EFFICIENT MULTI-STORY
LIGHT-FRAMED CONSTRUCTION

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AIA Approved Continuing Education

Course Description

As architects design increasingly creative and complex commercial and multi-family light-frame wood buildings, thorough coordination among the design team is critical. This presentation will explore the importance of gravity and lateral force-resisting systems and thoughtful design decisions that enhance structural performance and construction feasibility. A case study of a multi-story light-frame wood project will illustrate key considerations in balancing architectural intent with efficiencies in framing and unit layouts to achieve aesthetically appealing, code compliant, cost-competitive projects.

Learning Objectives

1. Recognize the importance of gravity and lateral force-resisting systems in maintaining structural stability and protecting occupant safety in wood-frame buildings.
2. Identify common design challenges, such as floor and wall openings, irregular layouts, discontinuous structural systems, and how they impact a building's ability to resist lateral forces.
3. Explore how coordination and design decisions made early in the planning process can influence structural performance, cost, and construction feasibility, and gain insights for creating functional, aesthetically pleasing architectural layouts.
4. Examine a real-world case study to understand how architects and engineers collaborate to overcome challenges while achieving project goals.

OVERVIEW

Efficient Framing System Selection

- General Framing Techniques
- Select General Assemblies
  - Roof
  - Floor
  - Corridor
  - Walls
- Efficient Framing Layout
  - Unit layouts
  - Stacking lateral
  - Stacking gravity

- Engage contractor / framer early to get project specific feedback.

- Leverage relationships with trade partners.

FRAMING CONSIDERATIONS

Joist Selection

- » Alignment of wall studs vs floor joists
  - » Space of MEP in walls
  - » Level of coordination during construction

Joist Spacing

- » 16” O.C. vs 24” O.C.
- » Number of joists required
- » Joists depth / width
- » Required sheathing
- » Consider duct sizing

Raised heel roof trusses

- » Trusses vs joists
- » Loading on walls

FRAMING CONSIDERATIONS

Wall Framing - Studs:

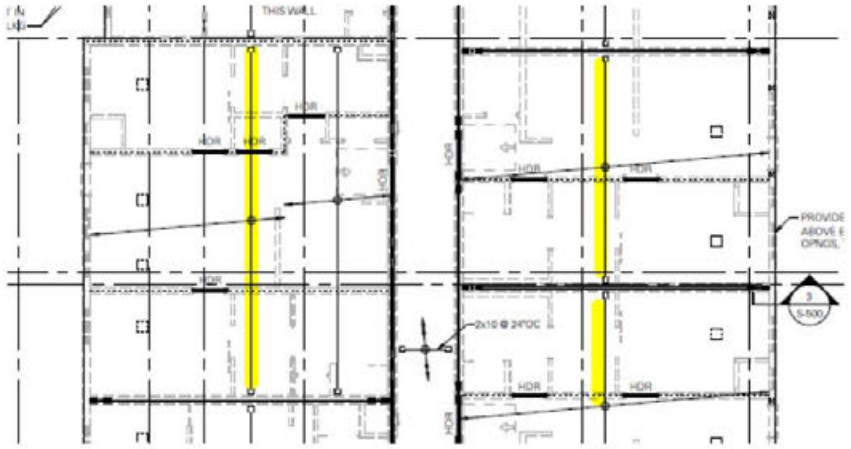
- » Exterior wall stud spacing
  - » 16” O.C. vs 24” O.C.
  - » Alignment with joists
  - » Siding attachment requirements
  - » Bearing stud sizing
- » Corner studs
  - » California corner
  - » Shear wall locations
  - » Sheathing and siding attachments

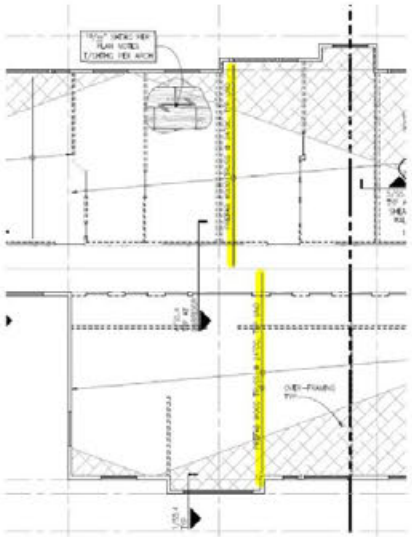
FRAMING CONSIDERATIONS

Wall Framing - Headers:

- » Heading sizing
  - » Full width of wall vs single ply
  - » Directly above opening vs tight to top plate
  - » Door / window alignment
  - » Loading on wall
  - » Wall insulation needs
- » Rim Joist header
  - » Do walls include rim joist? (Type III v Type V)
  - » Rim joist sizing
  - » Joist hangers

EARLY COORDINATION WITH **ARCHITECT AND STRUCTURAL**



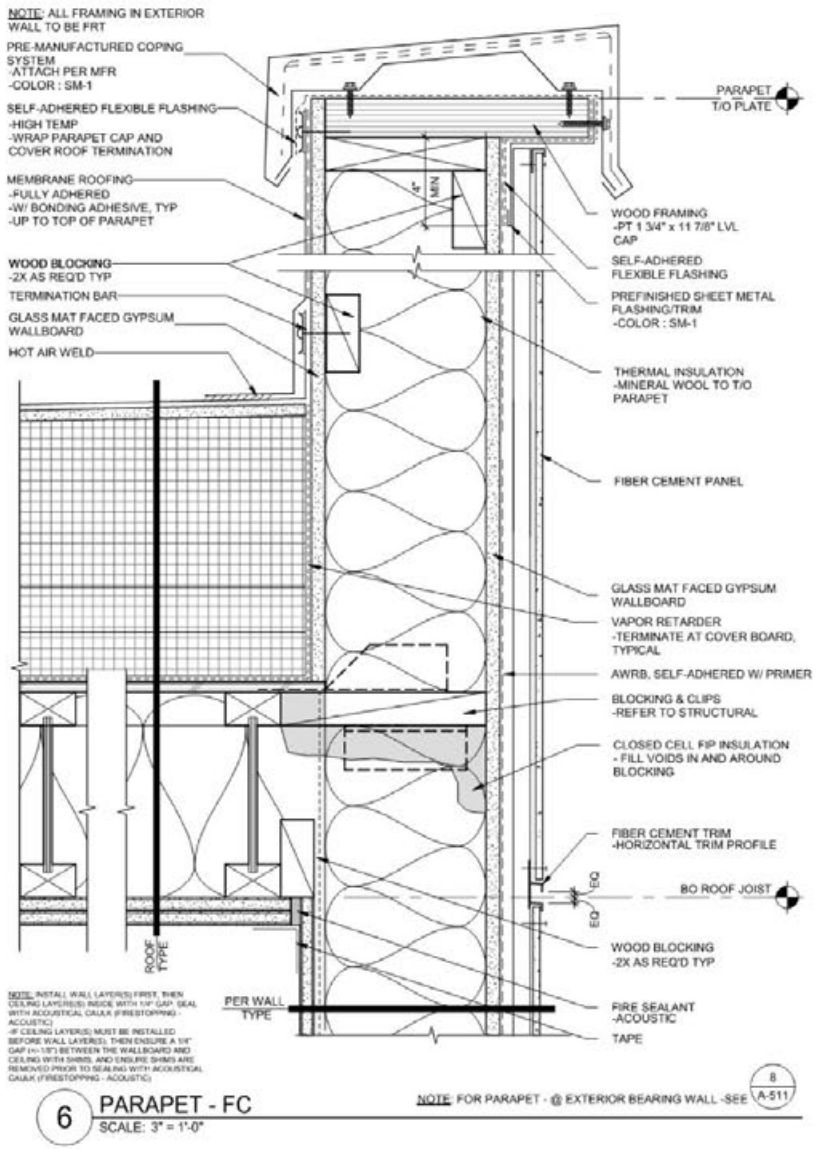


Short span (party wall to party wall)

- No sprinklers
- Added cost of sloped rigid insulation
- Limits exterior bearing walls for Type III-A
- Shallower

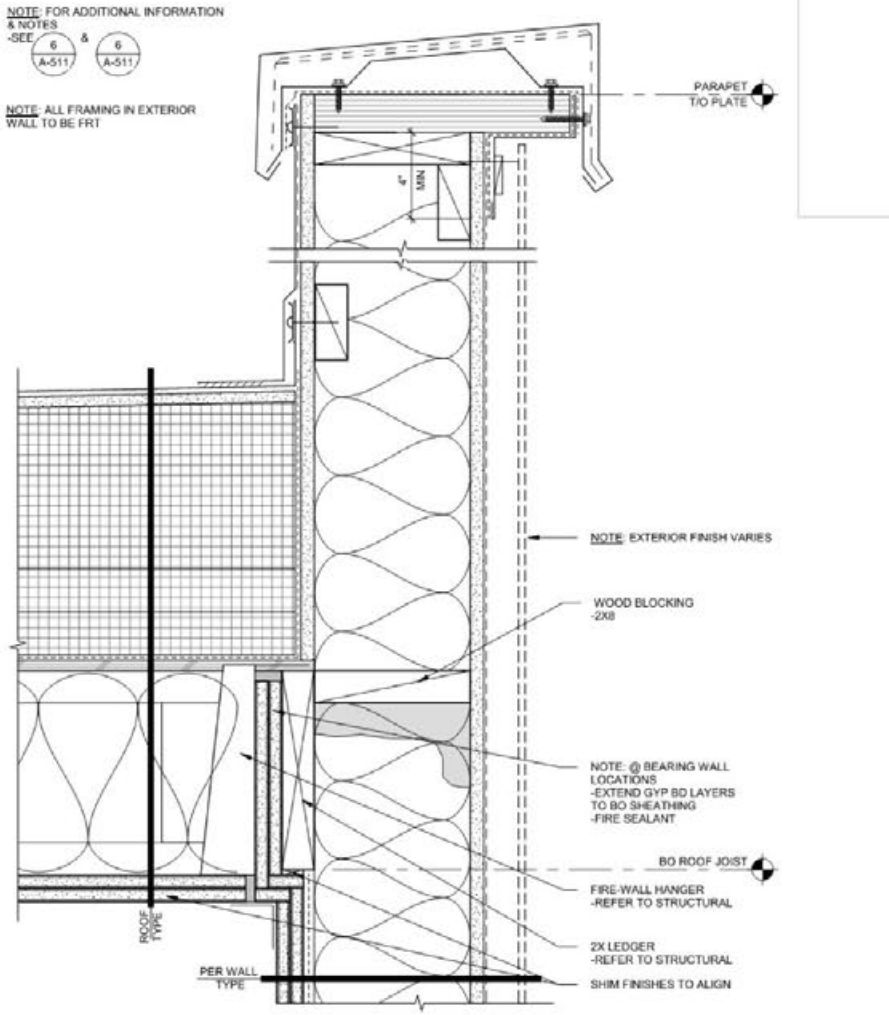
Long span (corridor wall to exterior)

- Slope trusses and eliminate rigid insulation
- Sprinkle confined space which can drive heel heights



6 PARAPET - FC
SCALE: 3" = 1'-0"

NON-BEARING 0 HOUR



8 PARAPET - EXTERIOR BEARING WALL
SCALE: 3" = 1'-0"

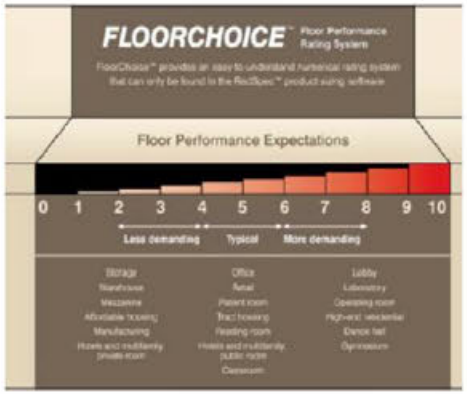
BEARING 2 HOUR

FLOOR ASSEMBLY | **JOIST SELECTION**

- **Solid sawn**
  - » Lowest cost
  - » Limited on spans
  - » Greater potential for shrinkage

- **Pre-fab press plate trusses**
  - » Deeper than I-joist. 14”-18” min. depth. Overall building height can be a challenge
  - » Can long span
  - » Limited suppliers in certain regions

- **I-Joist**
  - » Longer spans than solid sawn
  - » 16-18” max to be economical. 9 1/2” or 11 7/8” is most common
  - » Most common in NW



FLOOR ASSEMBLY **PERFORMANCE CRITERIA**

Get on the “same page” as the owner

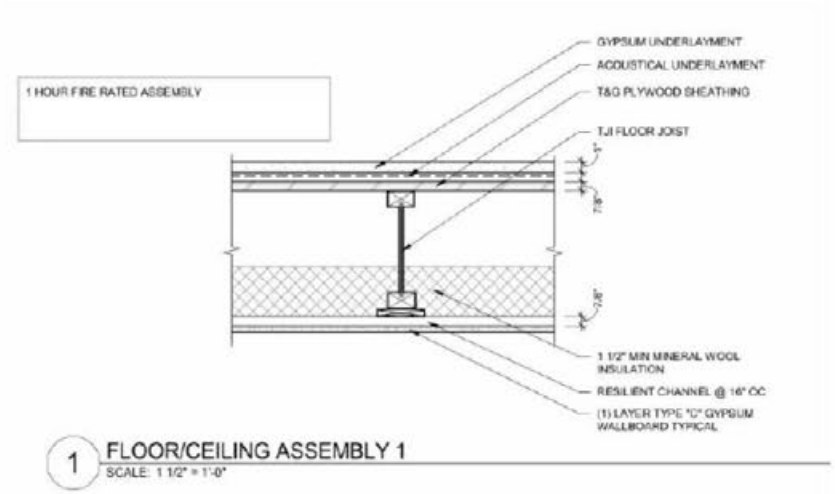
FLOOR ASSEMBLY | **FRAMING DIRECTION**

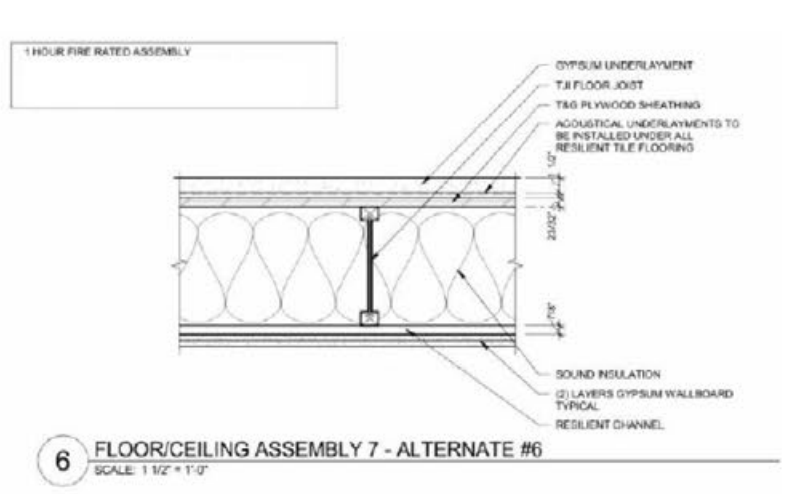
- **Short span (party wall to party wall)**
  - » Shorter floor to floor heights
  - » Utilize party walls and interior walls already present
  - » Exterior walls non-bearing for Type III-A

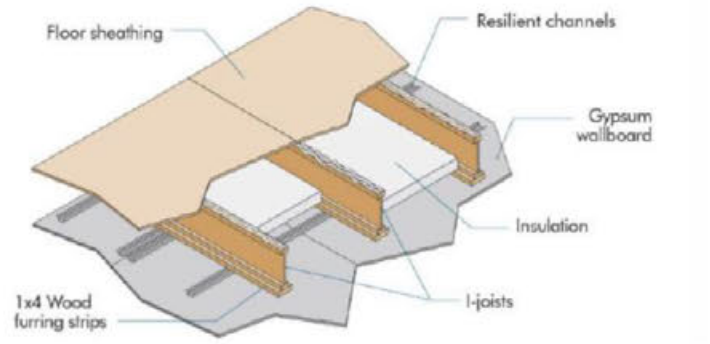
- **Long span (corridor to exterior)**
  - » Greater joist depth
  - » Less dead load on transverse shear walls so potentially larger footings
  - » Not utilizing interior walls so many times less efficient

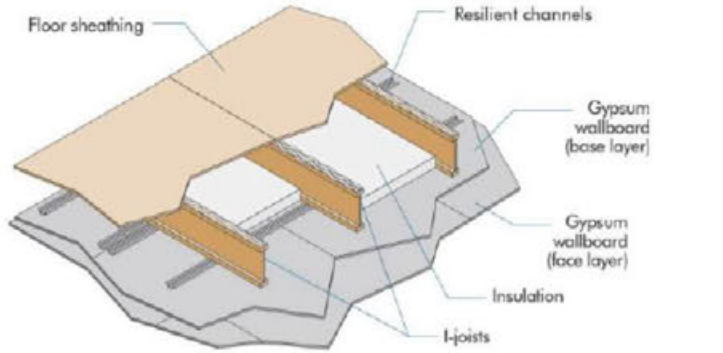
- **Coordinate fire rating / assembly with either**

FLOOR ASSEMBLY SINGLE LAYER GWB VS **TWO LAYER I-JOIST ASSEMBLY**

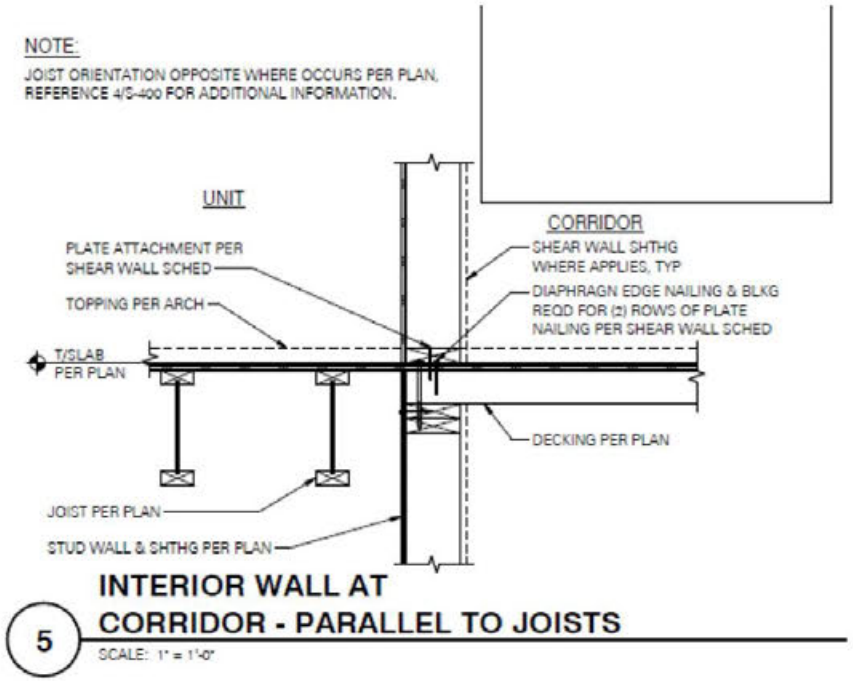


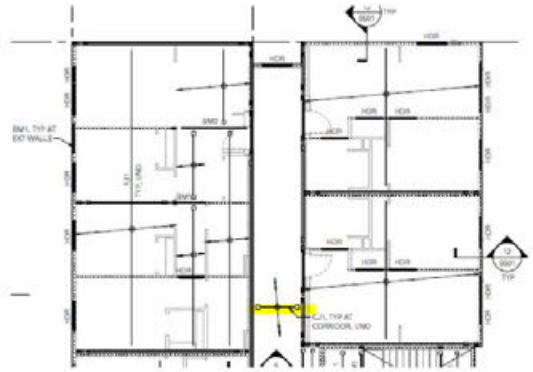




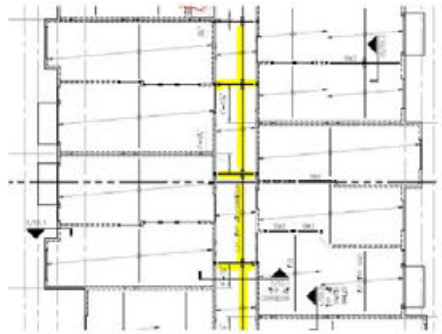


FLOOR ASSEMBLY | **CORRIDOR FRAMING**





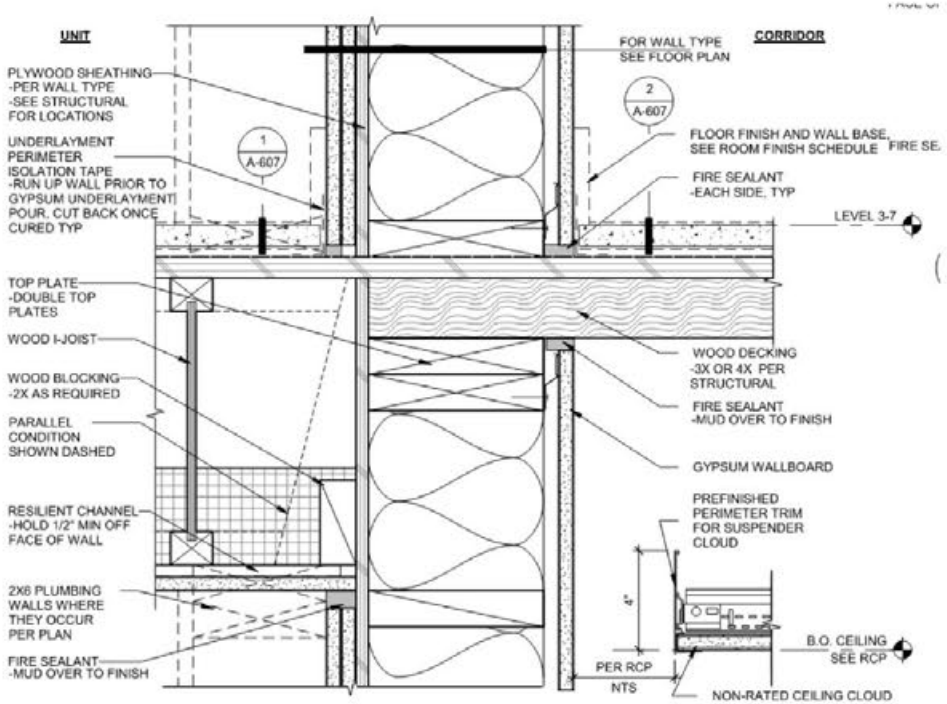
Ladder Framing



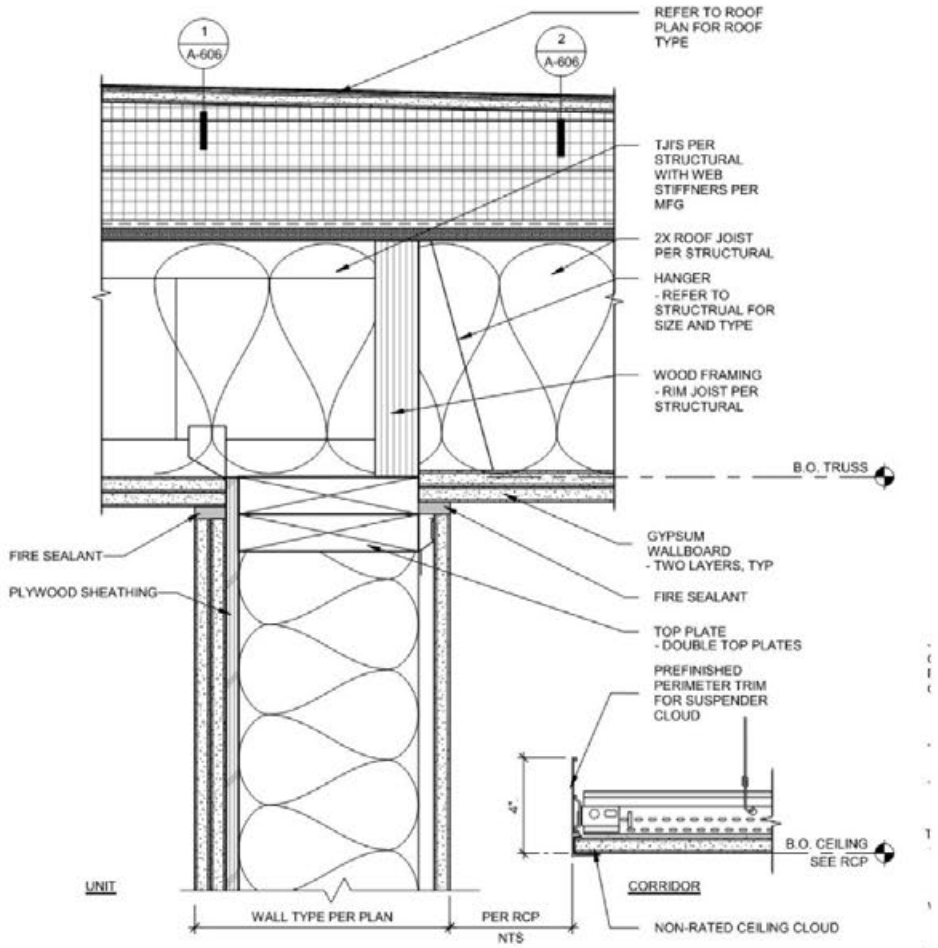
Parallel Framing with Cross Beams

3x Decking

FLOOR / CEILING ASSEMBLY 2 | **CORRIDOR**

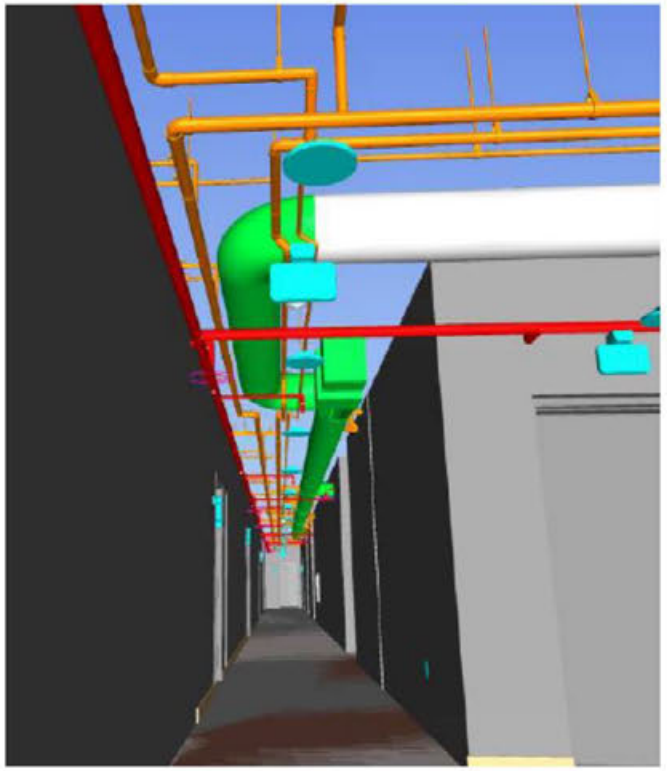


6 UNIT DEMISING WALL AT CORRIDOR
SCALE: 3" = 1'-0"



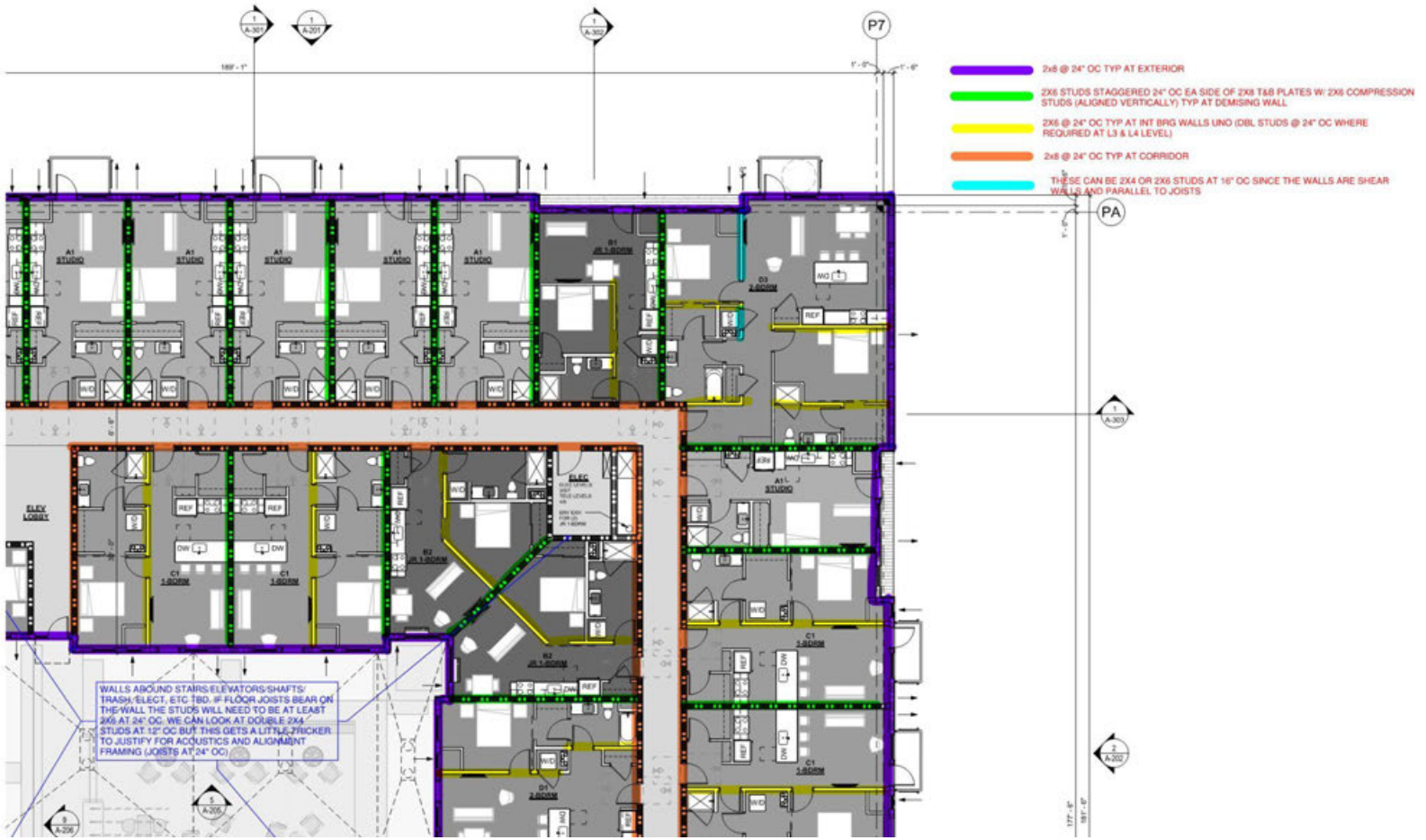
1 CORRIDOR WALL TO ROOF TRUSS
SCALE: 3" = 1'-0"

CLASH DETECTION EXAMPLE IN **FIRE CORRIDORS**



WALL **ASSEMBLIES**

- Understand wall assemblies relating to fire rating and stc rating



WALL **ASSEMBLIES**

Party
- Double
- Staggered studs on single plate

Interior
- If too tall - recommend changing from 2x4 to 2x6

Plumbing
- 2x8 or fur out

Exterior
- Parallel framing for Type III -A to make non-bearing

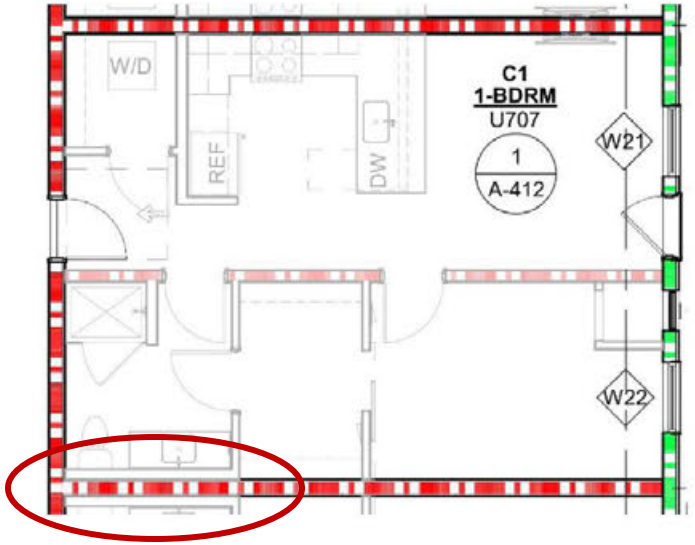
2X6 Stacked Framed Interior Bearing Wall

2X4 Framed Interior Bearing Wall Stud Packs

Staggered Stud on Single Plate

PLUMBING **WALLS**

- Considerations
  - Hold Down Coordination
  - Desired Corridor and Demising Wall Assemblies



EXTERIOR WALL **FRAMING**

2018 IBC

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame[f] (see Section 202)	3[a,b]	2[a,b]	1[b]	0	1[b]	0	3[a]	2[a]	2[a]	HT	1[b]	0
Bearing walls												
Exterior[e,f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT	1	0
Nonbearing walls and partitions Exterior	See Table 602											
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 1/2[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	1 1/2	1	1	HT	1[b,c]	0

TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE[a,d,g]

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H[h]	OCCUPANCY GROUP F-1, M, S-1[f]	OCCUPANCY GROUP A, B, E, F-2, I, R[e], S-2, U[h]
X < 5[k]	All	3	2	1
5 ≤ X < 10	IA, IVA	3	2	1
	Others	2	1	1
10 ≤ X < 30	IA, IB, IVA, IVB	2	1	1[f]
	IIB, VB	1	0	0
	Others	1	1	1[f]
X ≥ 30	All	0	0	0

2021 IBC

→ See Table 705.5

No change to requirements in table, only numbering

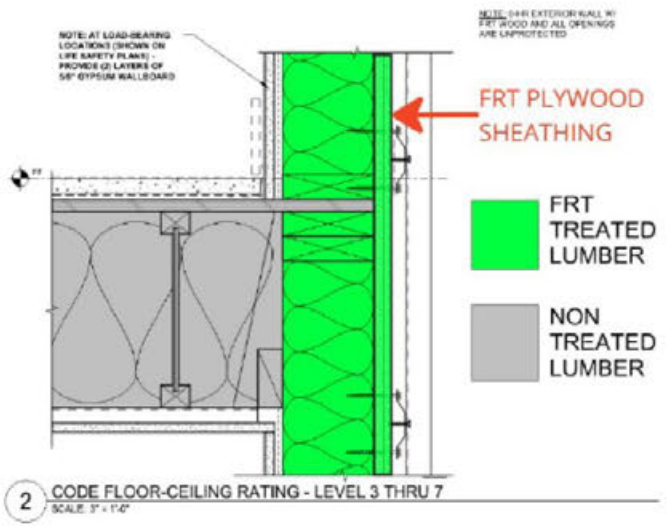
EXTERIOR WALL **FRAMING**

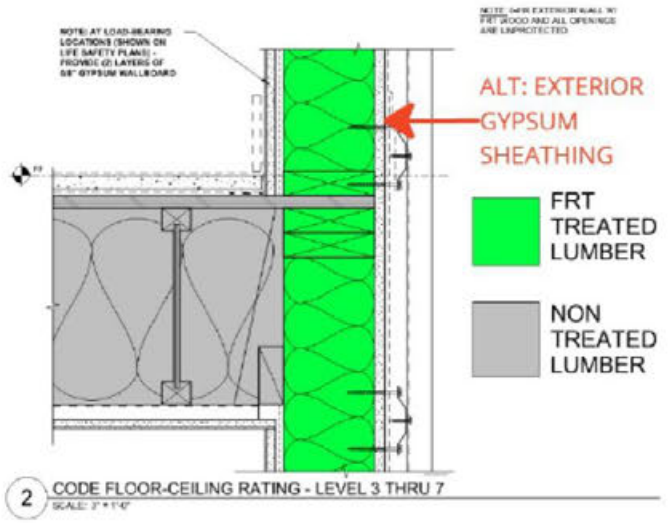
2018 IBC
602.3 Type III

Type III construction is that type of construction in which the exterior walls are of noncombustible materials 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.

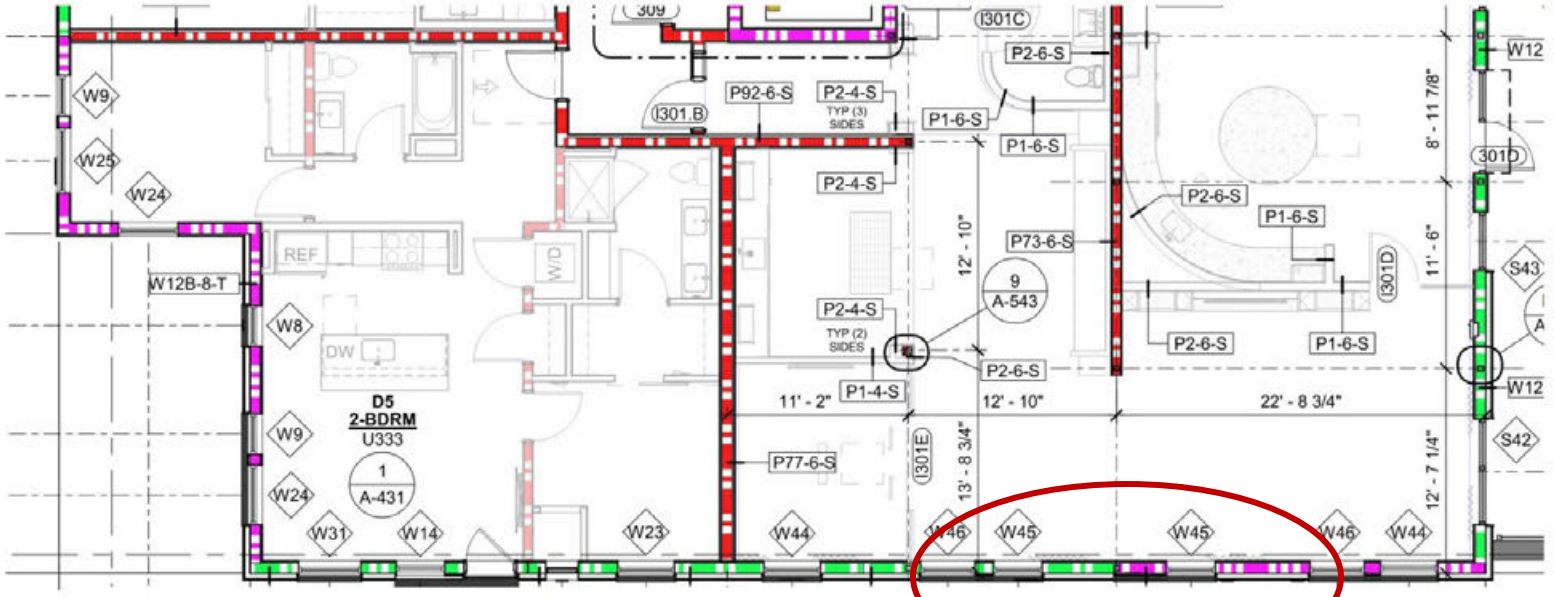
705.5 Fire-Resistance Ratings

Exterior walls shall be fire-resistance rated in accordance with Tables 601 and 602 and this section. The required fire-resistance rating of exterior walls with a fire separation distance of **greater than 10 feet (3048 mm) shall be rated for exposure to fire from the inside.** The required fire-resistance rating of exterior walls with a fire separation distance of less than or equal to 10 feet (3048 mm) shall be rated for exposure to fire from both sides.





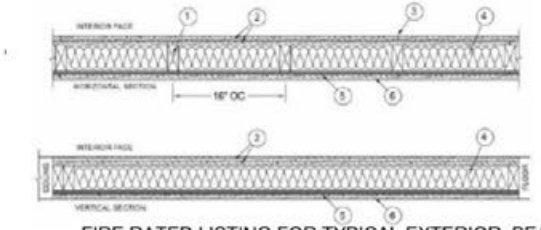
EXTERIOR WALL **FRAMING**



NOTE: THIS IS A PARTIAL SNIPPET OF REQUIRED UL ASSEMBLY - FULL ASSEMBLY AVAILABLE UPON REQUEST

Design No. V314
October 12, 2021

Bearing Wall Rating - 1 Hr Rating Exposed to Fire on Exterior Face (See Item 8)
Bearing Wall Rating - 2 Hr Rating Exposed to Fire on Interior Face
Finish Rating — 42 min (Exposed to Fire on Interior Face)
Loaded Per 2012 NDS Supplement, ASD Method, Wall Braced Mid-Height
Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.



1. **Framing Members*** — Pressure-treated, fire-retardant Wood Studs - nominal 2 by 4 in. spaced 16 in. OC effectively fire stopped. As an option, pressure-treated, fire-retardant Wood Studs nominal 2 by 6 in., spaced 24 in. OC effectively fire-stopped. treated lumber

2. **Gypsum Board*** — Nom 5/8 in. thick, 4 ft. wide, two layers applied vertically. Base layer nailed to wood studs and bearing plates 6 in. OC. with 6d cement coated nails, 1-7/8 in. long, 0.0915 in. shank diam, and 1/4 in. diam. head. The face layer, with joints staggered from base layer, nailed to the studs and bearing plates over the base layer, 8 in. OC with 6d cement coated nails, 2-3/8 in. long, 0.113 in. shank diam, 9/32 in. diam. head.

3. **Joints and Nailheads** — Gypsum board joints covered with tape and joint compound. Nail heads covered with joint compound.

4C. **Batts and Blankets*** — For use with Item 2A and 2B, as an alternate to Batts and Blankets (Item 4) — Faced or unfaced glass fiber batts 3-1/2 in. thick, nom 0.8 pcf (min R-13 thermal insulation rating), friction fit in the wall cavity between stud, plates, and cross bracing. Insulation may be applied in multiple layers to achieve final thickness.
See **Batts and Blankets*** (BZJZ) category for names of Classified manufacturers.

5. **Building Units*** — Pressure-treated, fire-retardant plywood installed vertically nailed to the wood framing with 1-7/8 in. long, 6d nails, spaced 6 in. OC. on the perimeter and 12 in. OC. in the field. Vertical and horizontal joints are backed by framing. Panels consisted in nominal size of 48 in. wide by 96 in. long by 15/32 in. thick. treated plywood

NOTE: IF PROPRIETARY PT/FRT PLYWOOD SHEATHING IS NOT USED, CONTRACTOR TO SUBMIT SIMILAR ASSEMBLY THAT MEETS FIRE RATING AND STC RATING

6. **Exterior Facings** — Any exterior facing, as authorized by the Authority Having Jurisdiction and installed in accordance with the manufacturer's installation instructions are allowed. Exterior facings may include, but are not limited to the following examples:

NOTE:

1. 2 HR RATED FROM INTERIOR, 0 HR RATED FROM EXTERIOR
2. IF PROPRIETARY PT/FRT PLYWOOD SHEATHING IS NOT USED, CONTRACTOR TO SUBMIT SIMILAR ASSEMBLY THAT MEETS FIRE RATING AND STC RATING
3. REFERENCE LIFE SAFETY PLAN IN GENERAL SHEETS FOR EXTERIOR BEARING WALL LOCATIONS
4. FIRE TREATED WOOD FRAMING SHALL BE PERMITTED WITHIN EXTERIOR WALL ASSEMBLIES OF 2 HR OR LESS -PER IBC 602.3 TYPE III

1 FIRE RATED LISTING FOR TYPICAL EXTERIOR BEARING WALL - 2 HR FROM INTERIOR, 0 HR FROM EXTERIOR
SCALE: 1 1/2" = 1'-0"

LOAD BEARING EXTERIOR WALL ASSEMBLY | **ENGINEERING JUDGEMENT**

Element	UL Assembly Design No. V314	Proposed Exterior Wall Assembly
Exterior Siding	Exterior Facings	Exterior Facings
Building Unit	Pressure treated fire-retardant plywood, installed vertically	One layer of 5/8" Type X glass faced exterior gypsum wallboard
Insulation	Faced or unfaced glass fiber batts 3½" nominal 0.8 pcf friction fit within the cavity between stud, plates, and cross bracing	Faced or unfaced Glass fiber batts, 3-1/2" nominal 0.8 pcf filled cavity between stud, plates, and cross bracing.
Joints and Fastener Heads	Gypsum board joints covered with tape and joint compound, nail heads covered with joint compound	Gypsum board joins covered with tape and joint compound.
Wood Studs	Pressure-treated, fire-retardant wood studs, nominal 2 inch by 4 inch spaced 16 inches o.c. effectively fire stopped	Pressure treated nominal 2" x 4" treated lumber framing space 16" on center.
Gypsum	Nominal 5/8 inch thick, 4 foot wide, two (2) layers applied vertically	Two (2) layers 5/8" GWB on the interior side of the assembly (4' wide applied vertically).
Fire-Resistance Rating	**2-Hour**	**2-Hour (minimum)**

Table 1: Comparison between UL V314 and the Proposed Assembly

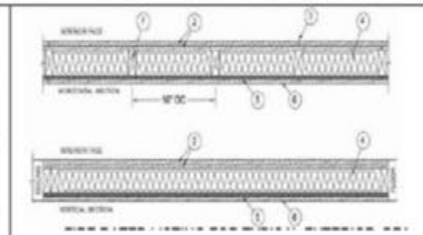
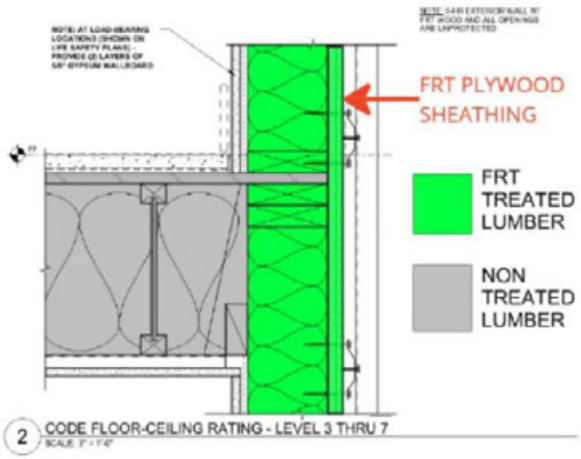
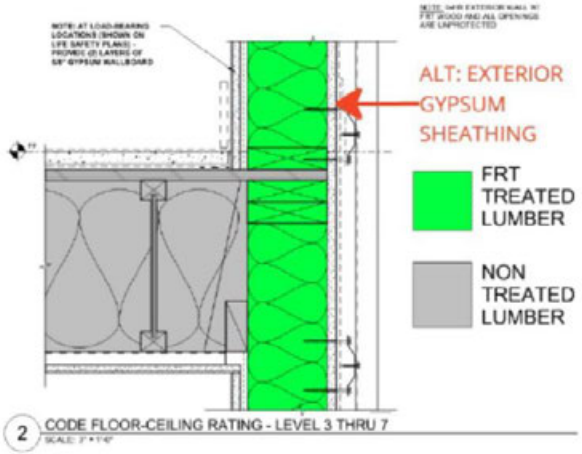
Proposed load bearing exterior wall assemblies on Levels 3-7.		• Exterior Siding. • One layer of 5/8" Type X glass faced exterior gypsum wallboard. • Faced or unfaced Glass fiber batts, 3-1/2" nominal 0.8 pcf filled cavity between stud, plates, and cross bracing. • Gypsum board joins covered with tape and joint compound. • Pressure treated nominal 2" x 4" treated lumber framing space 16" on center. • Two (2) layers 5/8" GWB on the interior side of the assembly (4' wide applied vertically).

Figure 2: Proposed Load Bearing Exterior Wall Assemblies on Levels 3-7.





EFFICIENT FRAMING LAYOUT | **UNIT LAYOUTS**

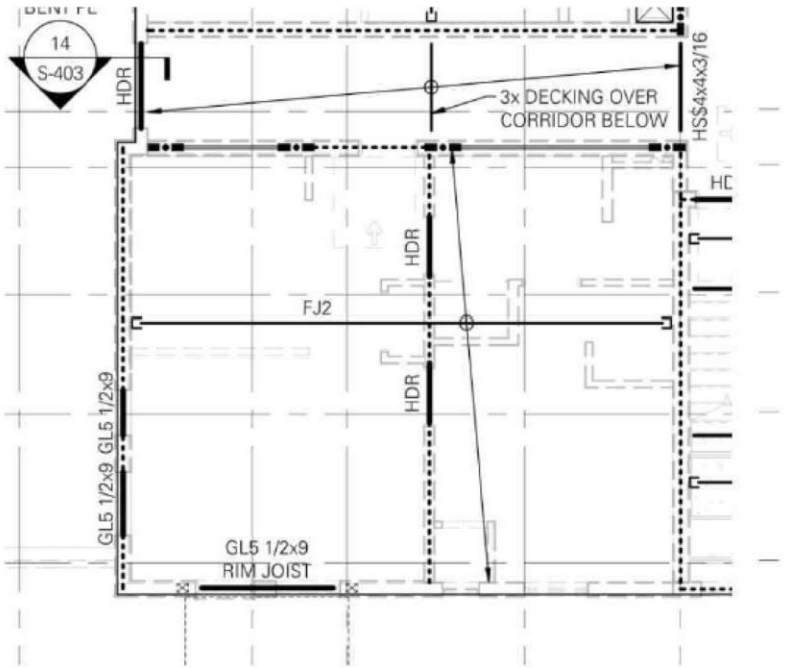
- Early coordination with architect and structural
- Provide architect with max typical joist spans (example below)

JOIST COMPARISON

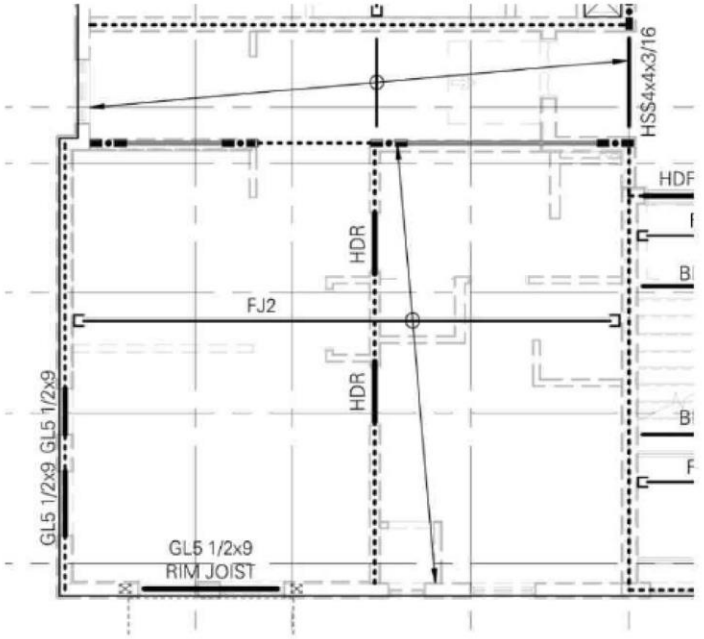
JOIST DEPTH	JOIST GRADE	JOIST SPAN	JOIST SPACING	SHEATHING THICKNESS	FLOOR PERFORMANCE RATING	LL DEFLECTION RATIO	JOIST/SHEATHING ASSEMBLY RELATIVE COST INDEX	
9-1/2"	I45	13'-0"	16" OC	3/4"	6.8	L/912	1.00	
9-1/2"	I45	13'-0"	24" OC	3/4"	4.9	L/641	0.79	
9-1/2"	I45	13'-0"	24" OC	7/8"	5.2	L/670	0.93	
9-1/2"	I45	13'-0"	24" OC	1-1/8"	5.4	L/700	1.07	
11-7/8"	I45	15'-6"	16" OC	3/4"	5.7	L/914	1.04	
11-7/8"	I45	15'-6"	24" OC	3/4"	3.5	L/642	0.83	
11-7/8"	I45	15'-6"	24" OC	7/8"	3.8	L/668	0.96	
11-7/8"	I45	15'-6"	24" OC	1-1/8"	4.1	L/696	1.10	
11-7/8"	I65	15'-6"	24" OC	1-1/8"	5.7	L/900	1.24	*I65 HIGHER JOIST GRADE SHOWN FOR COMPARISION TO ACHIEVE SAME RATING AS 16"OC
11-7/8"	I90	15'-6"	24" OC	1-1/8"	7.0	L/1115	1.37	*I90 HIGHER JOIST GRADE SHOWN FOR COMPARISION TO ACHIEVE RATING OF AT LEAST 6

- If units are non-stacking, then module party walls to stack
- Get units to stack

NON-STACKING UNITS **ALIGNMENT**



LEVEL 3 UNIT AND CORRIDOR



LEVEL 4 UNIT SPANNING OVER CORRIDOR

EFFICIENT FRAMING LAYOUT | **STACKING LATERAL**

- Stack the lateral system
- Provide architect early lateral layouts
- Provide minimum shear wall lengths
- Maximize interior shear walls
- Preferably no plumbing walls

EFFICIENT FRAMING LAYOUT | **STACKING GRAVITY**

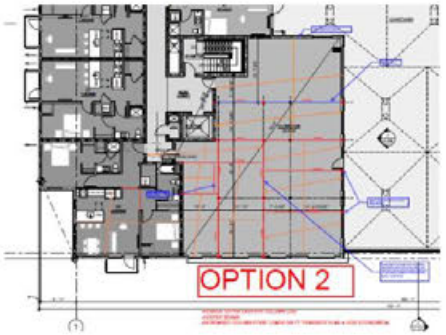
STACK THE GRAVITY SYSTEM

Non-stacking areas

- Shift walls parallel to framing to minimize transfer beams

Beams

- Provide options for cost / benefit analysis



THANK YOU!

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This concludes The American Institute of Architects Continuing Education Systems Course.