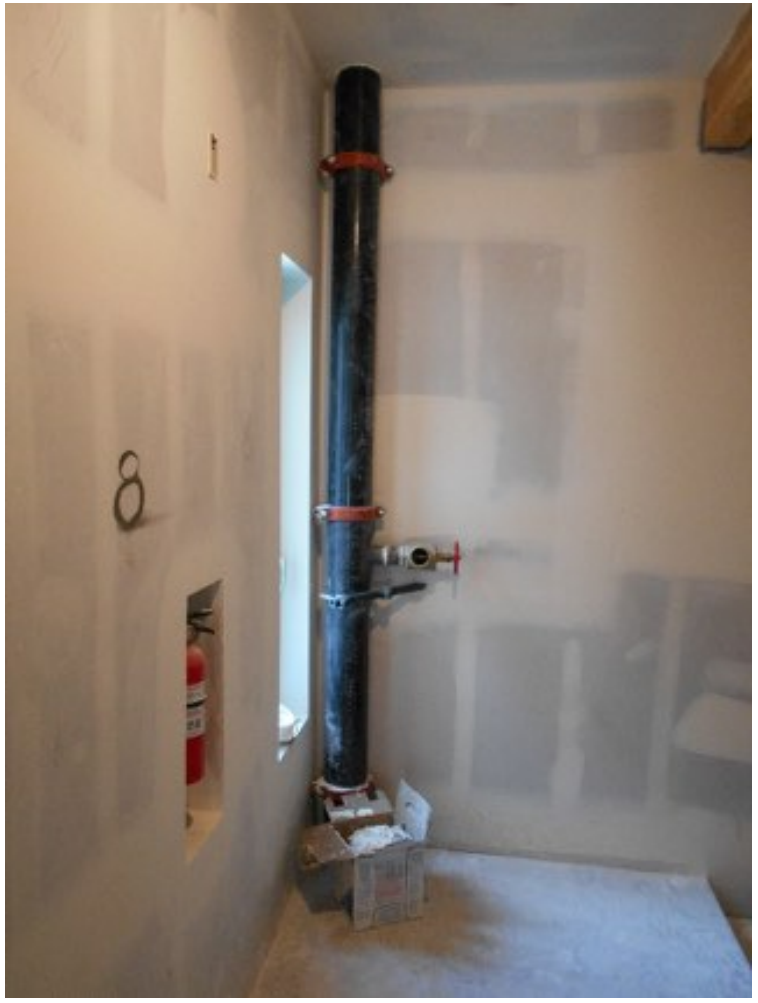
Exiting Routes



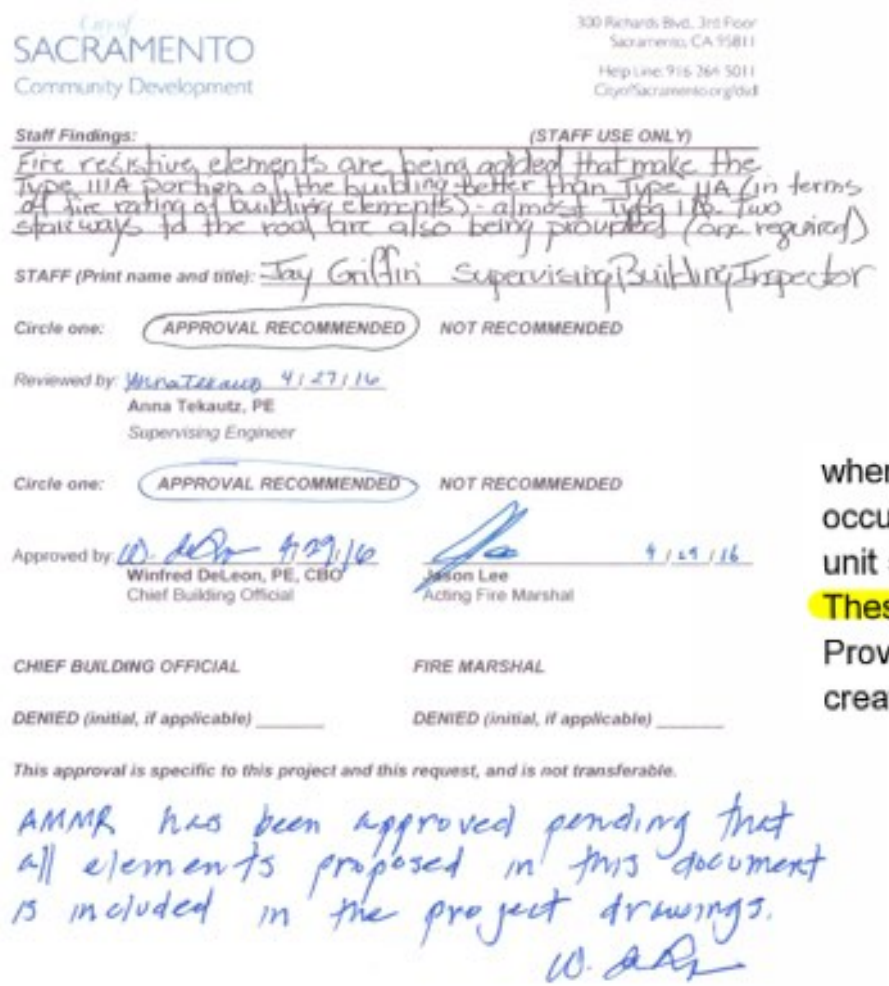
- Horizontal exit through fire separation wall
- Door frame attached to concrete wall panel
- Two communication devices in corridor per level

Fire Sprinklers

- Automatic sprinklers per NFPA 13



Compartments & Access



City of SACRAMENTO
Community Development

300 Richards Blvd., 3rd Floor
Sacramento, CA 95811
Help Line: 916 264 5011
CityofSacramento.org/dsd

Staff Findings: (STAFF USE ONLY)

Fire resistive elements are being added that make the Type IIIA portion of the building better than Type IIA (in terms of fire rating of building elements) - almost Type I. Two stairways to the roof are also being provided (are required)

STAFF (Print name and title): Jay Griffin Supervising Building Inspector

Circle one: APPROVAL RECOMMENDED NOT RECOMMENDED

Reviewed by: 4/27/16
Anna Tekautz, PE
Supervising Engineer

Circle one: APPROVAL RECOMMENDED NOT RECOMMENDED

Approved by: 4/29/16
Winfred DeLeon, PE, CBO
Chief Building Official

4/29/16
Jason Lee
Acting Fire Marshal

CHIEF BUILDING OFFICIAL FIRE MARSHAL

DENIED (initial, if applicable) _____ DENIED (initial, if applicable) _____

This approval is specific to this project and this request, and is not transferable.

AMMR has been approved pending that all elements proposed in this document is included in the project drawings.

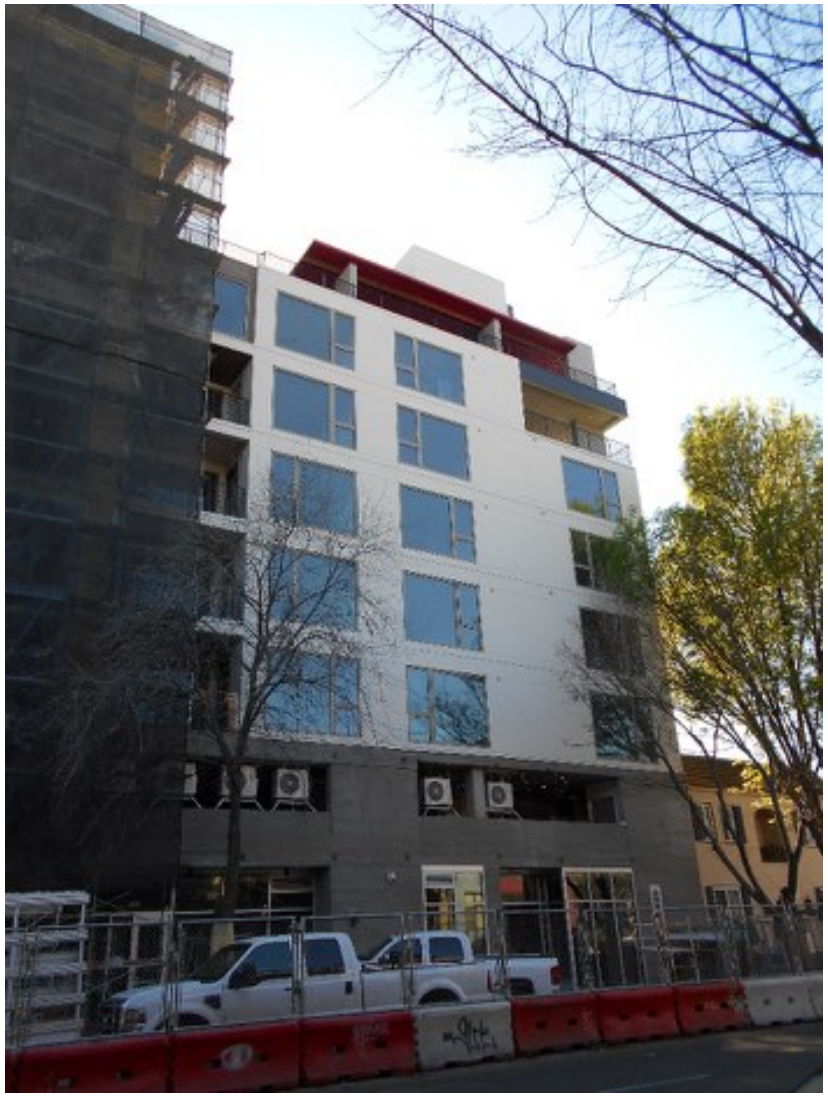
- Compartments facilitate in fire fighting
- Additional stair access to roof

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.


1300


F097C


1430 Q



Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

Owner:
D&S Development

Architect:
HRGA

Structural Engineer:
Ryan Miller, S.E., LEED AP
BUEHLER
rmiller@buehlerengineering.com