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Shaft Wall Solutions for Wood-Frame Structures

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WoodWorks – Wood Products Council

Atlanta WSF, April 25, 2018

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

Course Description

It is fairly common for light wood-frame commercial and multi-family buildings to include another material for the shaft construction. However, many designers and contractors have come to realize that wood-frame shaft walls are a code-compliant means of reducing cost and shortening construction schedule. In this presentation, detailing for elevator, stair and mechanical shafts will be reviewed along with relevant code provisions. Discussion will focus on fire resistance-rated design parameters, but will also include other architectural and structural considerations related to shaft walls.

Learning Objectives

1. Review fire resistance-rated code provisions relevant to wood shaft wall design.
2. Introduce shaft wall assembly types, evaluating their applicability to elevator, stair and mechanical shafts.
3. Provide detailing options that establish fire resistance continuity at framing intersections.
4. Recognize structural design considerations for stair and elevator shafts.

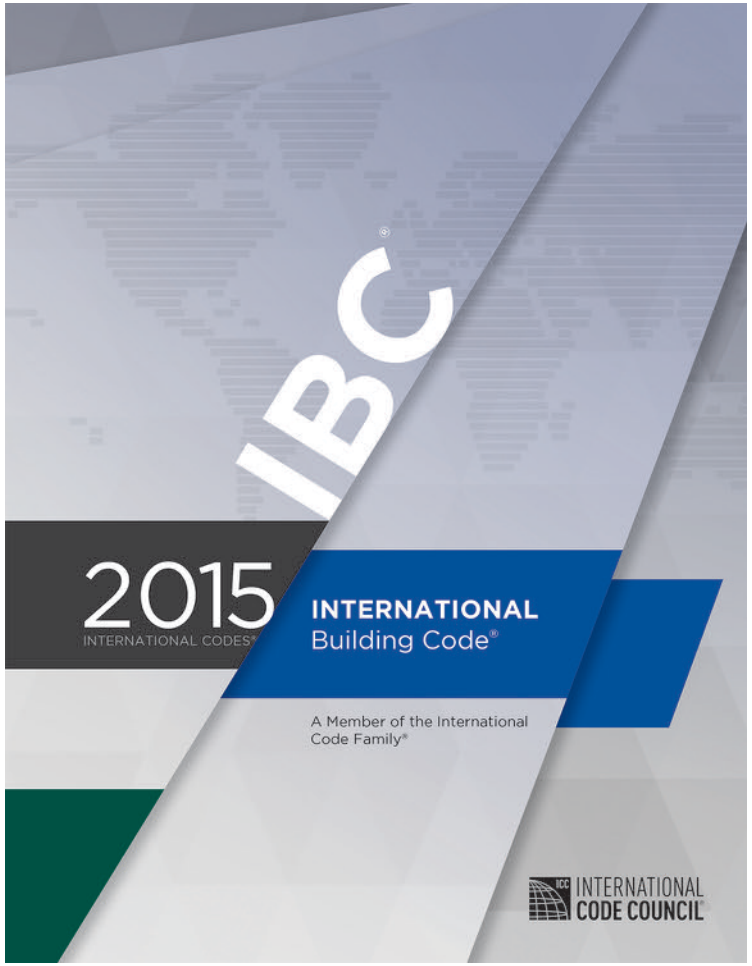
Shaft Walls

Shaft Walls

Shaft Walls Form Shaft Enclosures

"The purpose of shafts is to confine a fire to the floor of origin and to prevent the fire or the products of the fire (smoke, heat and hot gases) from spreading to other levels"

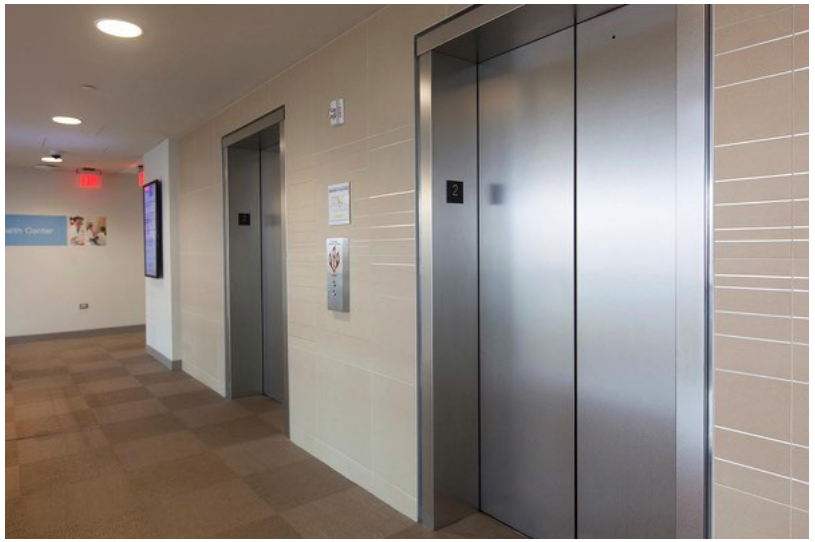
Source: IBC Commentary to Section 713.1



Types of Shaft Walls

Types of Shafts:

- **Elevator**
- **Stair**
- **Mechanical**



Code requirements apply to any/all shaft enclosures. Some points of shaft wall construction and detailing apply to all types of shafts. Some are unique to each type of shaft.

More on the differences later…

Shaft Wall Materials

Light Frame Wood Shaft Walls

- Cost
- Construction Schedule
- Material Compatibility (movement & lateral load resistance)

Shaft Wall Savings – Case Study

Switch to Wood Framed Shaft Walls Saves Project $176,000

- Gala at Oakcrest, Euless, TX
- 4 Story, 135,000 sf multi-family building
- 2 Elevator Shafts, 3 Stair Shafts, all originally designed in masonry – project was otherwise all wood framed
- Initial estimates were total of $266,000 for all 5 shafts
- Team switched to wood shafts, cut $176,000 from cost and at least 3 weeks from schedule

Source: Gardner Capital Construction, project General Contractor & Developer

Shaft Wall Materials

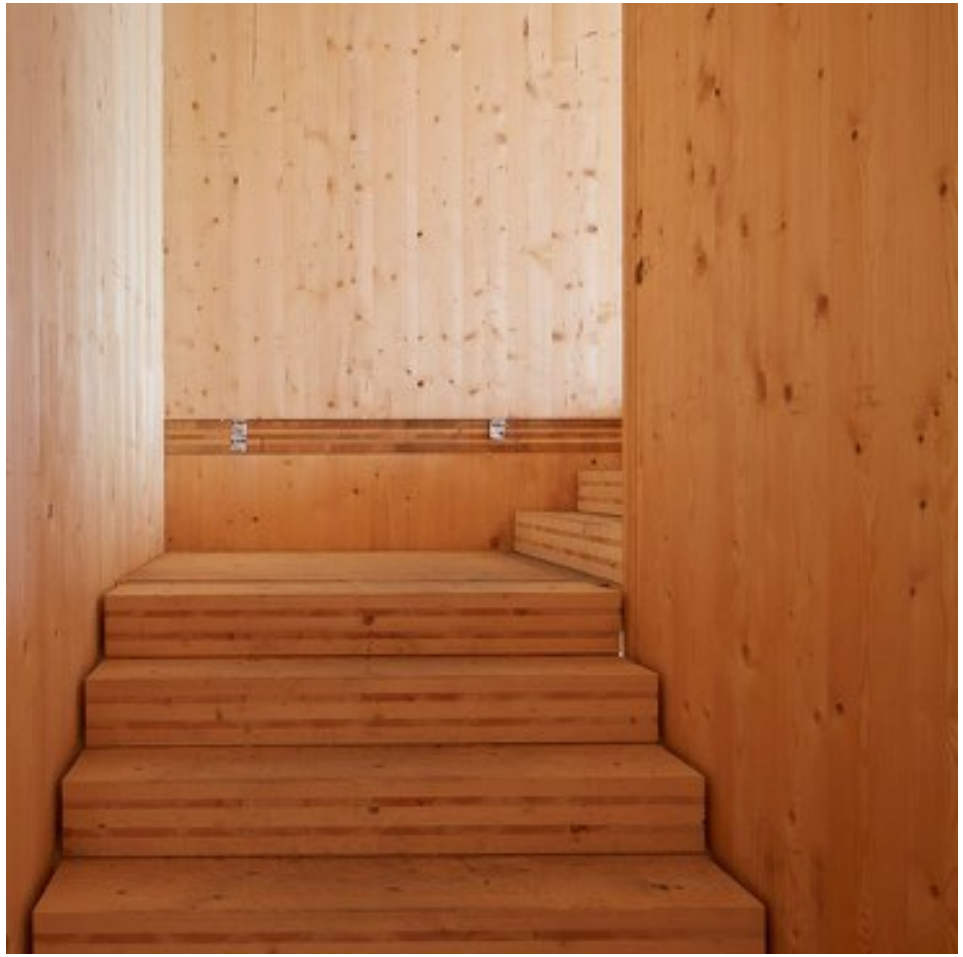


Photo: Will Pryce

Shaft Wall Materials

Mass Timber Shaft Walls

- Cost
- Construction Schedule
- Material Compatibility (movement & lateral load resistance)
- Can double as architectural feature
- Similar to tilt up or continuous wall applications
- Successful fire tests for 2 Hr mass timber shaft walls exist (exposed and protected)

Photo: Lendlease

Shaft Wall Design Topics - Agenda

1. Wall Definition
2. Materials
3. Continuity
4. Supporting Construction
5. Joints & Penetrations
6. Exterior Walls
7. Assemblies
8. Floor to Shaft Wall Intersections
9. Stair, Elevator & Mechanical Shafts – Differences
10. Non-Wood Shaft Walls

Defining Shaft Wall Requirements

IBC defines 5 different types of fire-resistance rated walls:

- **Light Frame Bearing Walls (IBC 704.4.1)**
- **Exterior Walls (IBC 705)**
- **Fire Walls (IBC 706)**
- **Fire Barriers (IBC 707)**
- **Fire Partitions (IBC 708)**

Defining Shaft Wall Requirements

Code requirements for shaft enclosures contained in IBC Section 713

SECTION 713
SHAFT ENCLOSURES

713.1 General. The provisions of this section shall apply to shafts required to protect openings and penetrations through floor/ceiling and roof/ceiling assemblies. *Interior exit stairways* and *ramps* shall be enclosed in accordance with Section 1023.

- **IBC 713.2: Shaft Walls shall be constructed as Fire Barriers**
- **Many shaft wall provisions contained in IBC Section 707 – Fire Barriers**

Shaft Wall Materials

SECTION 707
FIRE BARRIERS

707.2 Materials.
Fire barriers shall be of materials permitted by the building type of construction.

- Wood-framed shaft walls permitted for any shaft walls in construction types III, IV and V
- FRT wood-framed shaft walls may be used for non-bearing shaft walls in construction types I and II (pending AHJ interpretation)

Shaft Wall Materials

Type III Construction:

Any material permitted by code for all interior elements

Fire-retardant treated wood for exterior walls

Type IV Construction:

Heavy/mass timber members (or any wood wall min. 1 hr) for all interior elements

Fire retardant treated wood or CLT for exterior walls

Type V Construction:

Any material permitted by code for all interior and exterior elements

Shaft Wall Materials

	Type III	Type IV	Type V
Interior Shaft Walls	Any code permitted wood framing	Heavy timber or any code permitted wood framing (min. 1 hr rated required)	Any code permitted wood framing
Exterior Shaft Walls	Fire-retardant treated wood	Fire-retardant treated wood or CLT	Any code permitted wood framing

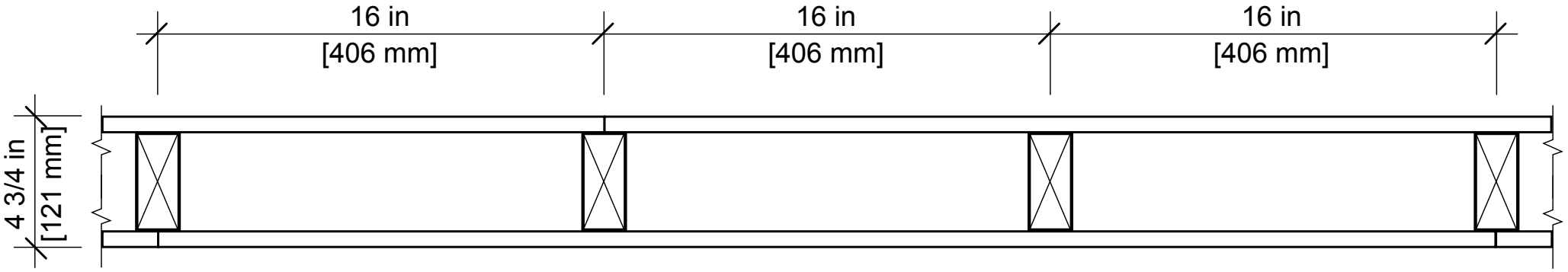
Info on unique fire rating requirements of exterior shaft walls to come in a bit…

Defining Shaft Wall Requirements

Shaft Wall Hourly Ratings:

713.4 Fire-Resistance Rating:

- 2 hours when connecting 4 stories or more
- 1 hour when connecting less than 4 stories
- Number of connected stories includes basement but not mezzanine
- Fire rating of shaft walls shall not be less than floor assembly penetrated, but need not exceed 2 hours



There is no restriction on combustible material within shaft walls or fire barriers in Types III, IV or V construction.

Continuity Provisions

SECTION 713
SHAFT ENCLOSURES

713.5 Continuity.

Shaft enclosures shall have continuity in accordance with 707.5 for fire barriers.

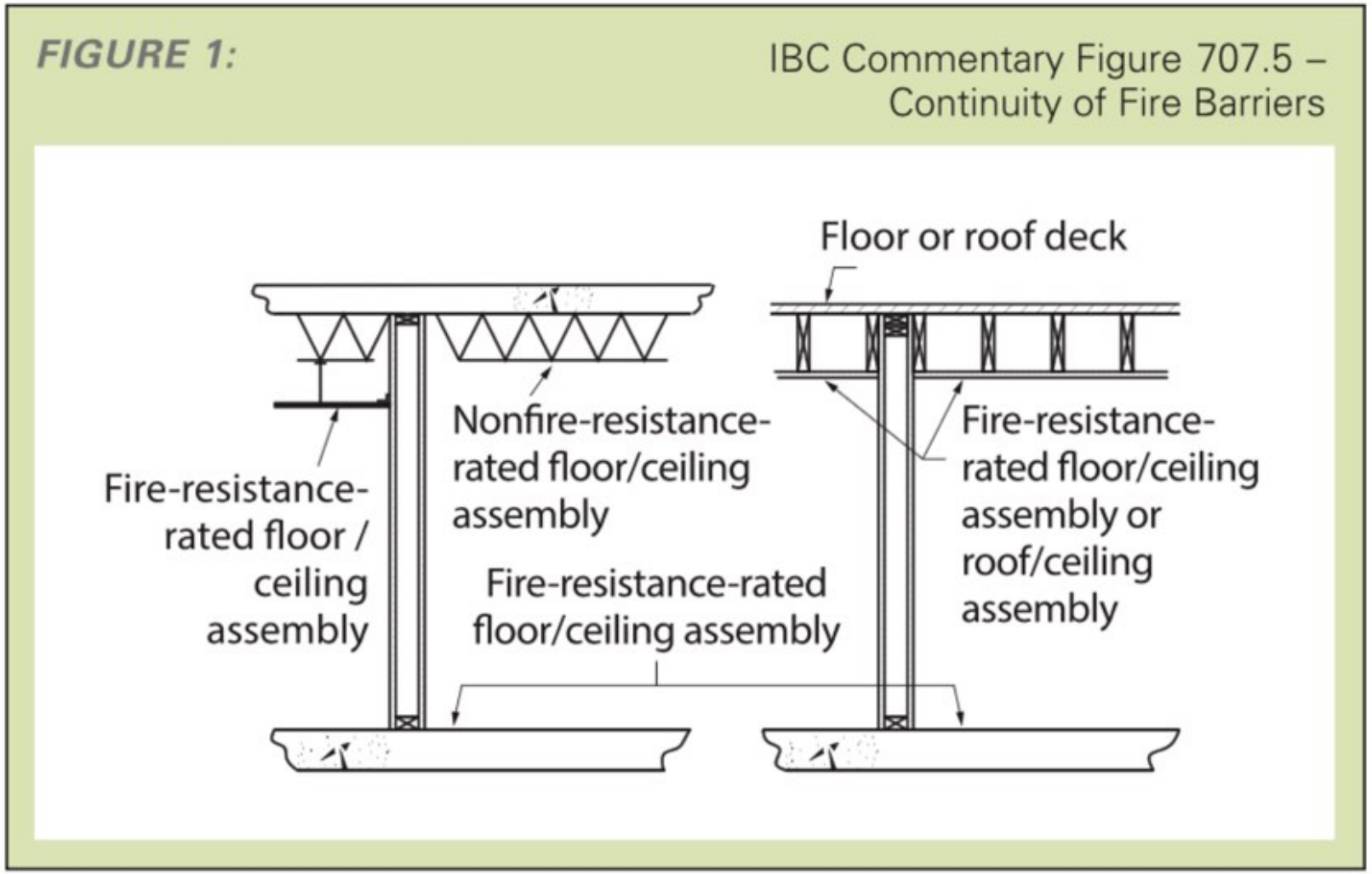
SECION 707
FIRE BARRIERS

707.5 Continuity.

Fire barriers shall extend from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, slab or deck above and shall be securely attached thereto. Such fire barriers shall be continuous though concealed space such as the space above a suspended ceiling. Joints and voids at intersections shall comply with Sections 707.8 and 707.9.

Continuity Provisions

What do these continuity provisions look like?



Continuity Provisions

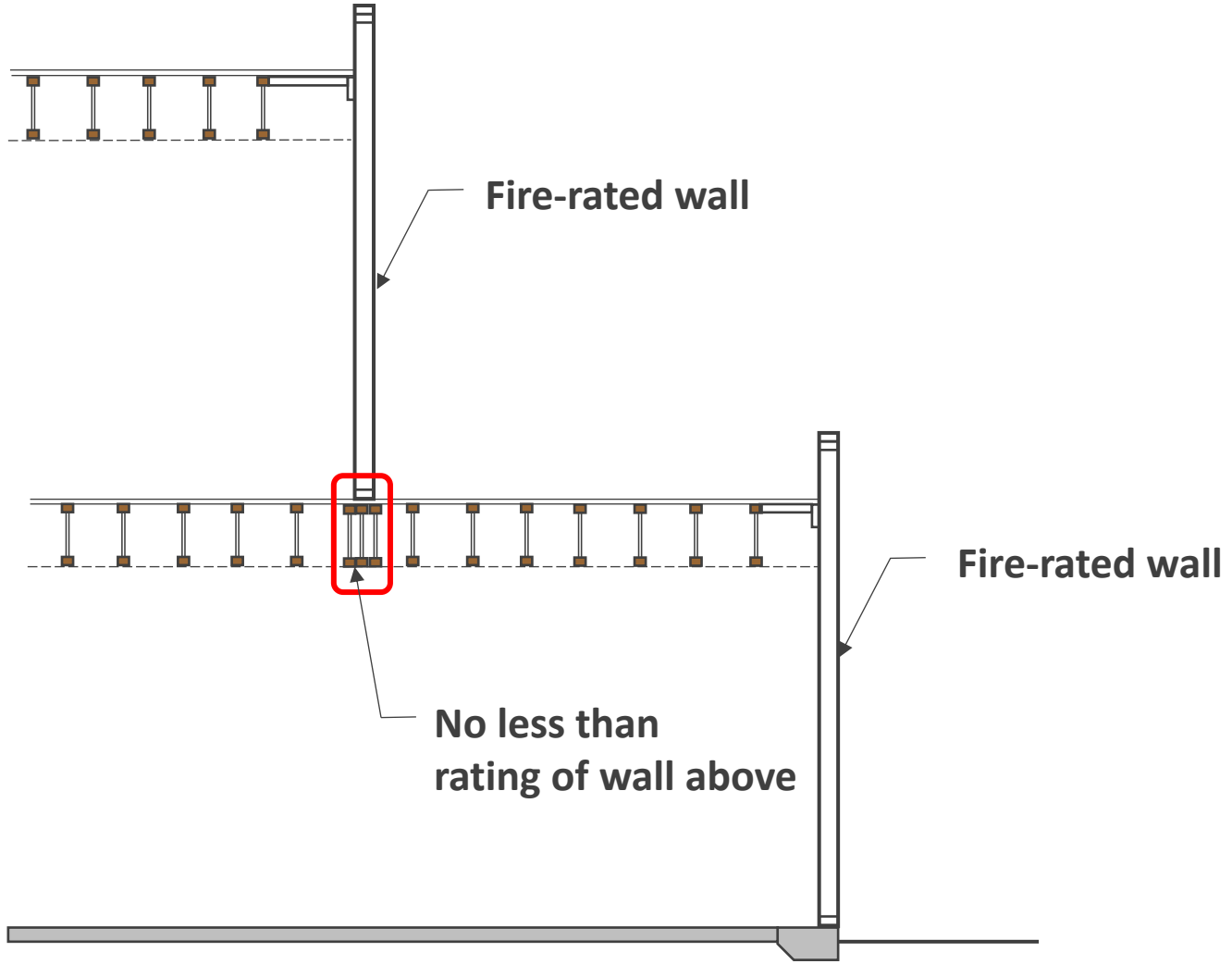
Fire barriers, including shaft walls, must extend from top of sheathing to underside of sheathing. Sheathing does not obstruct continuity.

Supporting Construction Provisions

IBC 707.5.1 Supporting Construction:

- The supporting construction for a fire barrier shall be protected to afford the required fire-resistance rating of the fire barrier supported.

i.e. shaft walls that are not continuous to lowest level



The intent of a fire barrier is to provide fire confinement. If a fire barrier wall is supported directly by a wall below, the intersecting floor should not be considered a supporting element.

Joints in Shaft Walls

SECION 707
FIRE BARRIERS

707.5 Continuity.
Joints and voids at intersections shall comply with Sections 707.8 and 707.9.

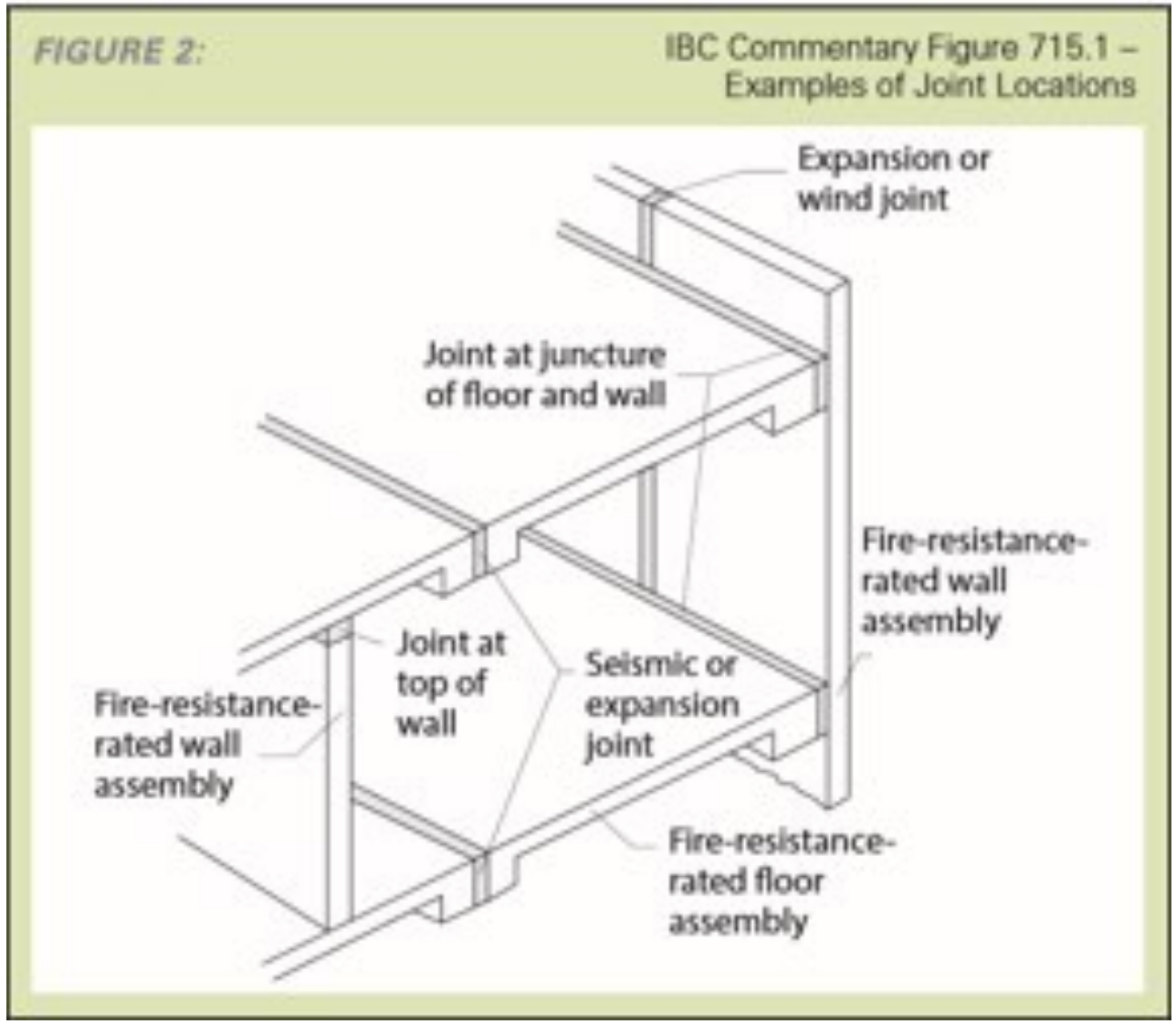
707.8 Joints.
Joints made in or between fire barriers, and joints made at the intersection of fire barriers with underside of a fire resistance-rated floor or roof sheathing, slab or deck above, and the exterior vertical wall intersection shall comply with Section 715.

Does floor sheathing / a floor assembly intersecting a shaft wall constitute a joint? In wood-frame construction, typically, no.

Joints in Shaft Walls

SECTION 202
DEFINITIONS

Joint. *The opening in or between adjacent assemblies that is created due to building tolerances, or is designed to allow independent movement of the building in any plane caused by thermal, seismic, wind or any other loading.*



Assembly intersections that are in direct contact and securely attached are not considered joints.

Penetrations in Shaft Walls

SECTION 713
SHAFT ENCLOSURES

713.8 Penetrations.
Penetrations in shaft enclosure shall be protected in accordance with Section 714 as required for fire barriers. Structural elements such as beams or joists, where protected in accordance with Section 714 shall be permitted to penetrate a shaft enclosure.

SECION 707
FIRE BARRIERS

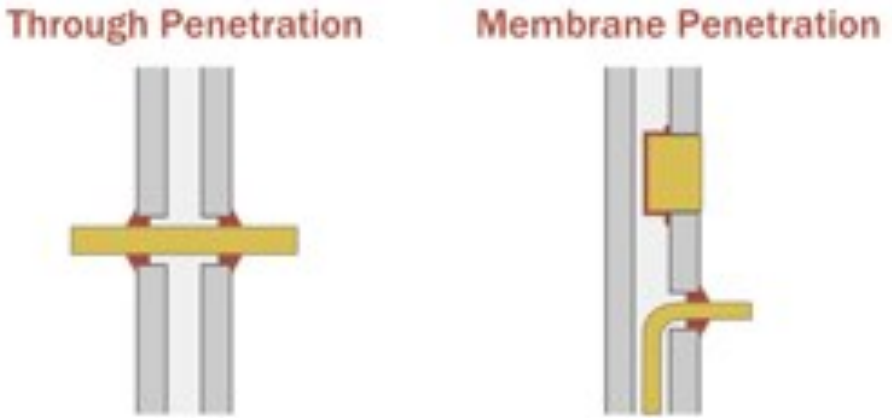
707.7 Penetrations.
Penetrations of fire barriers shall comply with Section 714.

Penetrations in Shaft Walls

Where are structural penetrations in shaft walls common?

- Main Floor Joists to Shaft Wall Connection
- Stair framing to Shaft Wall Connection

Penetrations in Shaft Walls



SECTION 714
PENETRATIONS

714.3.1.1 Fire-resistance-rated assemblies.
Penetrations shall be installed as tested in an approved fire resistance rated assembly.

OR

714.3.1.2 Through-penetration firestop system.
Through penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E814 or UL 1479, with a minimum positive pressure differential of .01 inch of water and shall have an F rating of not less than the required fire-resistance rating of the wall penetrated.

Penetrations in Shaft Walls

To some, a new way of thinking:

Many are familiar with firestopping for MEP, but not structure, especially wood structure

Penetrations in Shaft Walls

Stair landing beam shaft wall structural penetration prior to firestop system installation

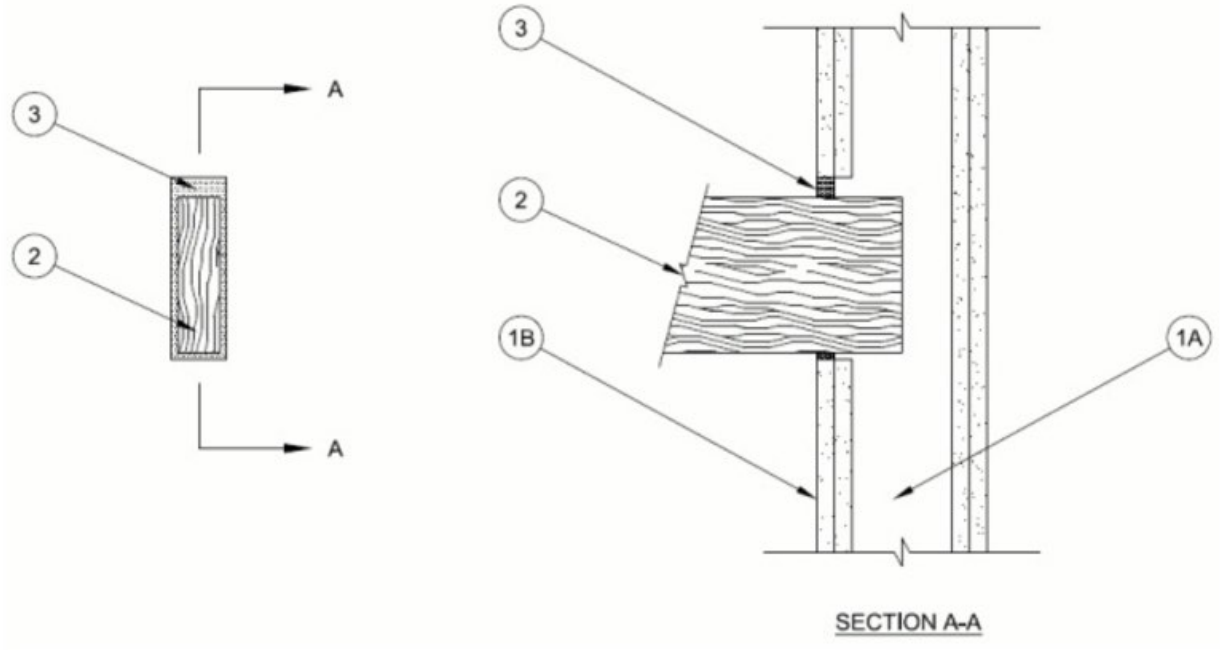
- Some firestopping systems available as tested configurations for wood conditions
- Most manufacturers can provide engineering judgement details / certification statements for this condition

Penetrations in Shaft Walls

System No. W-L-7244

August 24, 2016

ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Ratings — 1 and 2 Hr (See Item 1)	F Ratings — 1 and 2 Hr (See Item 1)
T Ratings — 1 and 2 Hr (See Item 1)	FT Ratings — 1 and 2 Hr (See Item 1)
	FH Ratings — 1 and 2 Hr (See Item 1)
	FTH Ratings — 1 and 2 Hr (See Item 1)



SECTION A-A

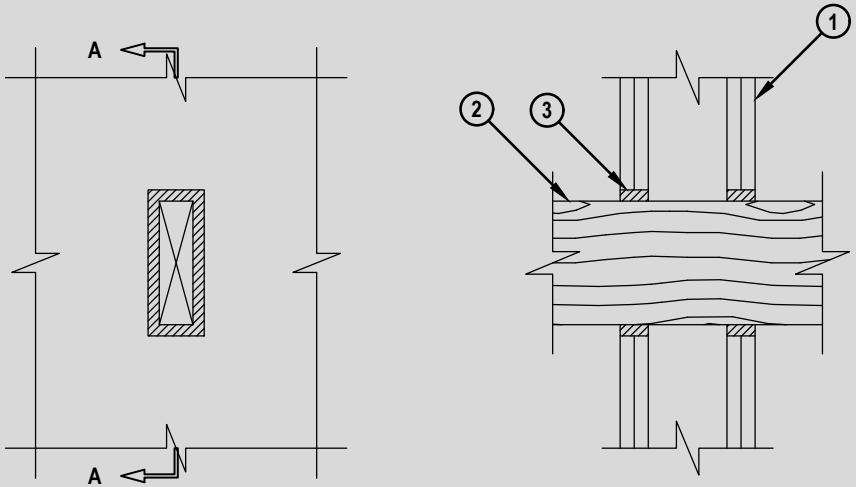
DH

ENGINEERING JUDGMENT FIRESTOP DETAIL

F-RATING = 2-HR.

FRONT VIEW

SECTION A-A



1. GYPSUM WALL ASSEMBLY (UL/cUL CLASSIFIED) WITH MINIMUM 2" x 6" WOOD STUDS (2-HR. FIRE-RATING).
2. NOMINAL 3-1/2" x 9-1/2" WOOD MEMBER (NON FIRE-RATED).
3. MINIMUM 1-1/4" DEPTH HILTI FS-ONE MAX INTUMESCENT FIRESTOP SEALANT.

NOTES : 1. MAXIMUM SIZE OF OPENING = 4-1/2" x 10-1/2".
2. ANNULAR SPACE = MINIMUM 1/4", MAXIMUM 1".
3. FIRE-RATING AND STRUCTURAL INTEGRITY OF ASSEMBLY IS DEPENDENT UPON THE PERFORMANCE OF WOOD MEMBER UNDER FIRE CONDITIONS.

THIS ENGINEERING JUDGMENT REPRESENTS A FIRESTOP SYSTEM THAT WOULD BE EXPECTED TO PASS THE STATED RATINGS IF TESTED.
(REFERENCE : UL/cUL SYSTEM NO. W-L-1054 & W-L-7130; INTERNAL TESTING)

		Sheet 1 of 1	Drawing No.
	Designed by Coey Lee	Scale 11/64" = 1"	251723a
		Date Jan. 30, 2017	

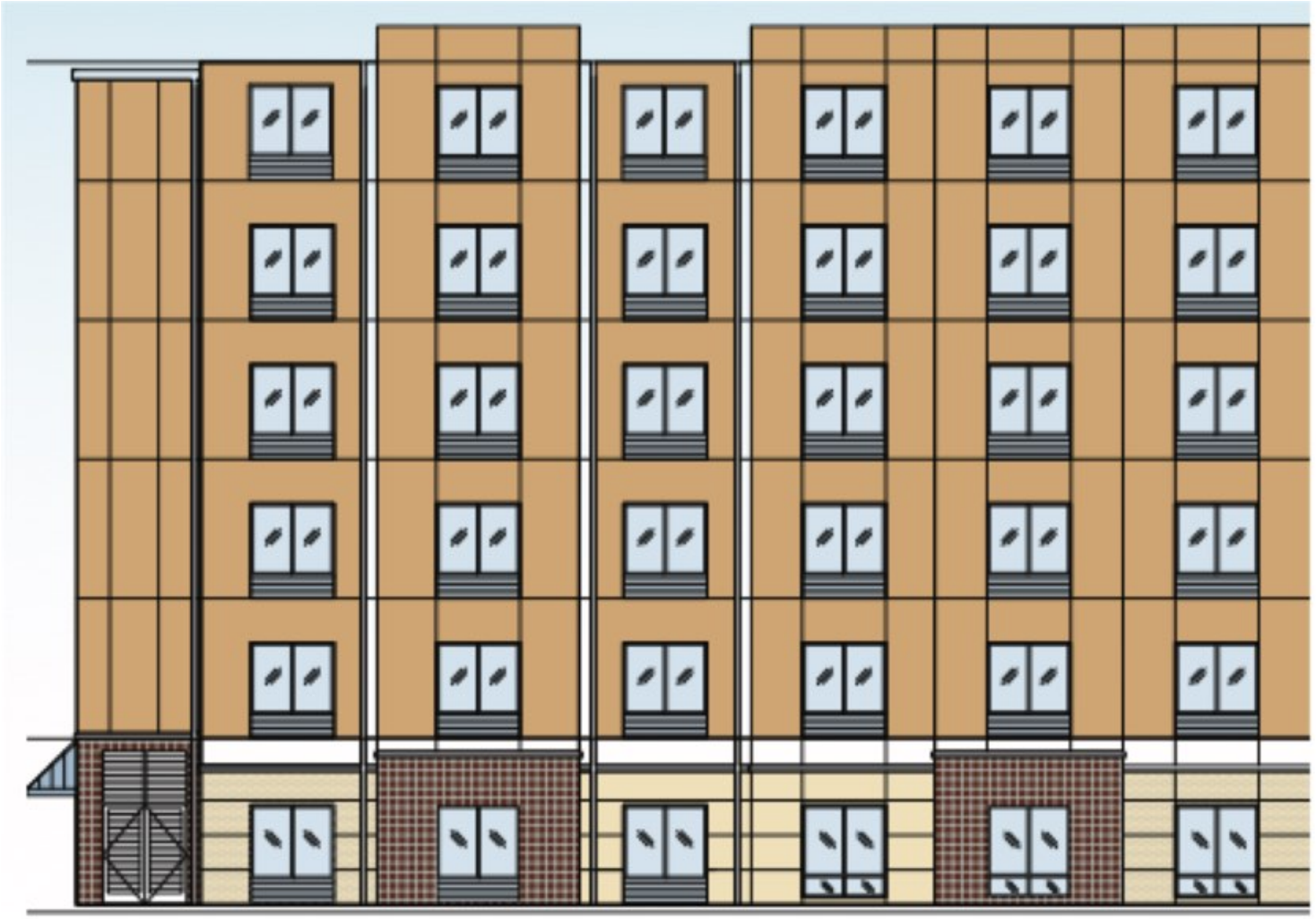
Saving Lives through Innovation and Education

Structural members are specifically called out as allowable penetrants in shaft enclosures.

Shaft Walls that are also Exterior Walls

Stair and elevator shaft enclosures are commonly placed along the exterior of the building

When a shaft wall also serves as the exterior wall of a building, unique provisions exist



Shaft Walls that are also Exterior Walls

713.6 Exterior walls.

Where exterior walls serve as a part of a required shaft enclosure, such walls shall comply with the requirements of Section 705 for exterior walls and the fire resistance-rated enclosure requirements shall not apply.

Exception: *Exterior walls required to be fire-resistance rated in accordance with Section 1021.2 for exterior egress balconies, Section 1023.7 for interior exit stairways and ramps and Section 1027.6 for exterior exit stairways and ramps.*

Shaft Walls that are also Exterior Walls

Exterior bearing wall fire resistance rating per Table 601

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	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e,f] Interior	3 3[a]	2 2[a]	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1½[b]	1[b,e]	1[b,e]	0[e]	1[b,e]	0	HT	1[b,e]	0

Shaft Walls that are also Exterior Walls

Exterior non-bearing wall fire resistance rating per Table 602

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[e]	OCCUPANCY GROUP F-1, M, S-1[f]	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U[h]
$X < 5^{b}$	All	3	2	1
$5 \le X < 10$	IA Others	3 2	2 1	1 1
$10 \le X < 30$	IA, IB IIB, VB Others	2 1 1	1 0 1	1[c] 0 1[c]
$X \ge 30$	All	0	0	0

Shaft Walls that are also Exterior Walls

Exterior Walls (IBC 705):

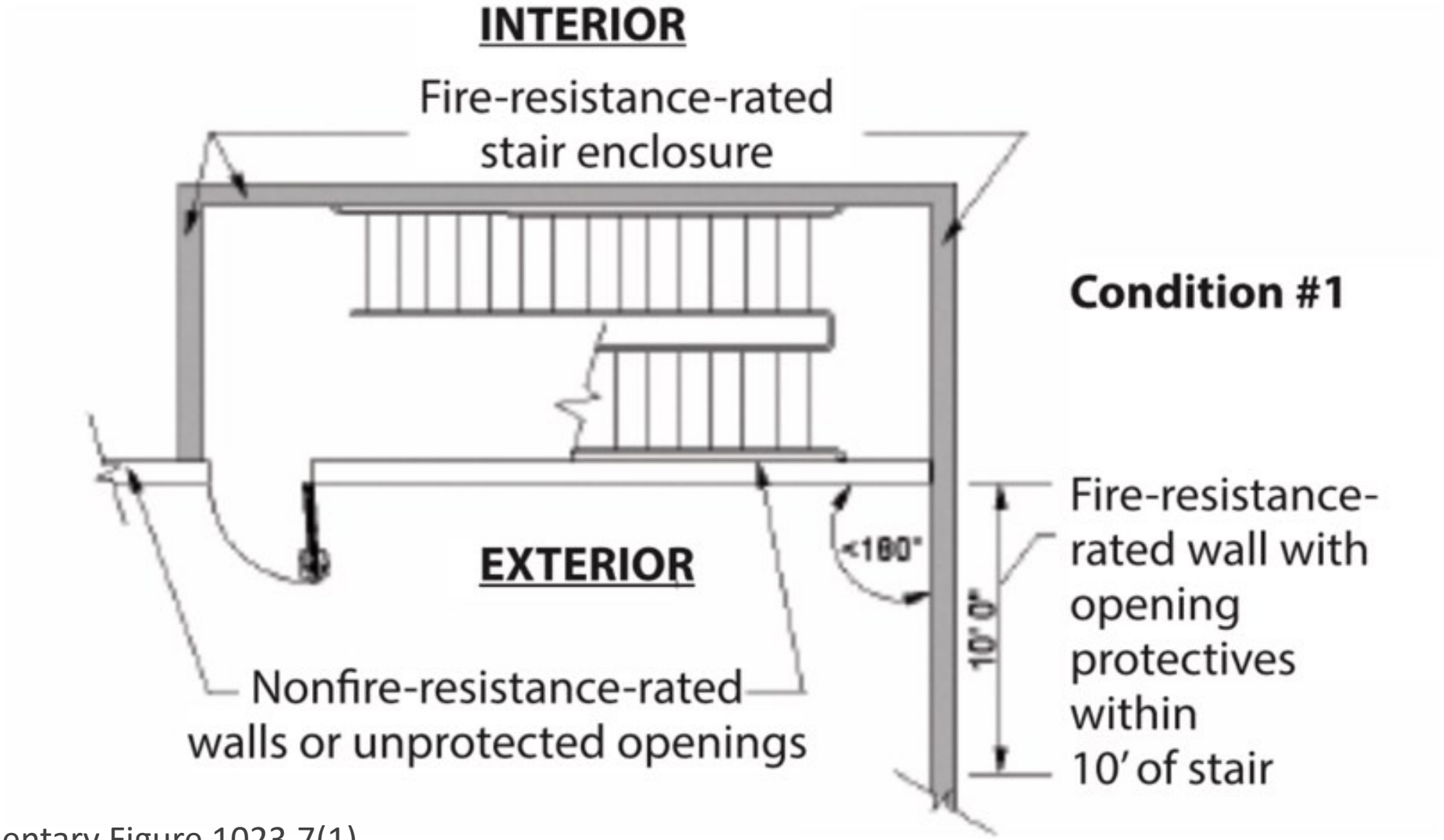
- Materials as permitted for type of construction (same as fire barrier) – 705.4
- Fire resistance only required from inside if fire separation distance is > 10 ft – 705.5
- Possible to have exterior shaft wall that does not require a fire resistance rating

Shaft Walls that are also Exterior Walls

1023.7 Interior exit stairway and ramp exterior walls.

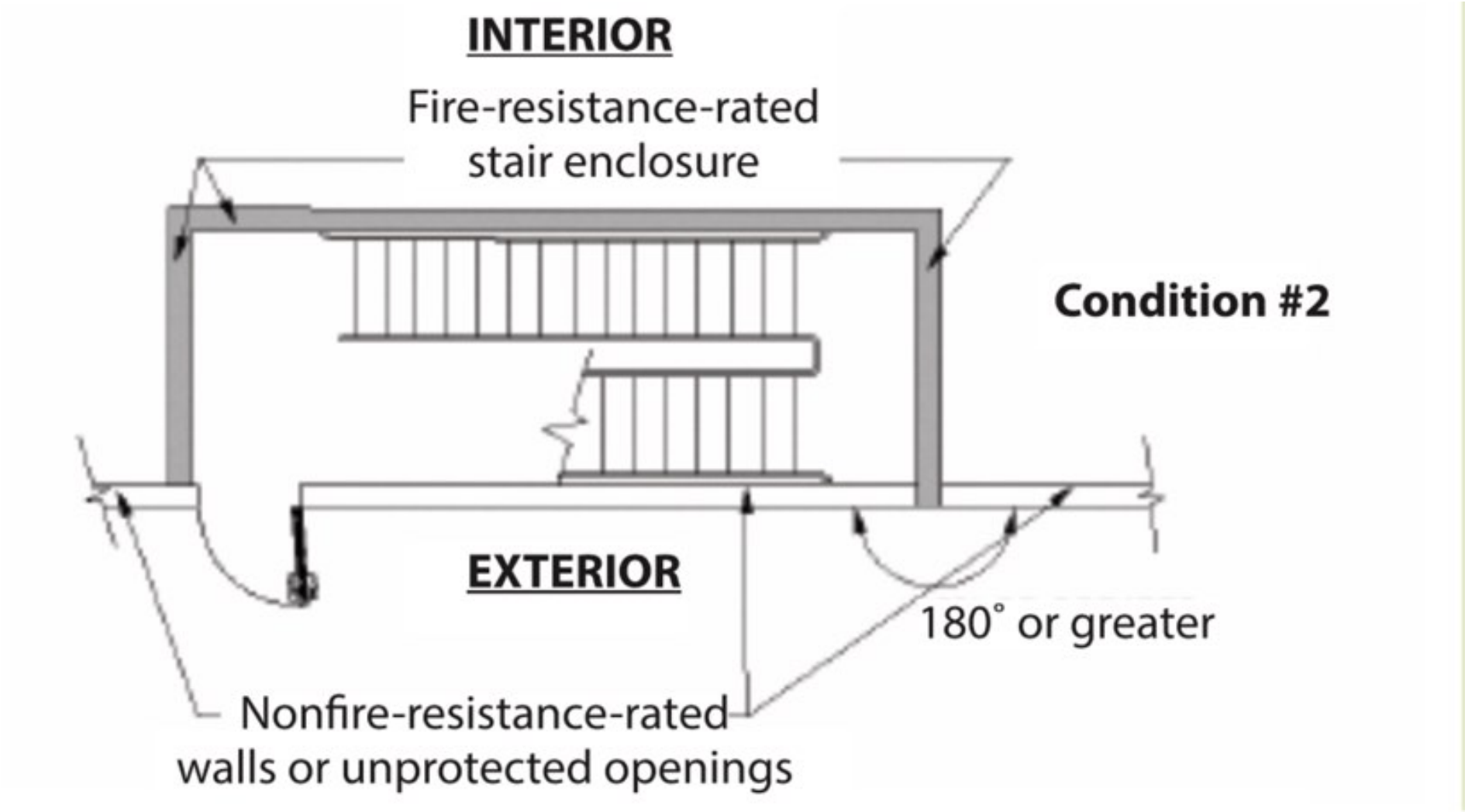
Exterior walls of the interior exit stairway or ramp shall comply with the requirements of Section 705 for exterior walls. Where nonrated walls or unprotected openings enclose the exterior of the stairway or ramps and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the building exterior walls within 10 feet (3048 mm) horizontally of a nonrated wall or unprotected opening shall have a fire-resistance rating of not less than 1 hour. Openings within such exterior walls shall be protected by opening protectives having a fire protection rating of not less than 3 /4 hour. This construction shall extend vertically from the ground to a point 10 feet (3048 mm) above the topmost landing of the stairway or ramp, or to the roof line, whichever is lower.

Shaft Walls that are also Exterior Walls



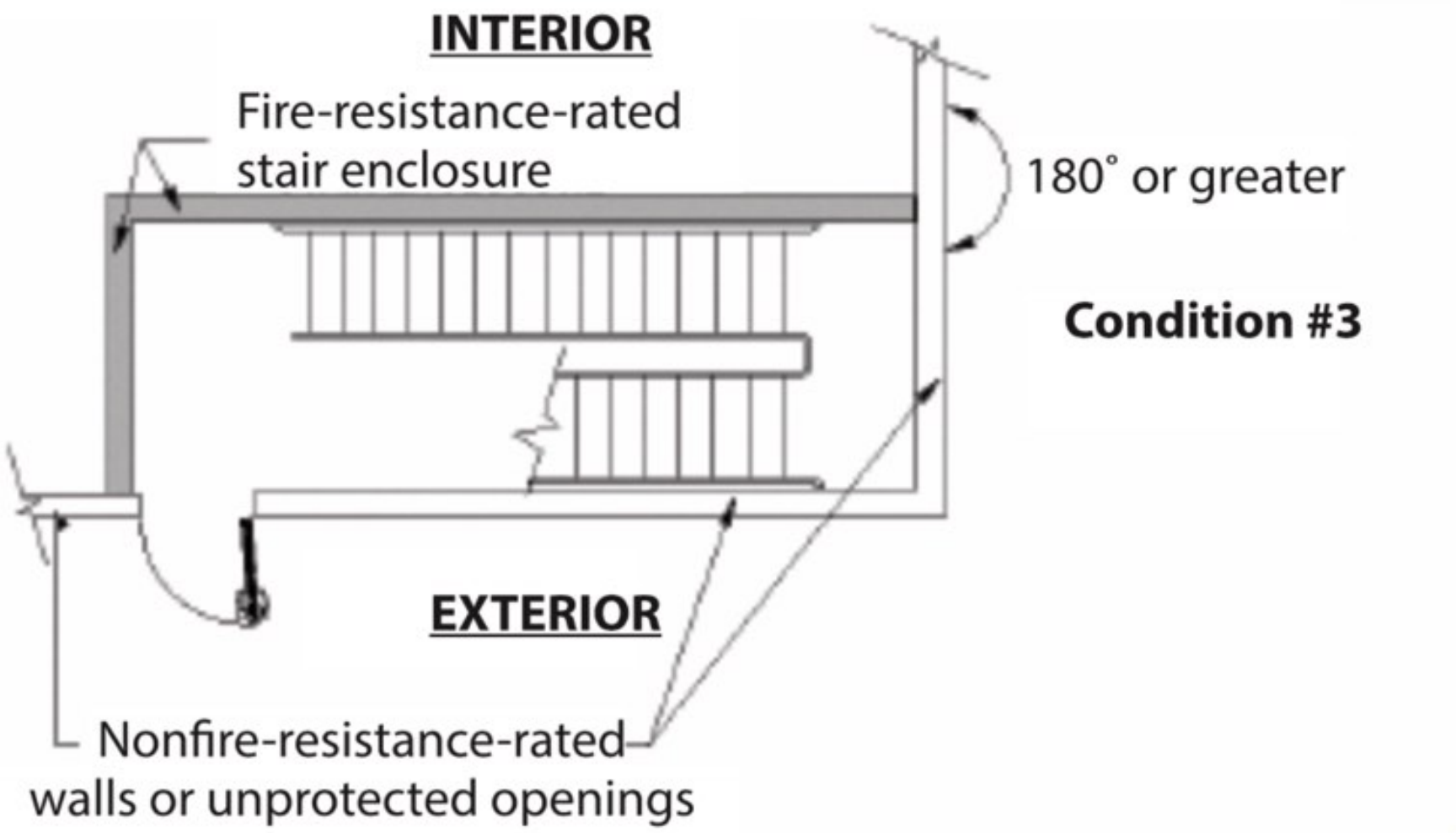
Source: IBC Commentary Figure 1023.7(1)

Shaft Walls that are also Exterior Walls



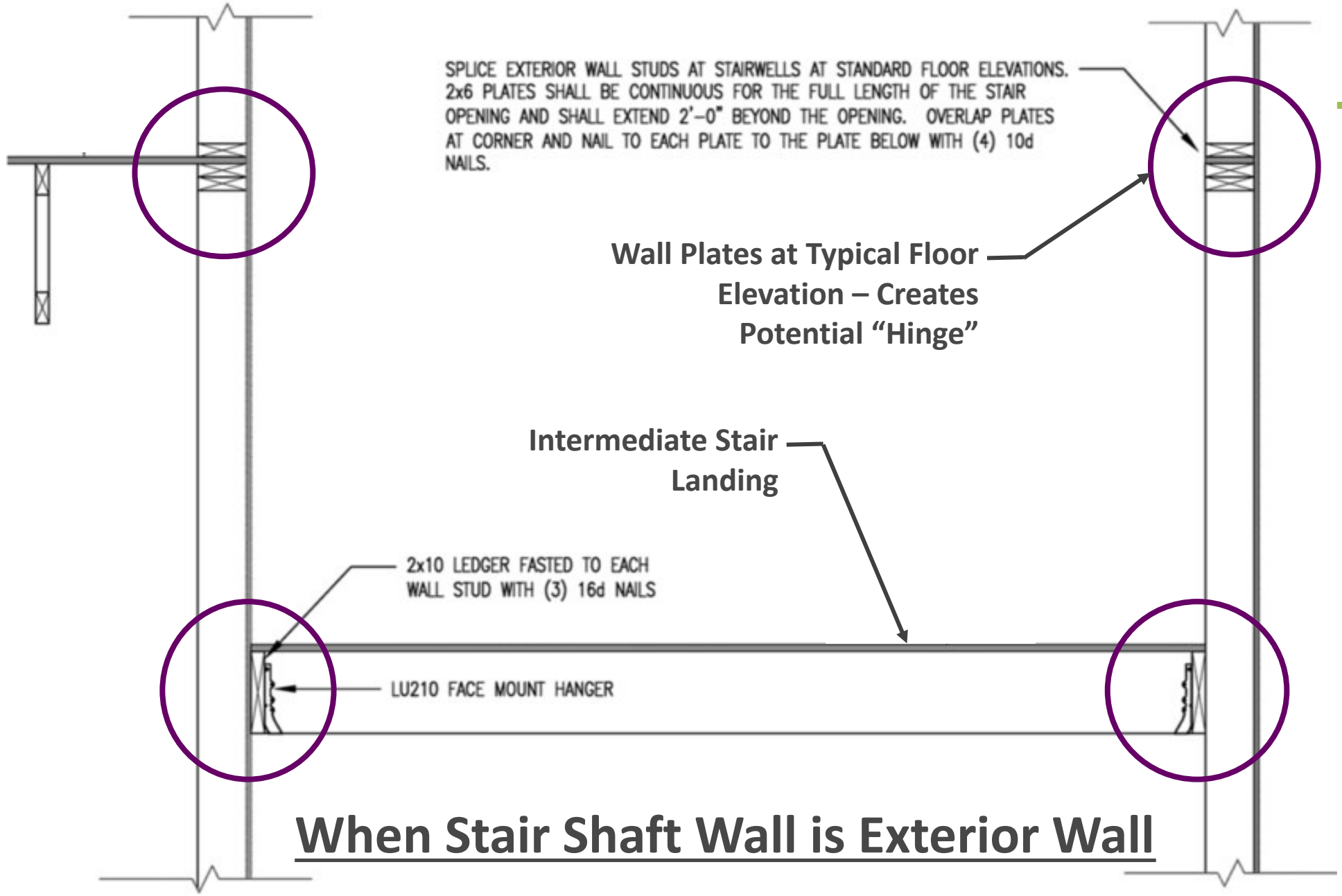
Source: IBC Commentary Figure 1023.7(1)

Shaft Walls that are also Exterior Walls



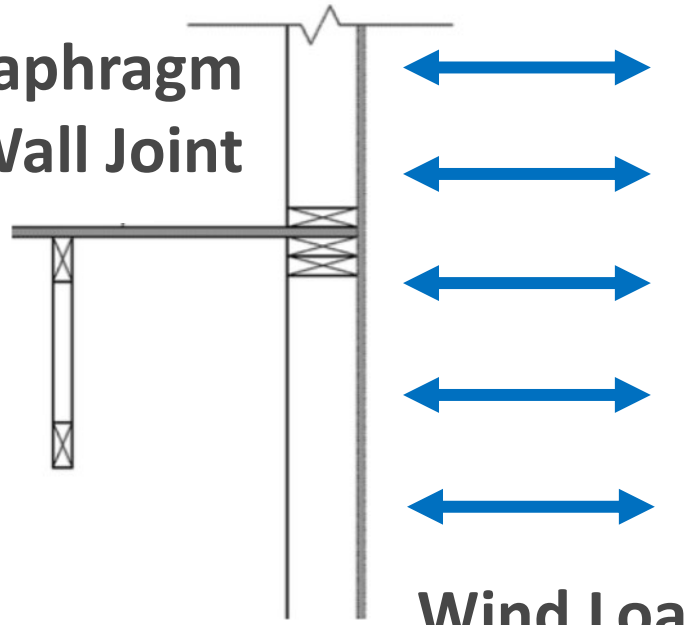
Source: IBC Commentary Figure 1023.7(1)

Shaft Walls that are also Exterior Walls

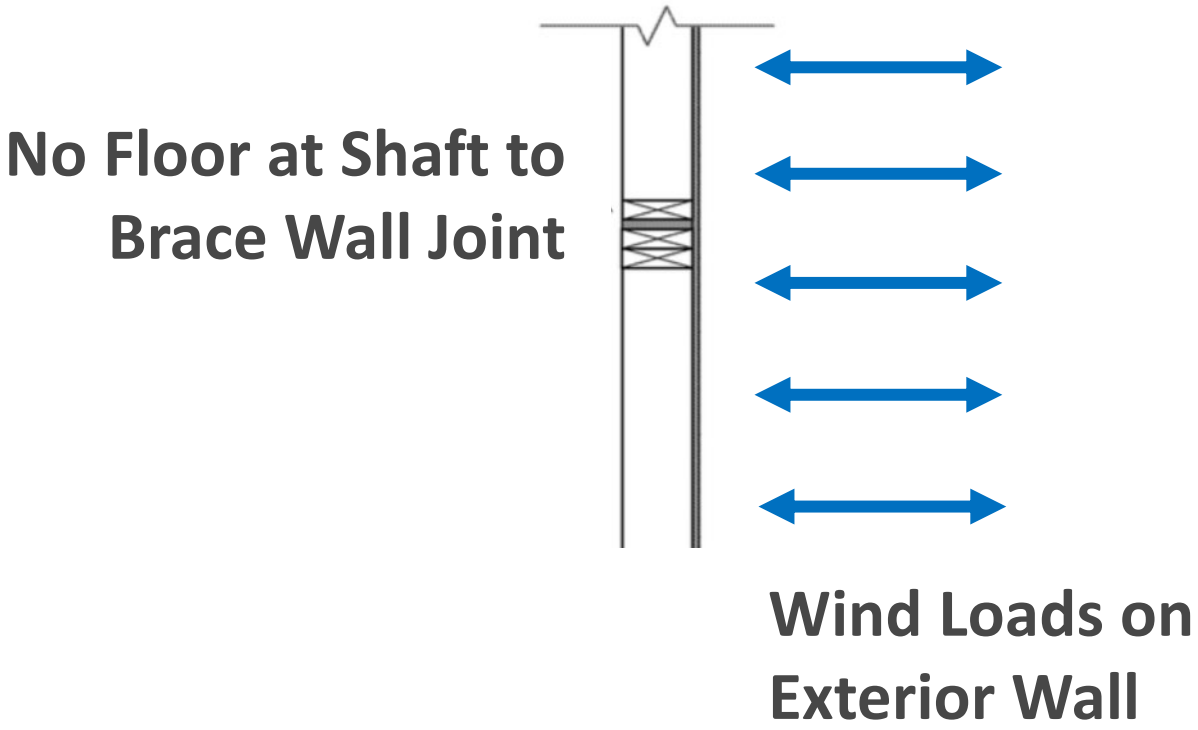


When Stair Shaft Wall is Exterior Wall

Shaft Walls that are also Exterior Walls

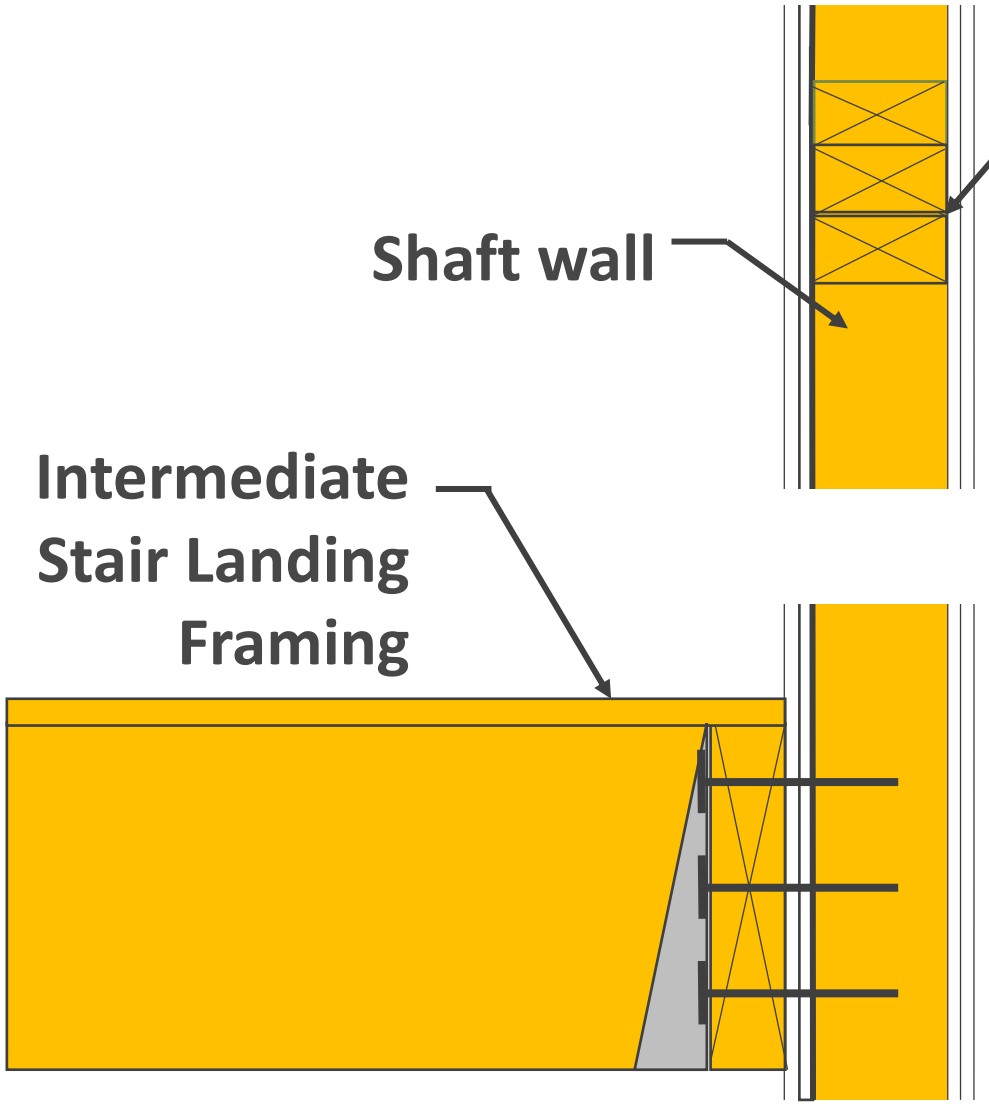


Typical Exterior Wall Condition



Exterior Wall That is Shaft Wall

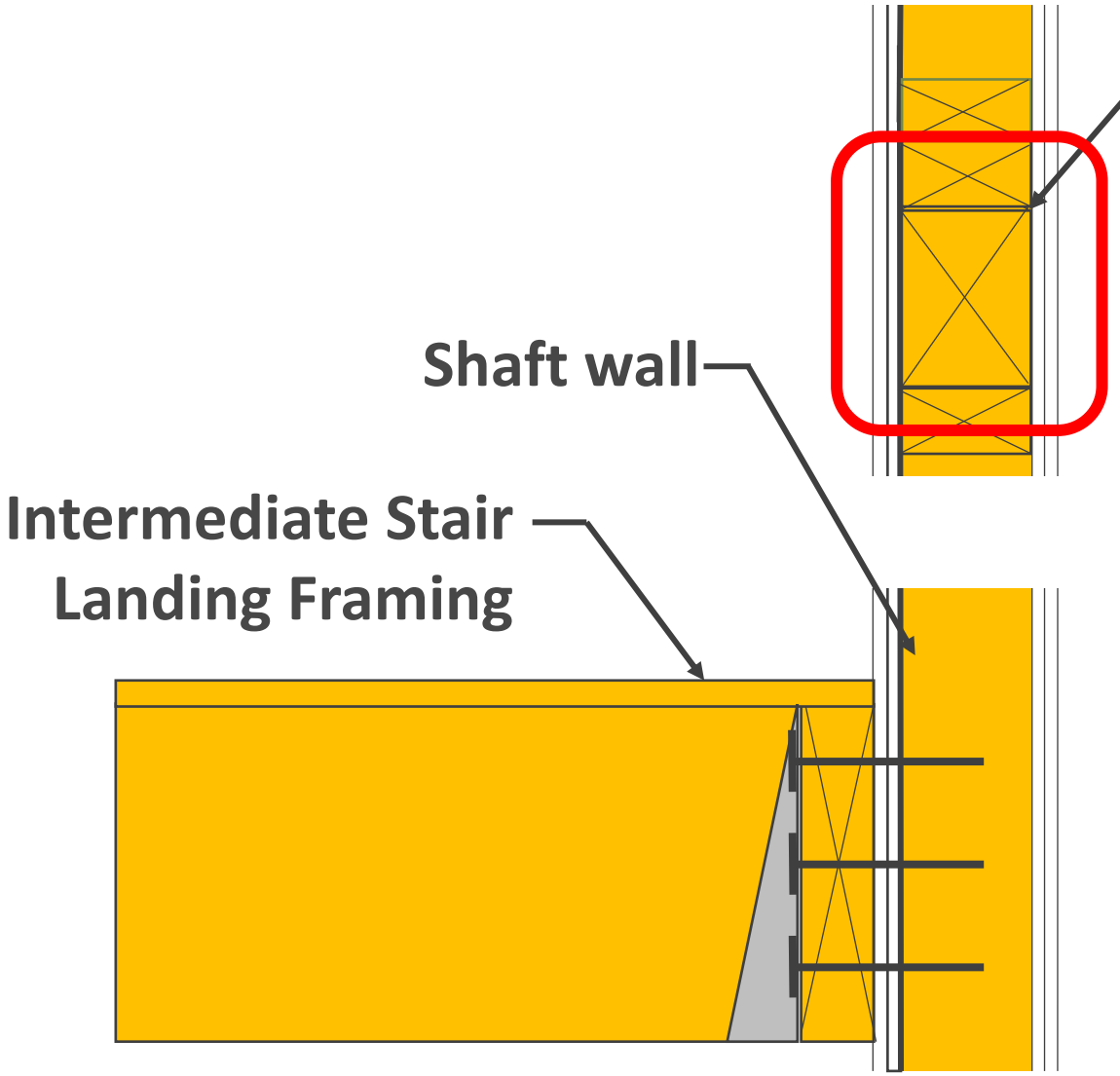
Shaft Walls that are also Exterior Walls



Consider “Hinge” at wall plates for out-of-plane wind & seismic loads due to lack of adjacent floor:

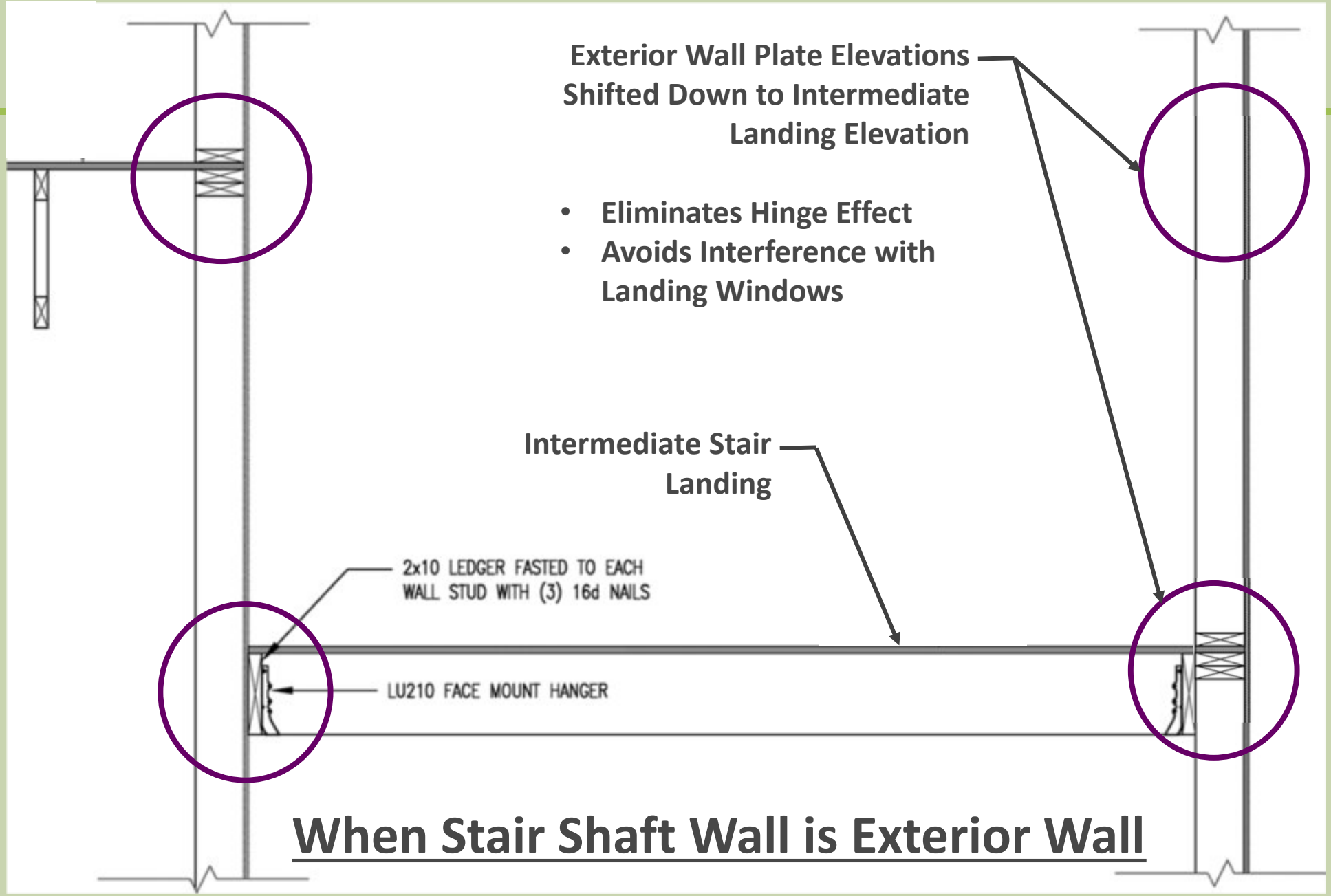
- Span plates horizontally

Shaft Walls that are also Exterior Walls



Consider “Hinge” at wall plates for out-of-plane wind & seismic loads due to lack of adjacent floor:

- Install additional member (rim) to span horizontally



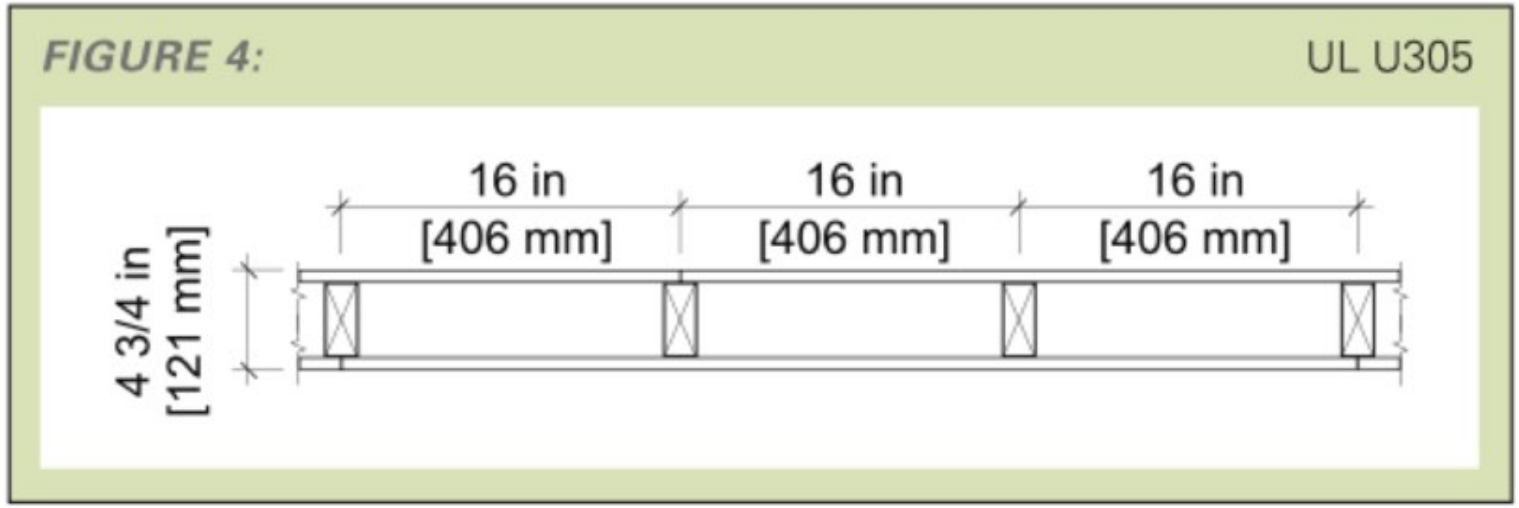
When Stair Shaft Wall is Exterior Wall

Shaft Wall Assemblies

Assembly selection considerations

- Fire resistance rating requirement (1 hr or 2 hr)
- Size and height of shaft
- Structural needs (gravity & lateral loads)
- Acoustics
- Space available for wall (allowed thickness)

Shaft Wall Assemblies



1-Hour Single Wall

- UL U305
- GA WP 3510
- UL U311
- IBC 2012 Table 721.1(2), Item 14-1.3
- UL U332

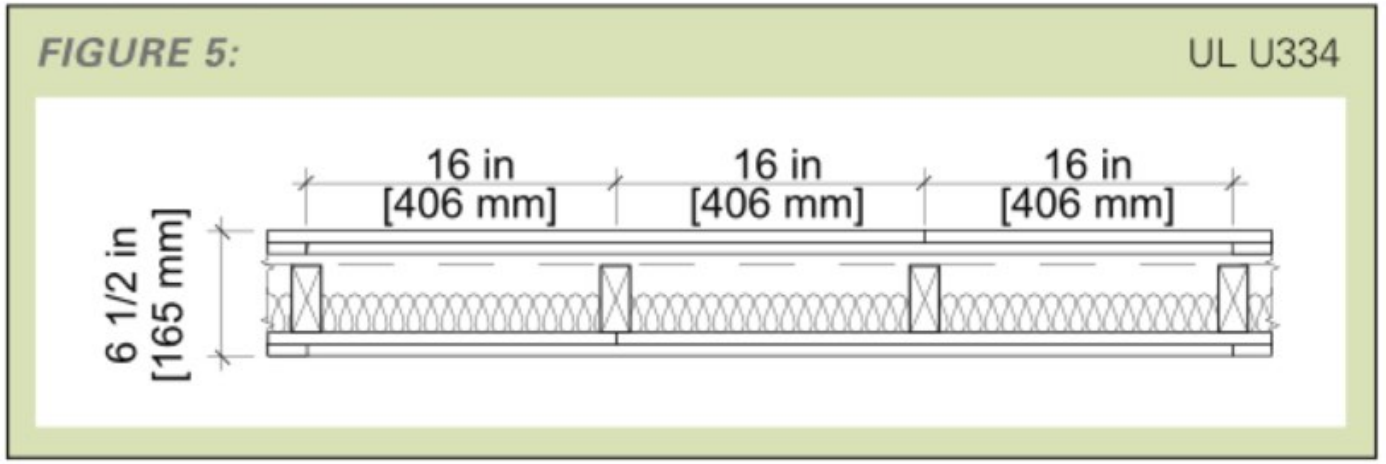
1-Hour Double Wall

- UL U341

1-Hour Wall with Shaftliner

- UL V455
- UL V433

Shaft Wall Assemblies



2-Hour Single wall

- UL U301
- UL U334
- IBC 2012 Table 721.1(2) Item Number 14-1.5
- IBC 2012 Table 721.1(2) Item Number 15-1.16

2-Hour Double Wall

- UL U342
- UL U370
- GA WP 3820

2-Hour Wall with Shaftliner

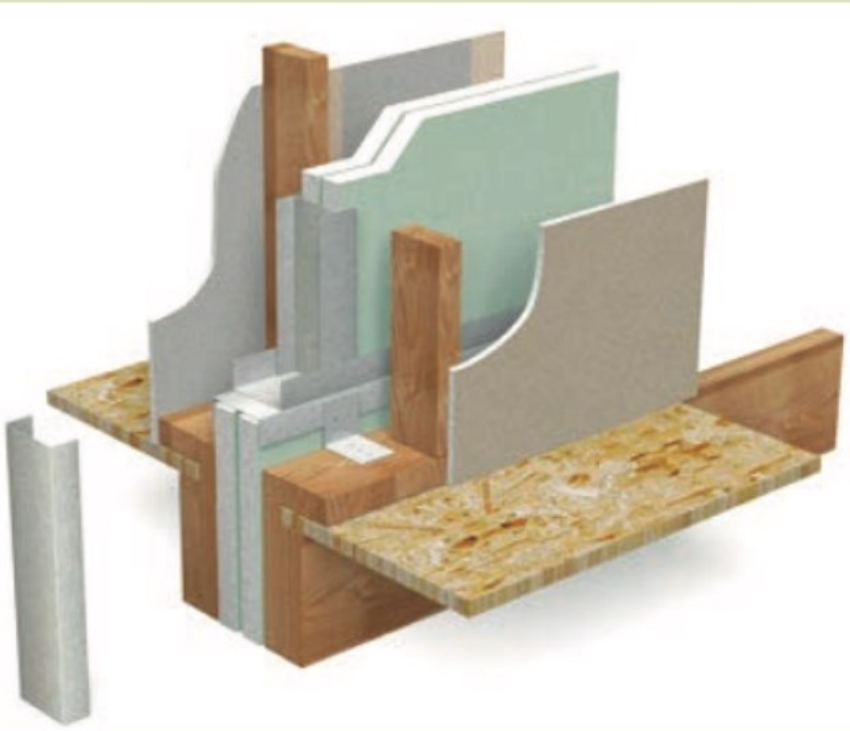
- UL U336
- UL U373
- UL U375
- UL V455
- UL V433
- GA ASW 1000

Shaft Wall Assemblies with Shaftliner

Shaftliner Unique Considerations

- Common for “party walls” in townhouse construction
- Many tested assemblies available for 1 hr and 2 hr applications
- May allow installation from one side only – useful in small MEP shafts where finishing from inside isn’t possible
- Some have height limitations, both per story and overall system
- Not structural, require back-up wood wall

FIGURE 6: Shaftliner Wall Assembly with Wood Wall Each Side

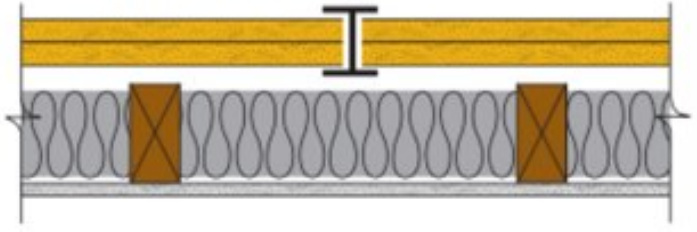


Credit: ClarkDietrich

Shaft Wall Assemblies W/Shaftliner

2-Hour Fire Rating

Design Reference: UL U373, ULC W312, WHI GP/WA 120-03, cUL U373



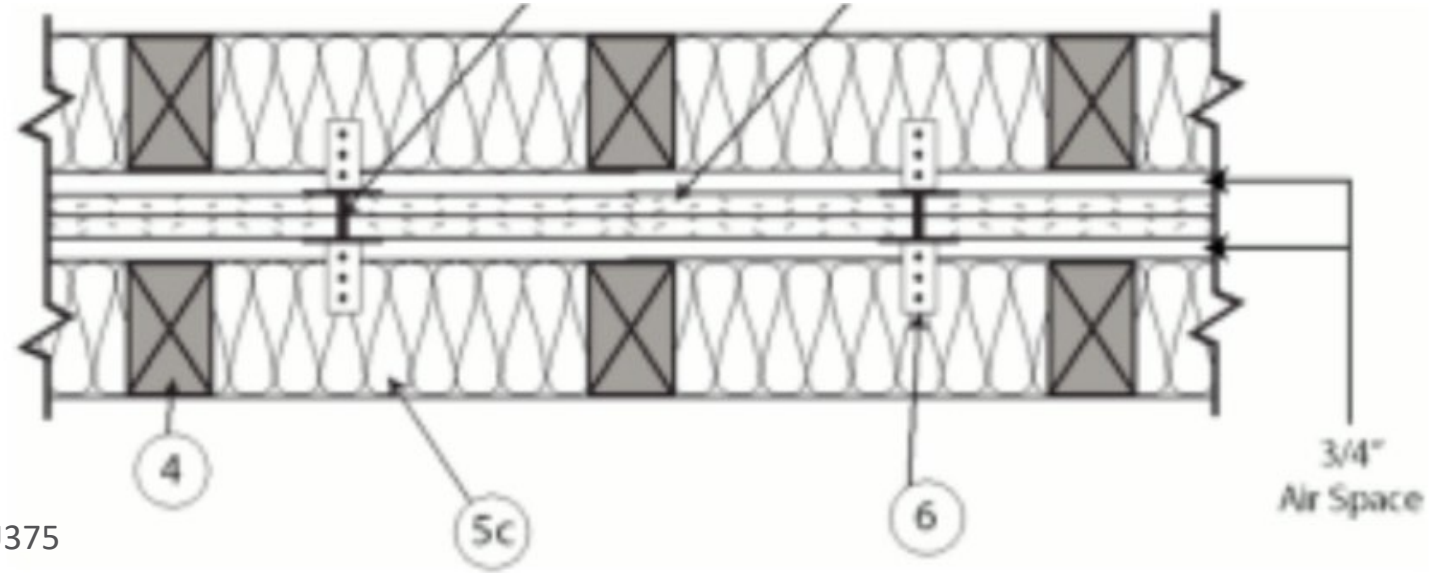
59 STC Sound Trans.

Test Reference: RAL TL 10-290

Two layers 1" (25.4 mm) DensGlass Shaftliner inserted in H-Studs 24" (610 mm) o.c. Min. 3/4" (19 mm) air space between liner panels and adjacent wood or metal framing.

Sound Tested with 2"x 4" stud wall with 1/2" (12.7 mm) ToughRock® wallboard or DensArmor Plus® interior panels and 3-1/2" (89 mm) fiberglass insulation in stud space.

Source: Georgia Pacific



Source: UL U375

Shaft Wall Assemblies W/Shaftliner

CT STUD LIMITING HEIGHTS (INTERIOR NONLOAD-BEARING)

Member	Deflection	5 PSF	7.5 PSF	10 PSF	15 PSF
2-1/2" 25ga	L/120	16'-10"	13'-8"	11'-10"*	8'-6"*
	L/240	11'-10"	9'-10"	8'-8"	7'-3"
	L/360	9'-10"	8'-3"	7'-3"	6'-2"

Source: Clarkdietrich

Some wall manufacturers will list a total system height limitation. If this is not a requirement of the tested assembly (i.e. UL or sim. requirement) can also perform a structural analysis of the walls, especially when stacking multiple stories, to verify adequacy

Shaft Wall Assemblies W/Shaftliner

Attachment Clips: Aluminum or steel angles, usually 14 – 16 gauge, 2” wide with 2” to 2-1/2” long legs. Attaches to wall framing and H-studs

H-Stud

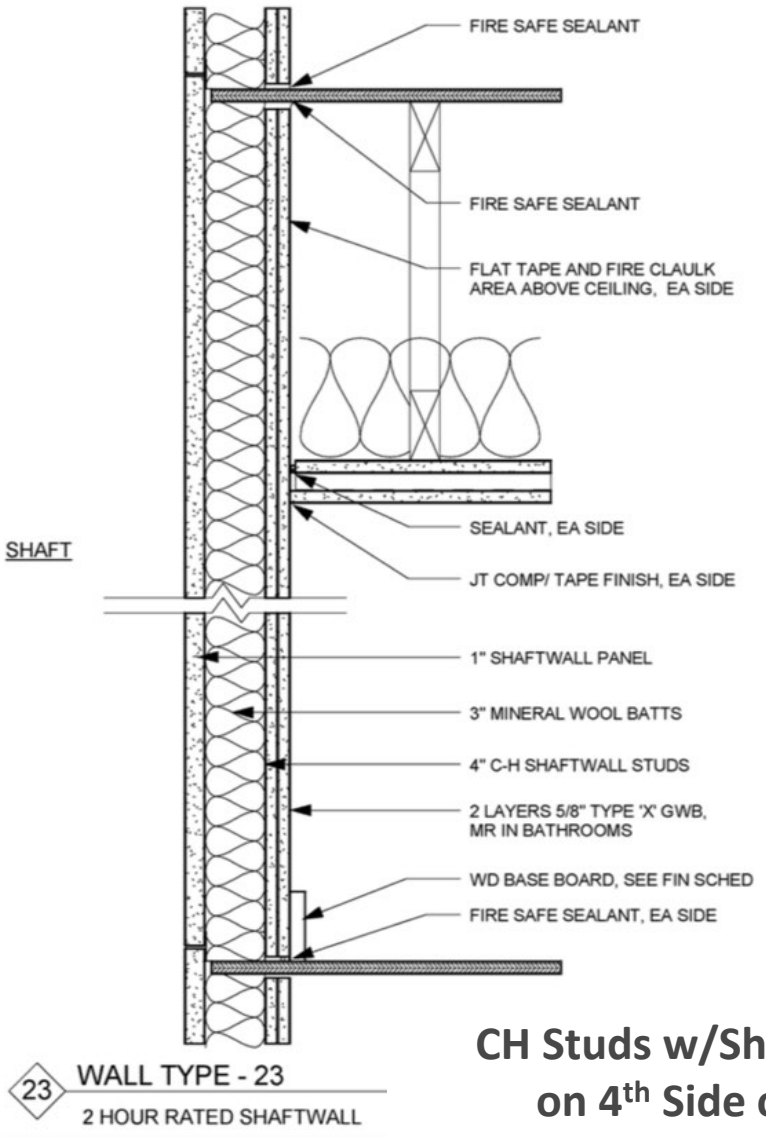
Source: Clarkdietrich

Example Shaftliner Clip Attachment Schedule per UL U375		
System No.	System Height Limitation	Attachment Clip Schedule
1	23 ft	10 ft o.c.
2	44 ft	Base to 20 ft: 5 ft o.c. 20 ft to 44 ft: 10 ft o.c.
3	66 ft	Base to 22 ft: 3’-4” o.c. 22 ft to 42 ft: 5 ft o.c. 42 ft to 66 ft: 10 ft o.c.

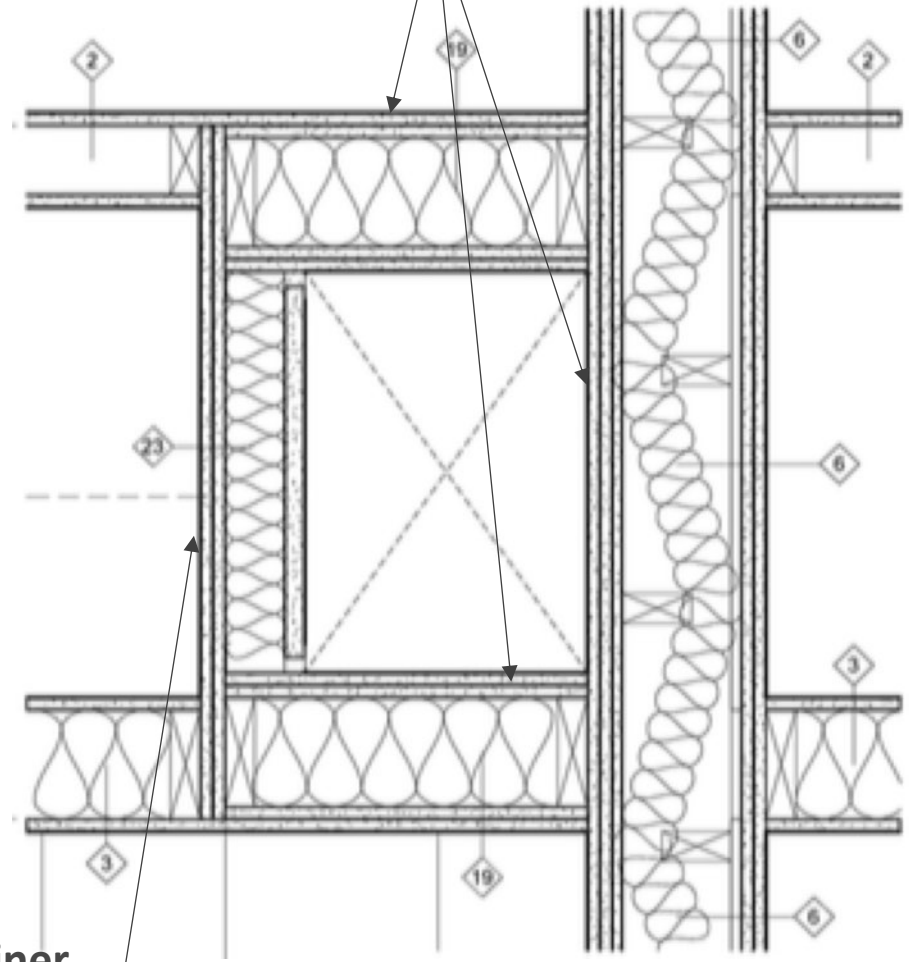
Shaft Wall Assemblies W/Shaftliner

Can also utilize wood framed shaft walls on 3 sides and CH studs with shaftliner on 4th side

Shaft Wall Assemblies W/Shaftliner



Wood Framed Wall on 3 Sides of Shaft



CH Studs w/Shaftliner on 4th Side of Shaft

Continuity Provisions

How do we achieve these requirements?

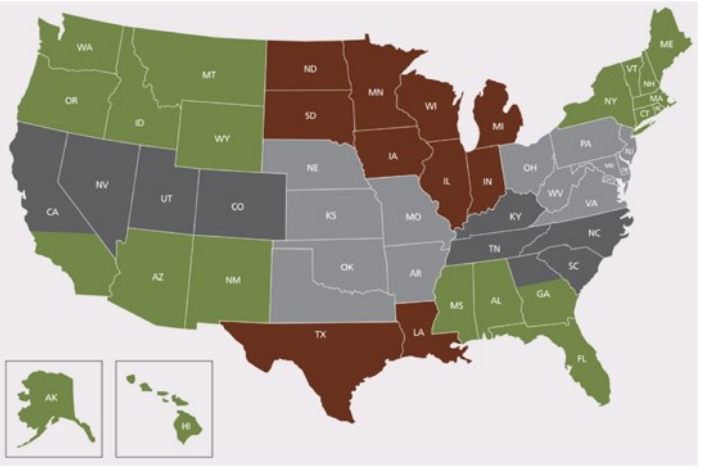
Continuity: The general requirements in 707.5 were not written with platform construction in mind . . . they were attempting to preclude large open concealed spaces to provide a continuous barrier between one portion of the building and another

Many jurisdictions have recognized that continuity of the fire barrier's fire protection can be maintained even if the wall framing does not extend to the underside of the decking above

We'll cover some detailing options later…

Floor to Shaft Wall Detailing

After shaft wall assembly is selected, need to consider how it will interface with floors and roof it intersects

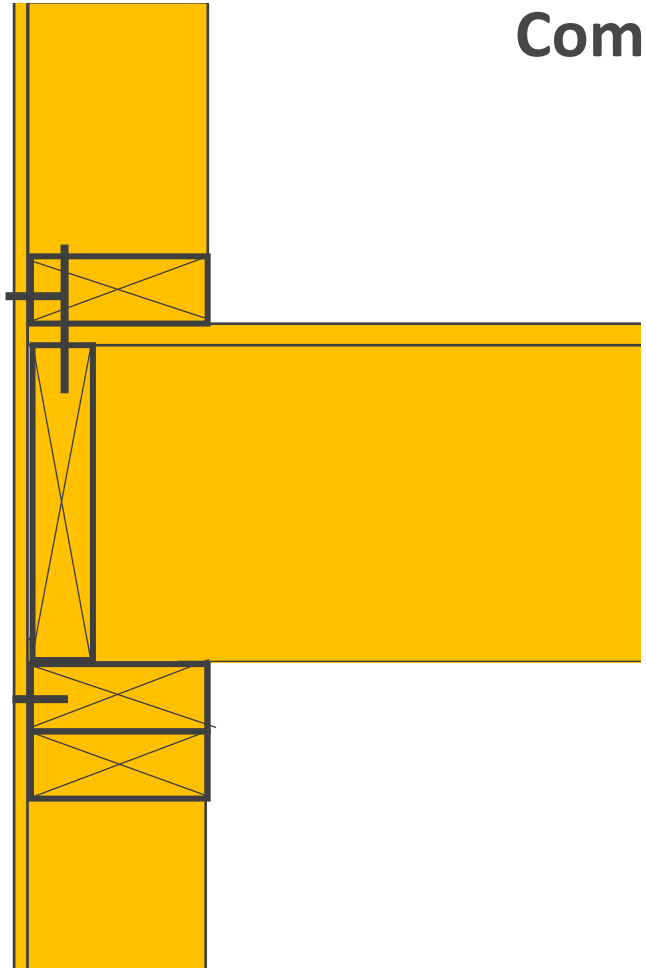


Some key considerations are:

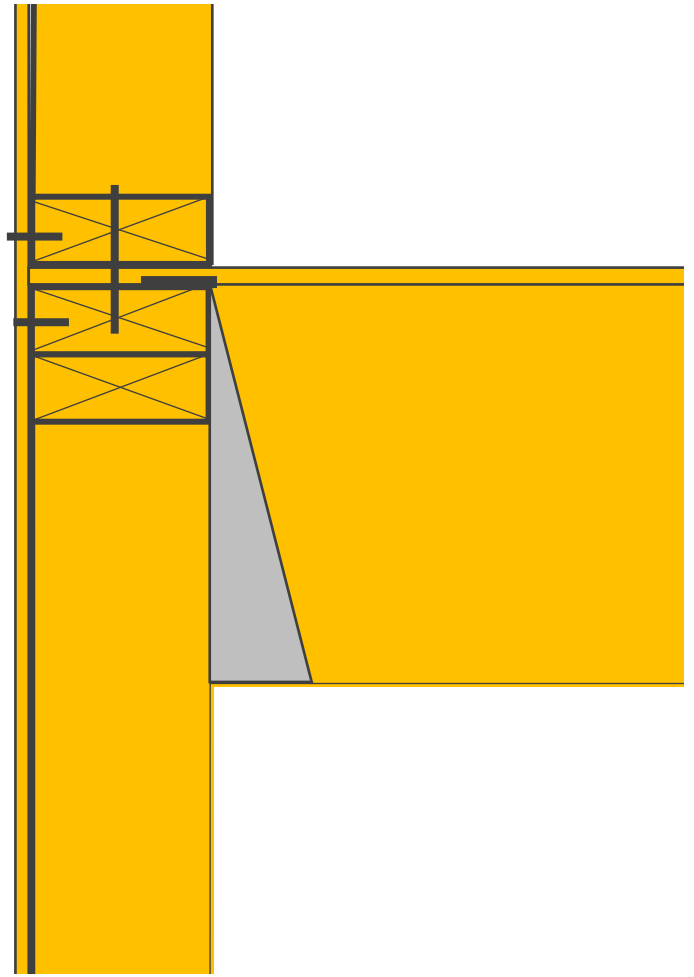
- Supporting Construction
- Continuity and Hourly Ratings
- Joints and Penetrations
- Depends on floor joist/truss type used, bearing condition
- No tested intersections exist; discuss desired detail and rationale with building official
- The following are just a few options - Contact local WoodWorks Regional Director for regional preferences, providing rationale, other insight

Floor to Shaft Wall Detailing

Common Details



Platform Framing

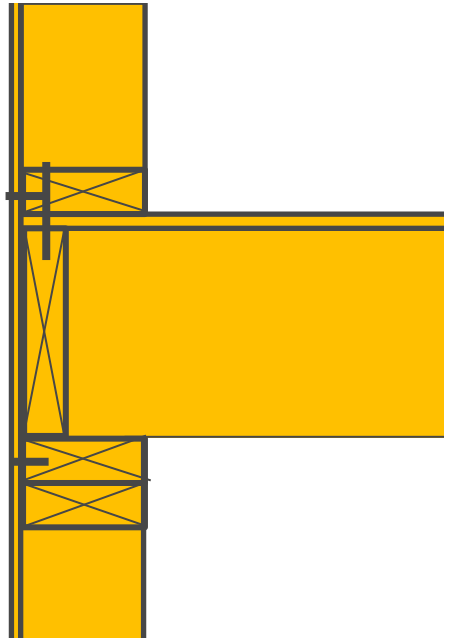


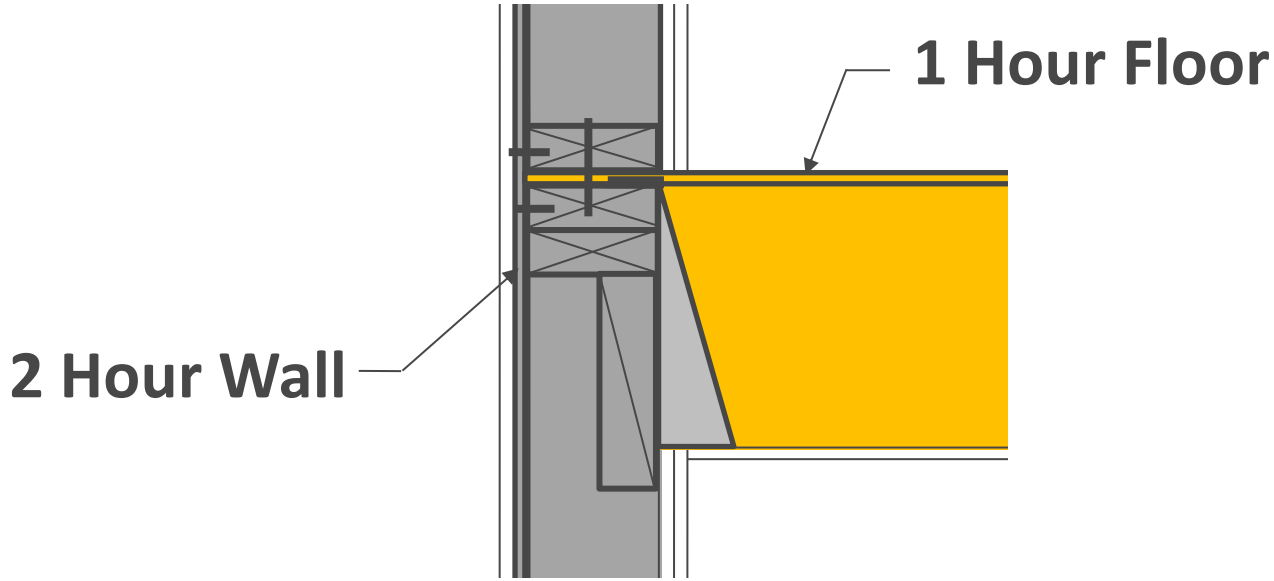
Semi-balloon Framing

Floor to Shaft Wall Detailing

Supporting Construction: In platform and semi-balloon frame construction, if we have a 2 hour shaft wall and a 1 hour floor, how do we achieve this?

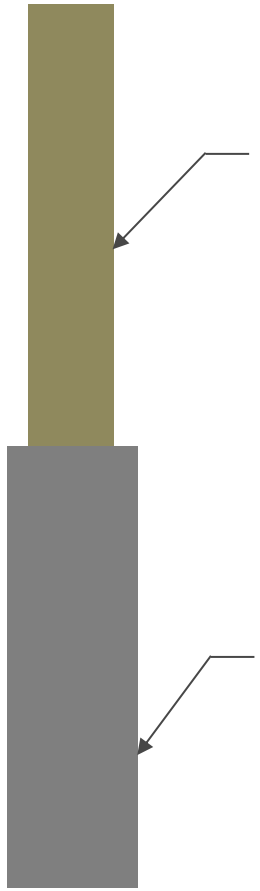
- If we are able to **demonstrate the wall's 2 hour continuity through the floor depth**, should not need to consider the floor "supporting construction"





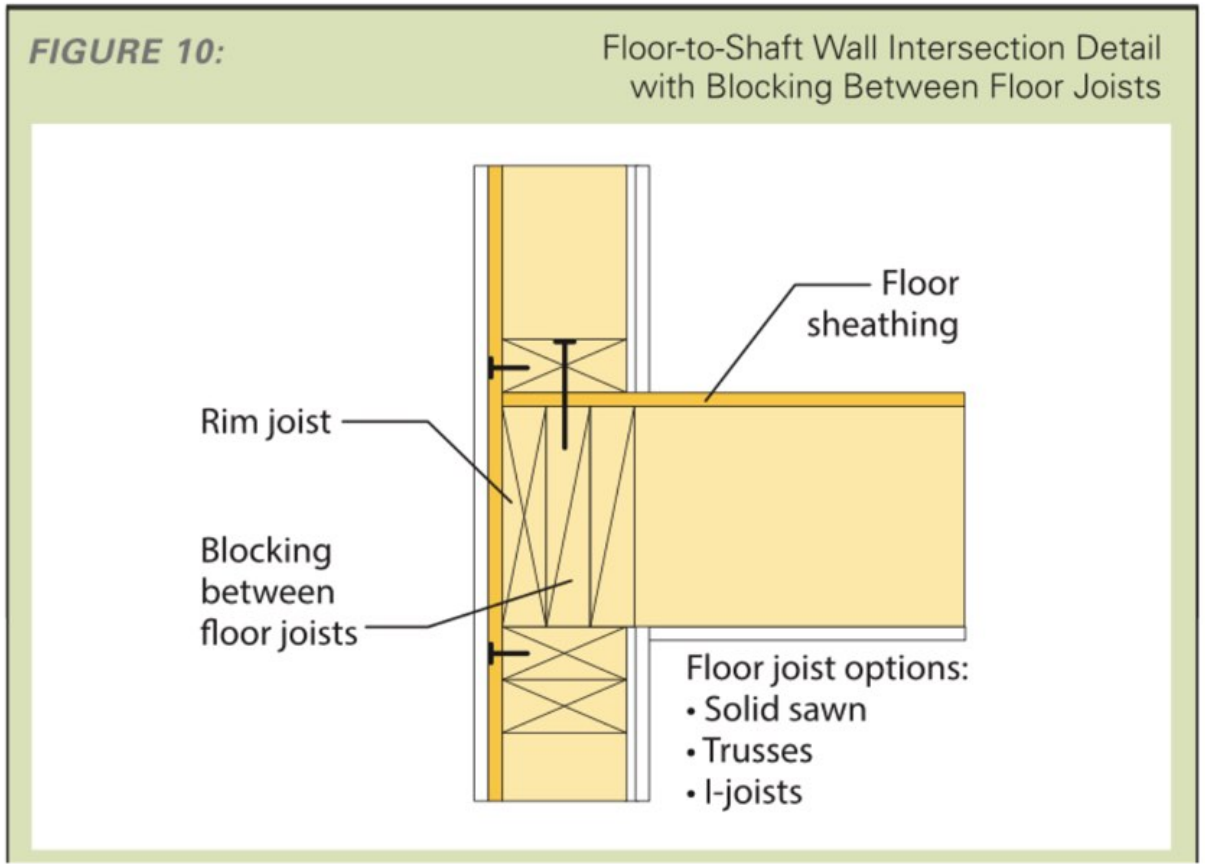
Floor to Shaft Wall Detailing

Concept of stacking different rated assemblies isn't new

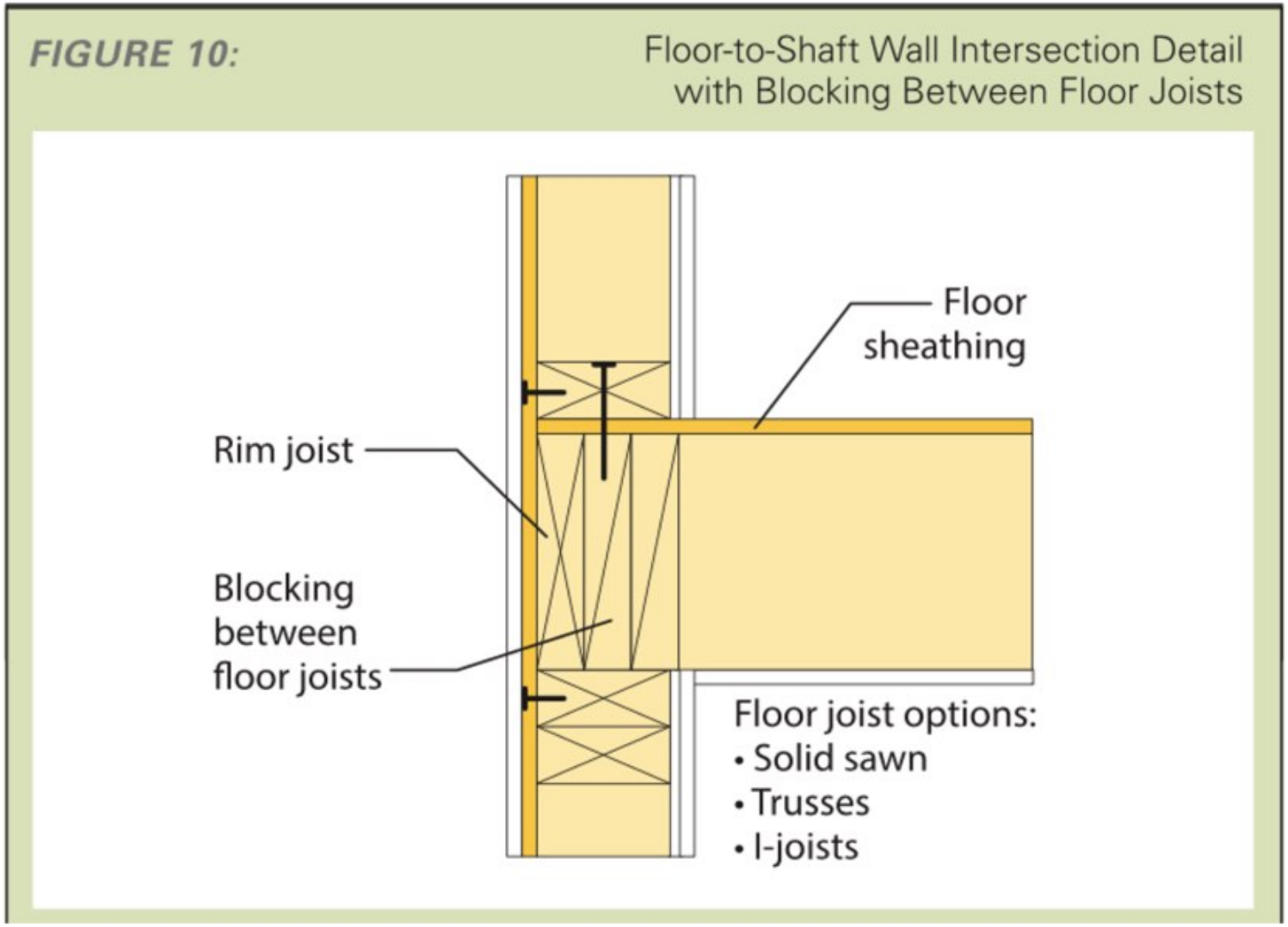


2 Hour CFS Wall

2 Hour Masonry Wall



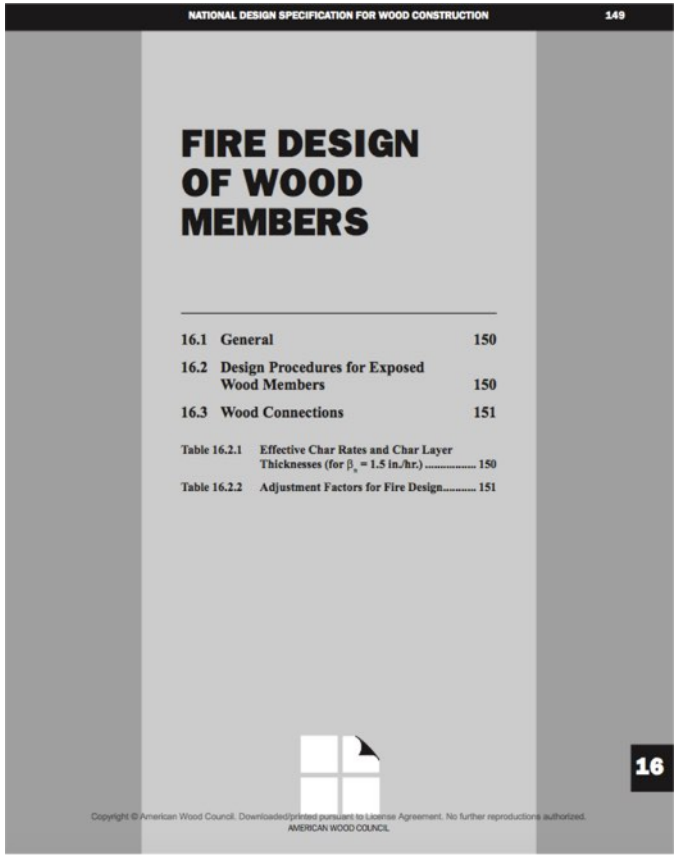
Floor to Shaft Wall Detailing

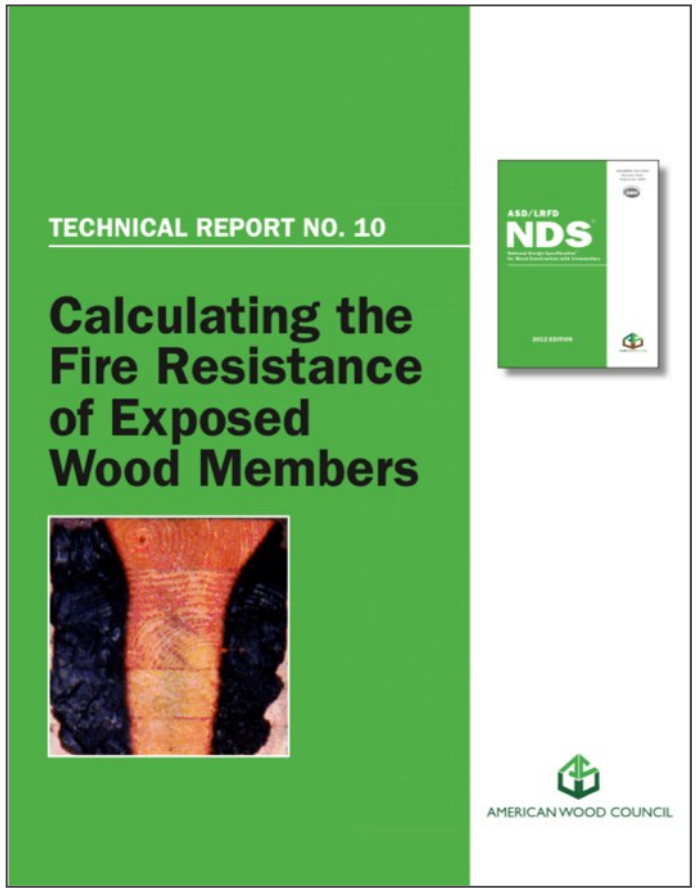


- Fire-resistance rating still continues to the underside of the deck
- Assumes a tested assembly to the top of wall plate
- Above wall top plate, uses 703.3 allowance for fire-resistance calculations per 722
- 722 allows NDS Chapter 16 methods for fire resistance calculations for exposed wood
- The combustibility of the material is not an issue; must meet the fire rating requirement

Calculated Fire Resistance of Wood

For Exposed Wood Members: IBC 722.1 References AWC's NDS Chapter 16 (AWC's TR 10 is a design aid to NDS Chapter 16)





Calculated Fire Resistance of Wood

For solid sawn, glulam and SCL wood members, nominal char rate = 1.5”/hr.

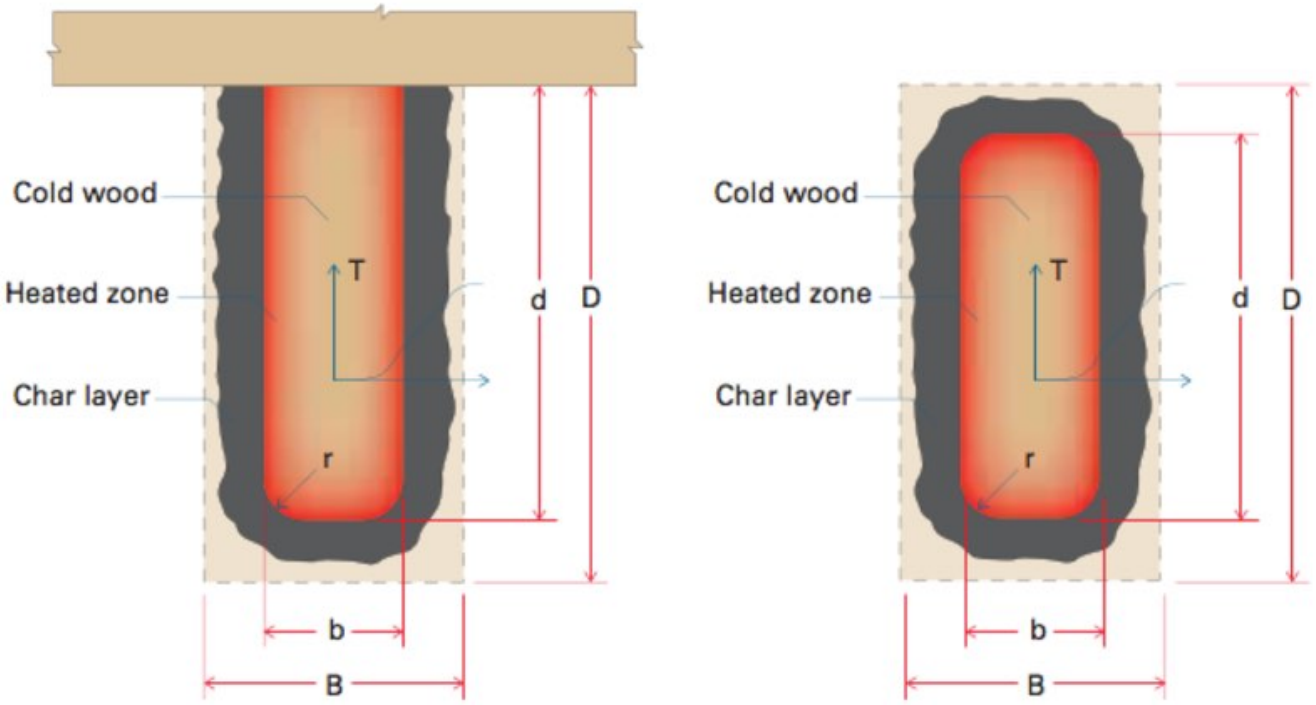
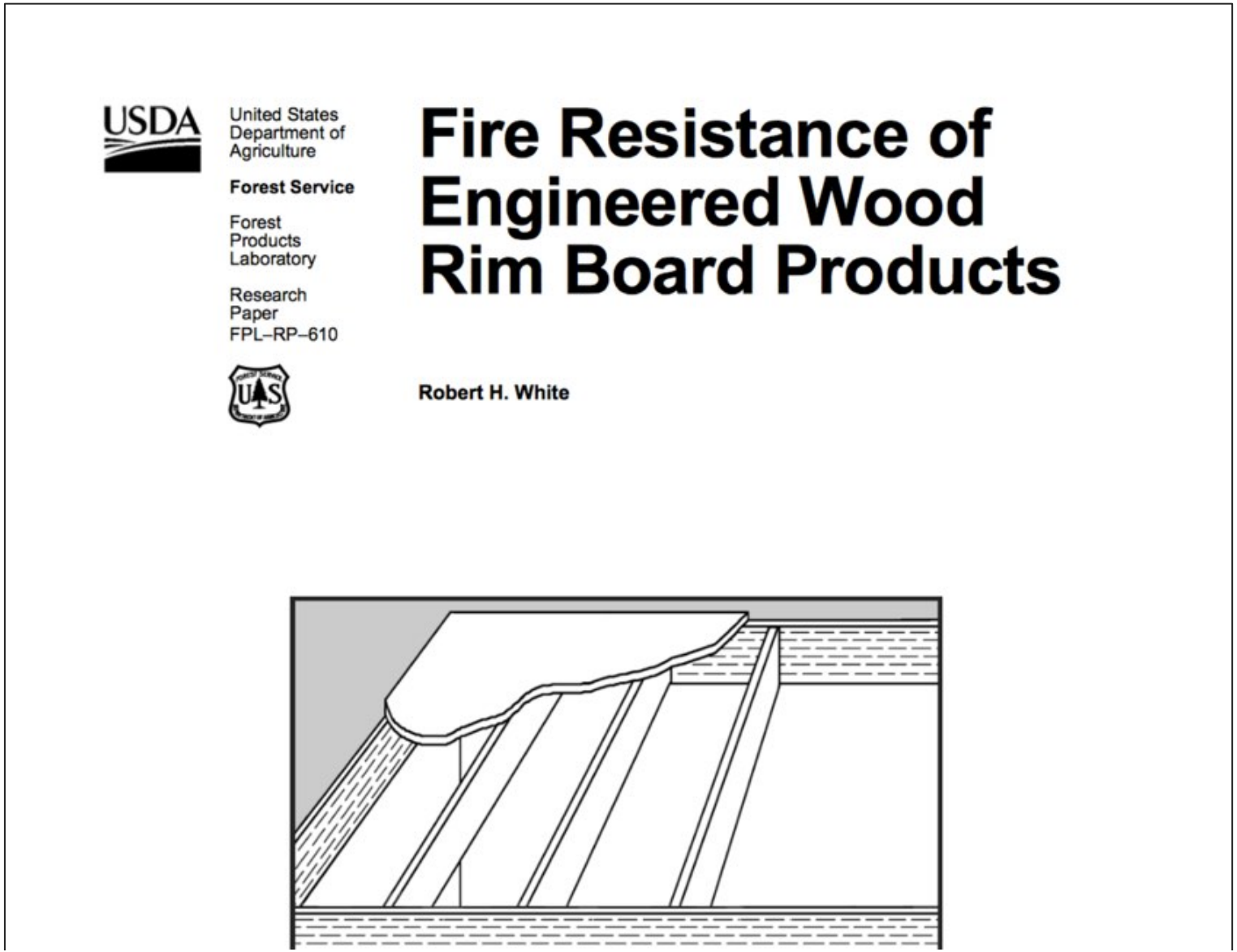


Figure 1-1 Reduction in member breadth and depth over time, t

Source: AWC’s TR 10

Calculated Fire Resistance of Wood

Report FPL-RP-610 from USDA FPL summarizes results from fire testing on rim boards



USDA

United States Department of Agriculture

Forest Service

Forest Products Laboratory

Research Paper FPL–RP–610

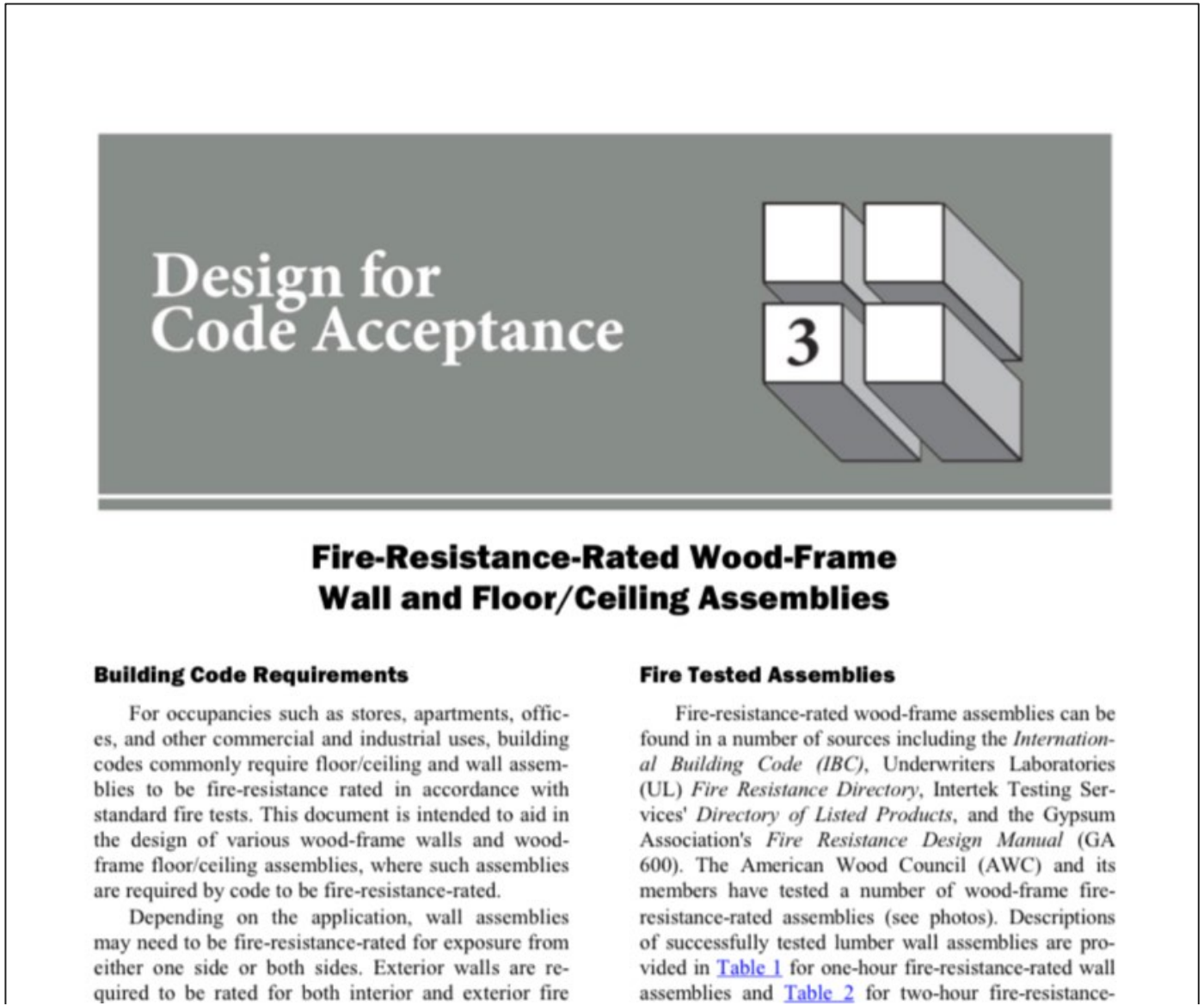
Fire Resistance of Engineered Wood Rim Board Products

Robert H. White

Calculated Fire Resistance of Wood

AWC's DCA3 provides floor to wall intersection detailing options

Although specific to exterior wall to floor conditions in type III construction, fire continuity principles can be applied



Design for Code Acceptance

3

Fire-Resistance-Rated Wood-Frame Wall and Floor/Ceiling Assemblies

Building Code Requirements

For occupancies such as stores, apartments, offices, and other commercial and industrial uses, building codes commonly require floor/ceiling and wall assemblies to be fire-resistance rated in accordance with standard fire tests. This document is intended to aid in the design of various wood-frame walls and wood-frame floor/ceiling assemblies, where such assemblies are required by code to be fire-resistance-rated.

Depending on the application, wall assemblies may need to be fire-resistance-rated for exposure from either one side or both sides. Exterior walls are required to be rated for both interior and exterior fire

Fire Tested Assemblies

Fire-resistance-rated wood-frame assemblies can be found in a number of sources including the *International Building Code (IBC)*, Underwriters Laboratories (UL) *Fire Resistance Directory*, Intertek Testing Services' *Directory of Listed Products*, and the Gypsum Association's *Fire Resistance Design Manual* (GA 600). The American Wood Council (AWC) and its members have tested a number of wood-frame fire-resistance-rated assemblies (see photos). Descriptions of successfully tested lumber wall assemblies are provided in Table 1 for one-hour fire-resistance-rated wall assemblies and Table 2 for two-hour fire-resistance-

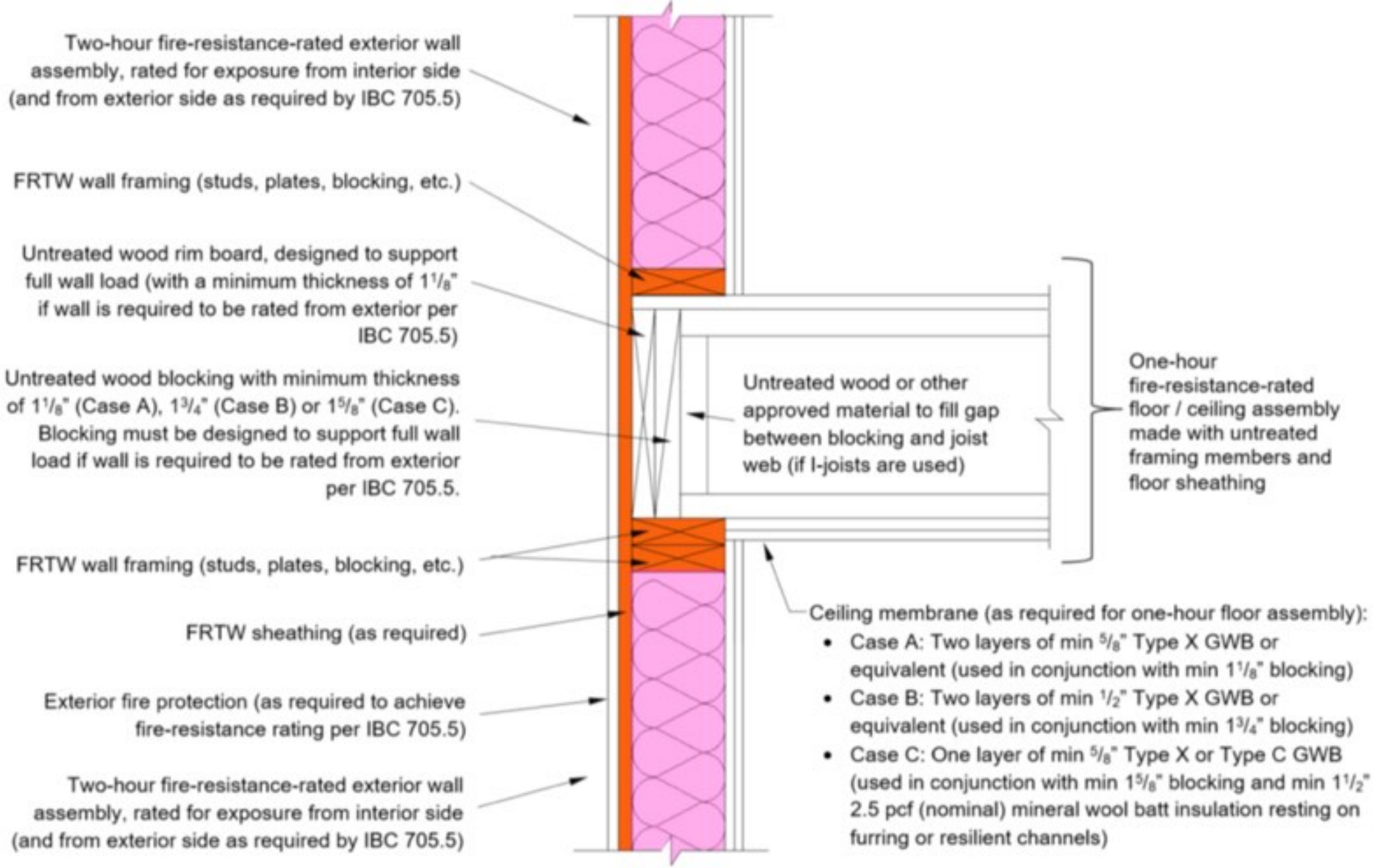
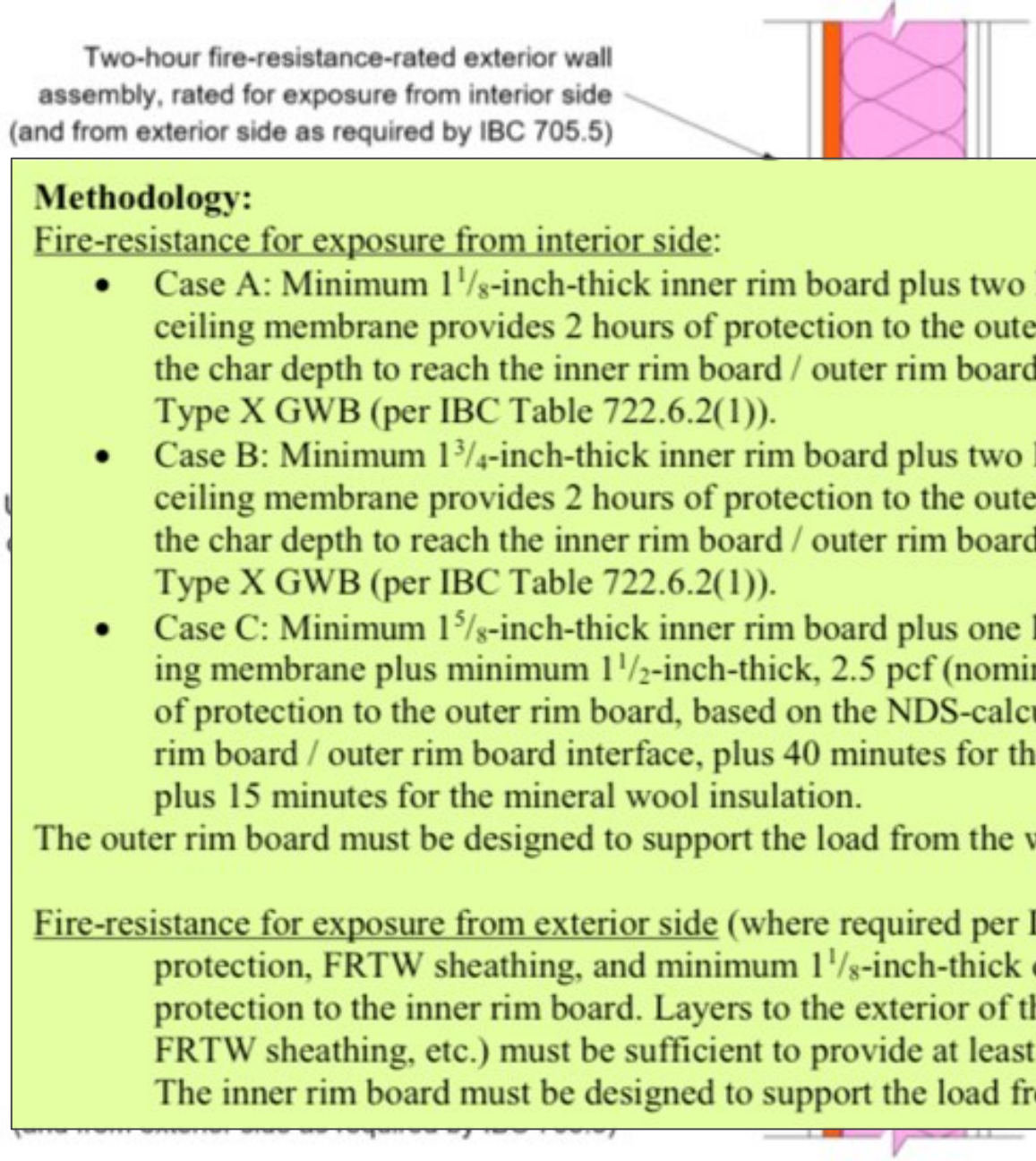


Figure 1A: Example detail for Type III-A exterior wall–floor intersection with rim board and blocking



Methodology:

Fire-resistance for exposure from interior side:

- Case A: Minimum $1^{1}/_{8}$-inch-thick inner rim board plus two layers of minimum $^{5}/_{8}$ in. Type X GWB in the ceiling membrane provides 2 hours of protection to the outer rim board, based on the NDS-calculated time for the char depth to reach the inner rim board / outer rim board interface plus 40 minutes for each layer of $^{5}/_{8}$ in. Type X GWB (per IBC Table 722.6.2(1)).
- Case B: Minimum $1^{3}/_{4}$-inch-thick inner rim board plus two layers of minimum $^{1}/_{2}$ in. Type X GWB in the ceiling membrane provides 2 hours of protection to the outer rim board, based on the NDS-calculated time for the char depth to reach the inner rim board / outer rim board interface plus 25 minutes for each layer of $^{1}/_{2}$ in. Type X GWB (per IBC Table 722.6.2(1)).
- Case C: Minimum $1^{5}/_{8}$-inch-thick inner rim board plus one layer of minimum $^{5}/_{8}$ in. Type X GWB in the ceiling membrane plus minimum $1^{1}/_{2}$-inch-thick, 2.5 pcf (nominal) mineral wool batt insulation provides 2 hours of protection to the outer rim board, based on the NDS-calculated time for the char depth to reach the inner rim board / outer rim board interface, plus 40 minutes for the $^{5}/_{8}$ in. Type X GWB (per IBC Table 722.6.2(1)), plus 15 minutes for the mineral wool insulation.

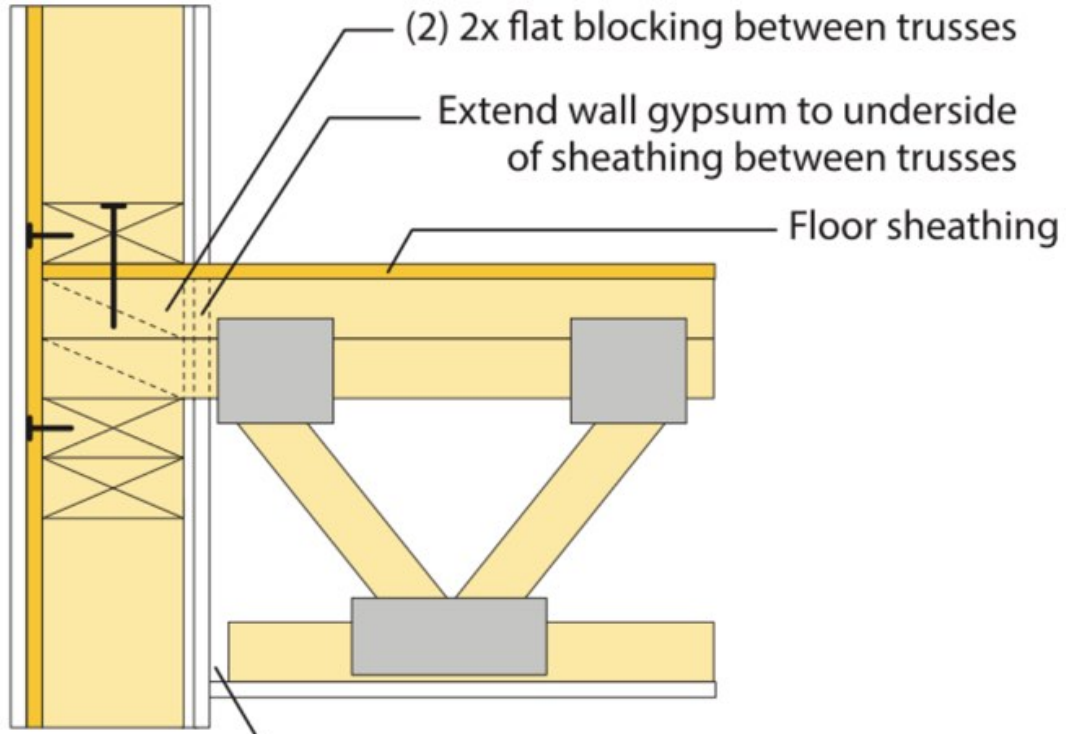
The outer rim board must be designed to support the load from the wall above.

Fire-resistance for exposure from exterior side (where required per IBC Section 705.5): A combination of exterior fire protection, FRTW sheathing, and minimum $1^{1}/_{8}$-inch-thick outer rim board is used to provide two hours of protection to the inner rim board. Layers to the exterior of the outer rim board (e.g., exterior fire protection, FRTW sheathing, etc.) must be sufficient to provide at least 80 minutes of protection to the outer rim board. The inner rim board must be designed to support the load from the wall above.

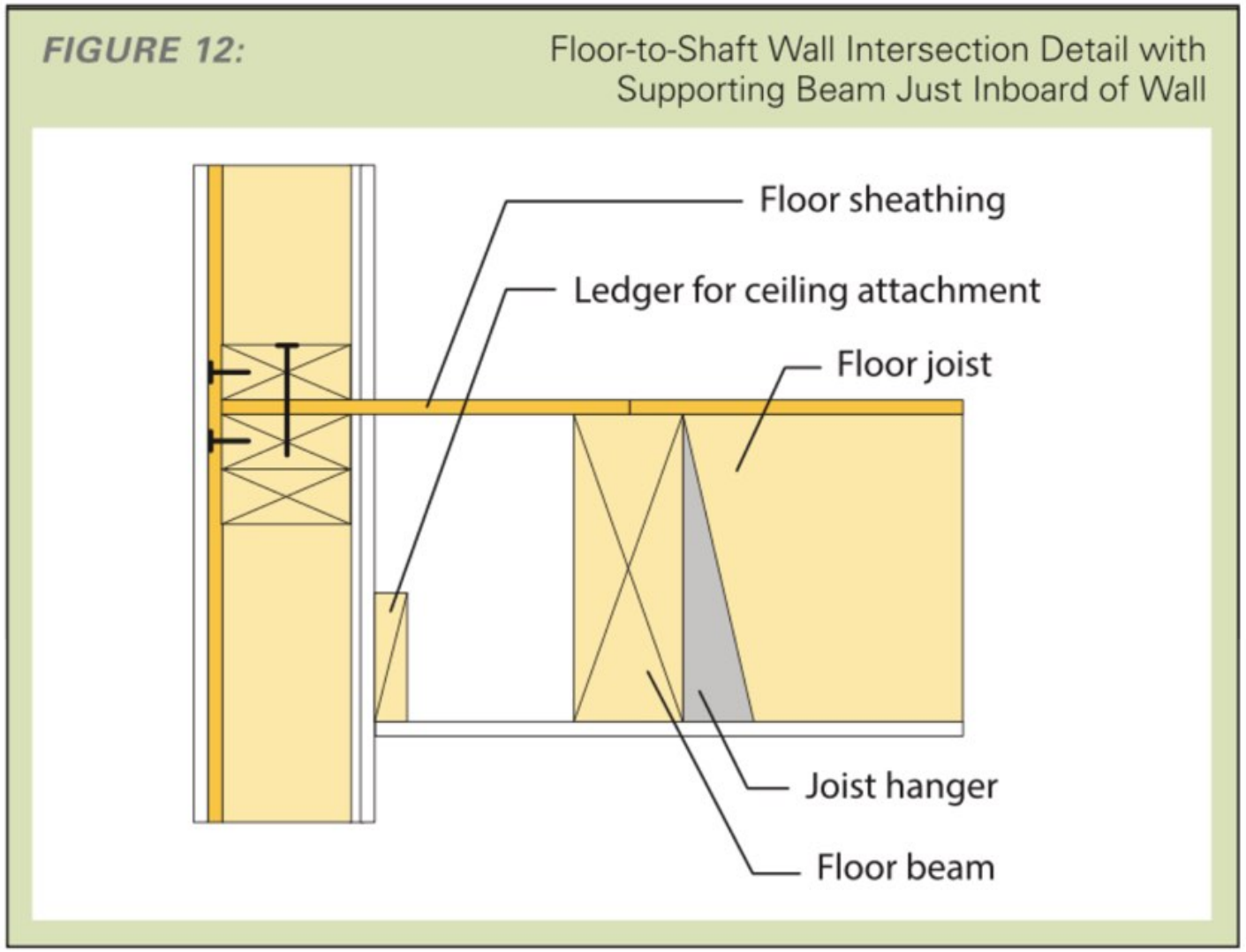
Figure 1A: Example detail for Type III-A exterior wall–floor intersection with rim board and blocking

Floor to Shaft Wall Detailing

FIGURE 11: Floor-to-Shaft Wall Intersection Detail with Gypsum Extending to Underside of Sheathing between Trusses

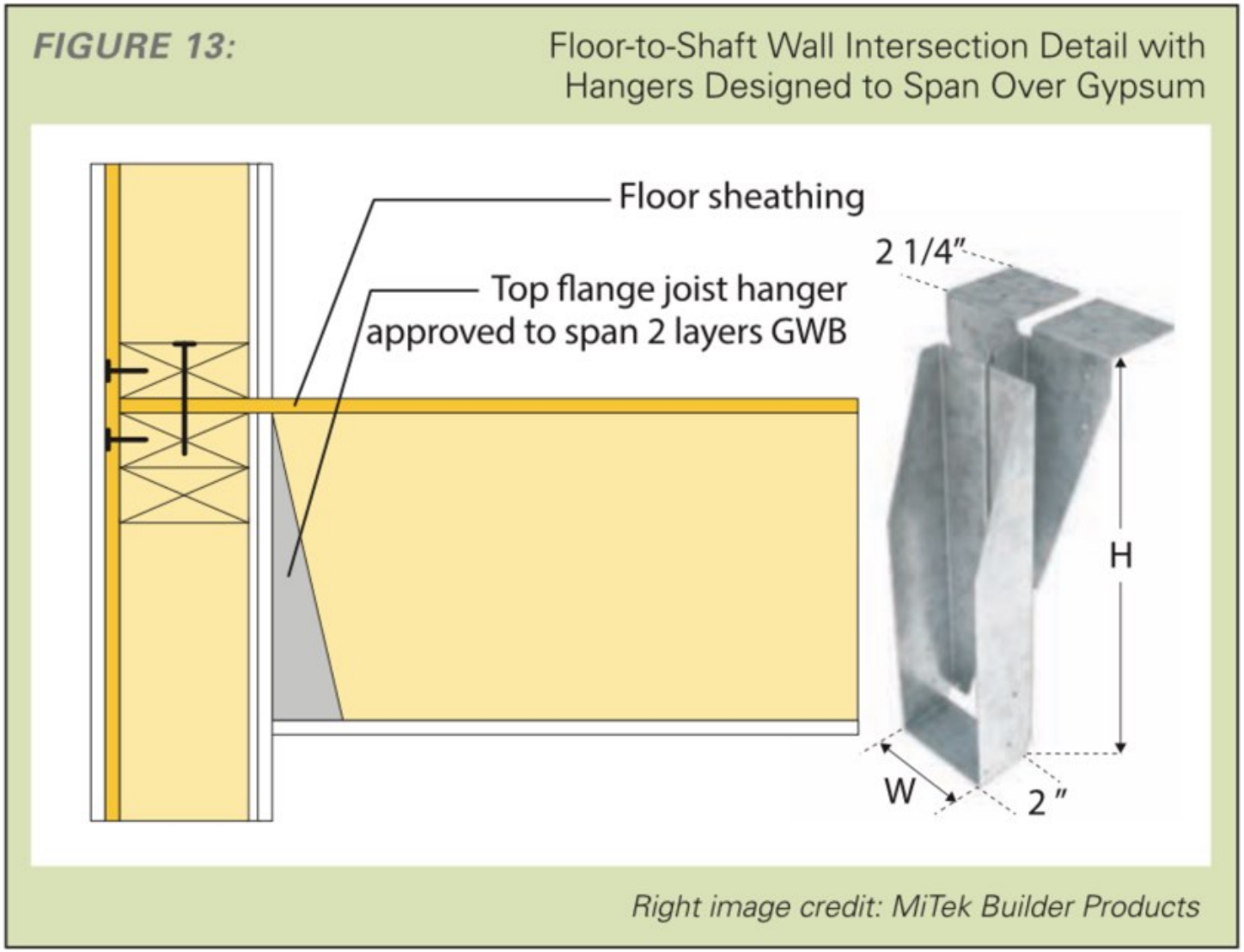


Floor to Shaft Wall Detailing

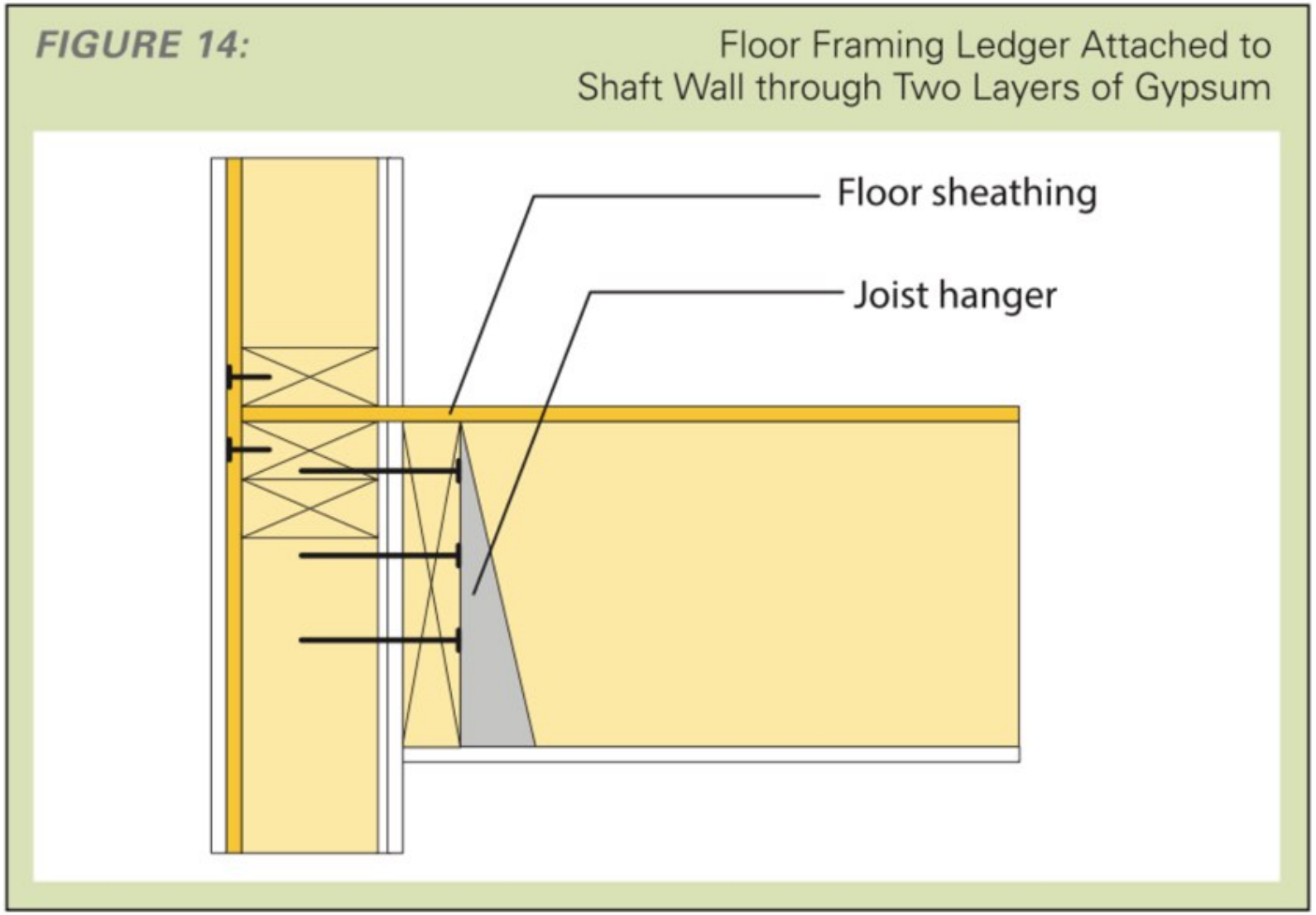


Floor to Shaft Wall Detailing

- Perhaps most conservative solution
- Cost and schedule are considerations
- Some require that wall gypsum be installed prior to hanger, some allow post-install
- Not uncommon in type III floor to exterior wall details – easy extension to shaft walls
- Several options on the market

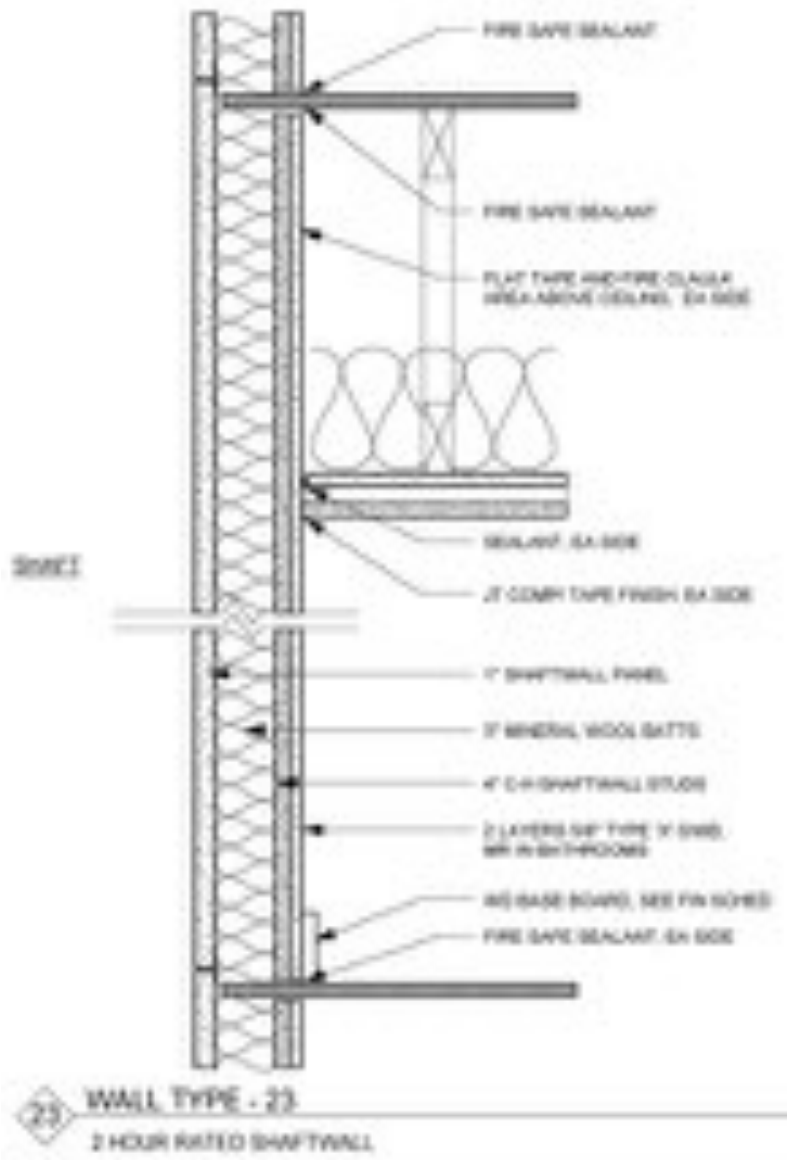


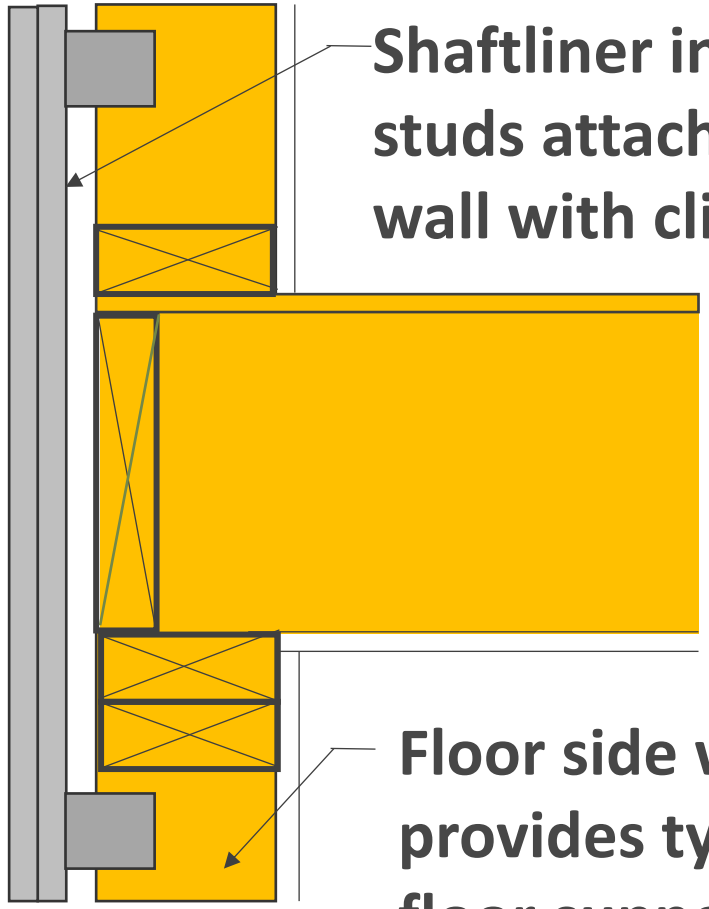
Floor to Shaft Wall Detailing



- Can be a challenge structurally to make fasteners work
- Scheduling and sequencing considerations
- Allows use of standard face mount hangers
- A common situation at stair shaft intermediate framing

Floor to Shaft Wall Detailing



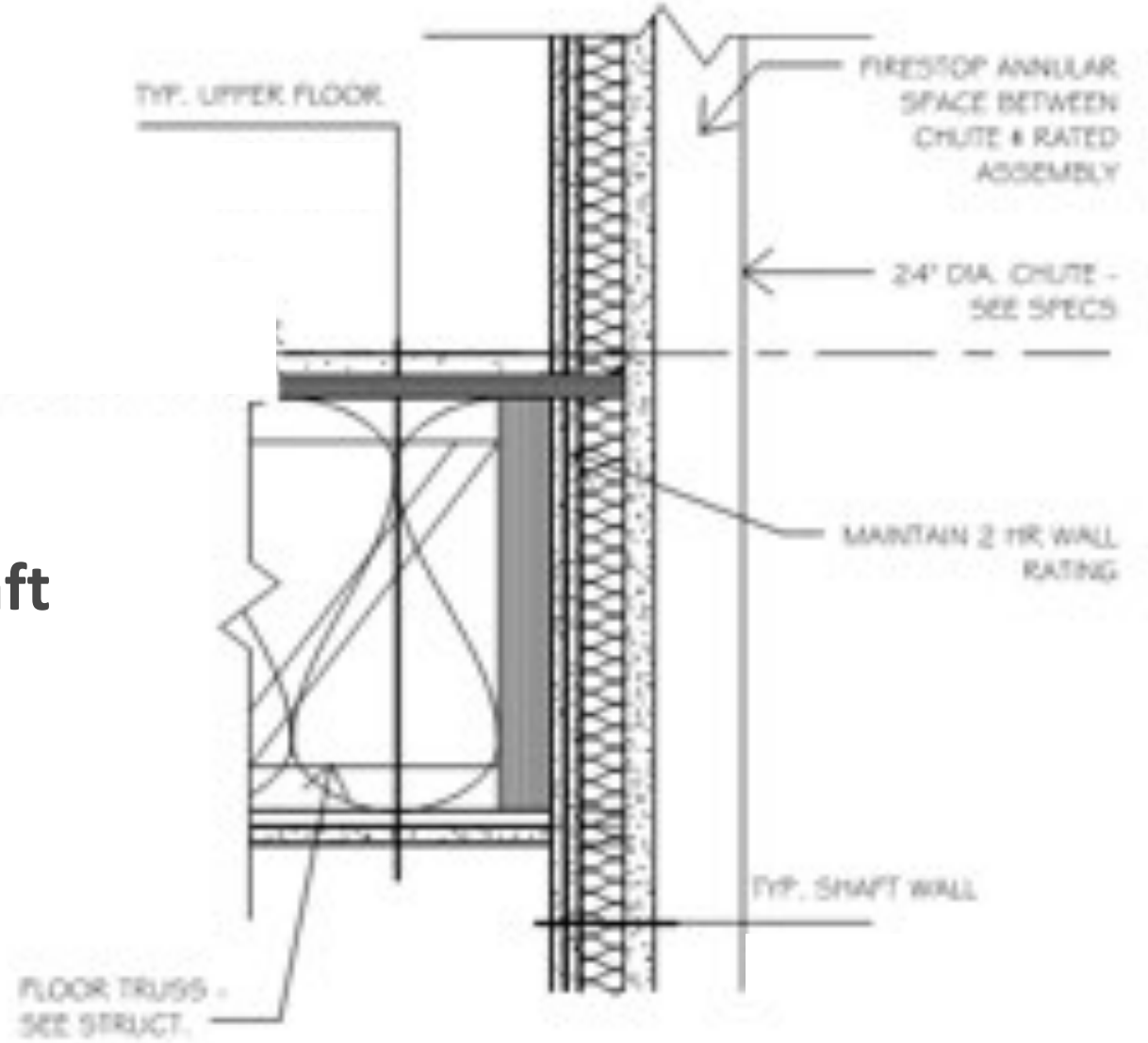


Shaftliner in H-studs attached to wall with clips

Floor side wall provides typical floor support

Floor to Shaft Wall Detailing

Option for intermittent support of shaft liner system



Floor to Shaft Wall Detailing

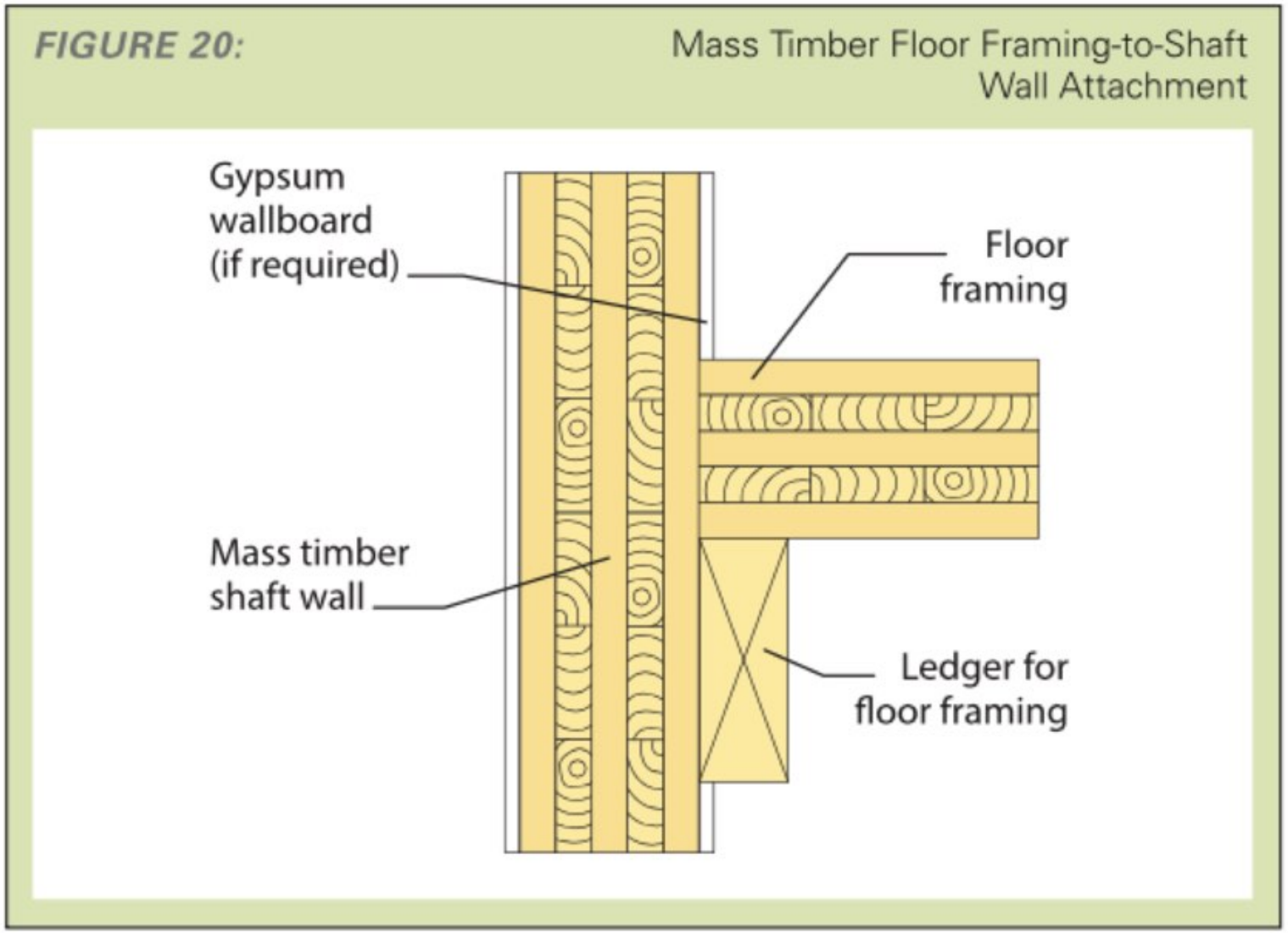
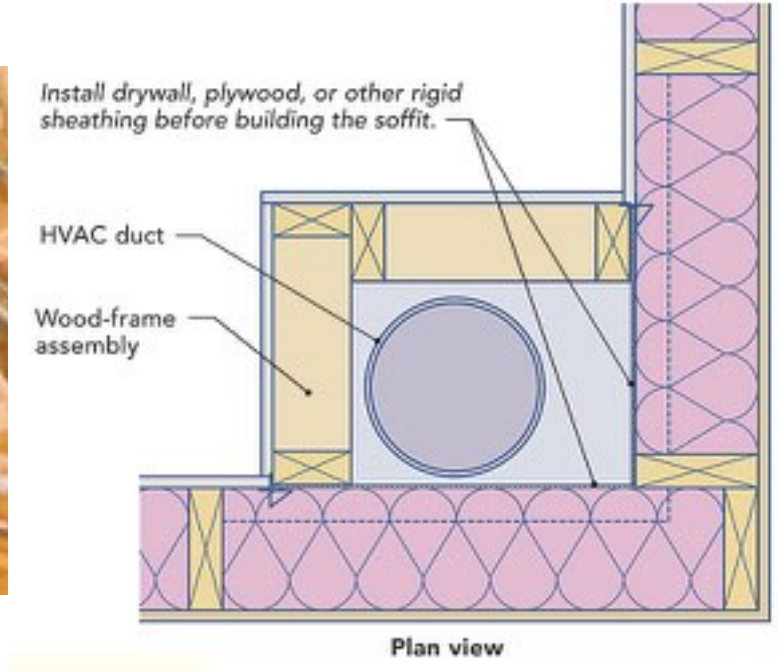


Photo: Alex Schreyer

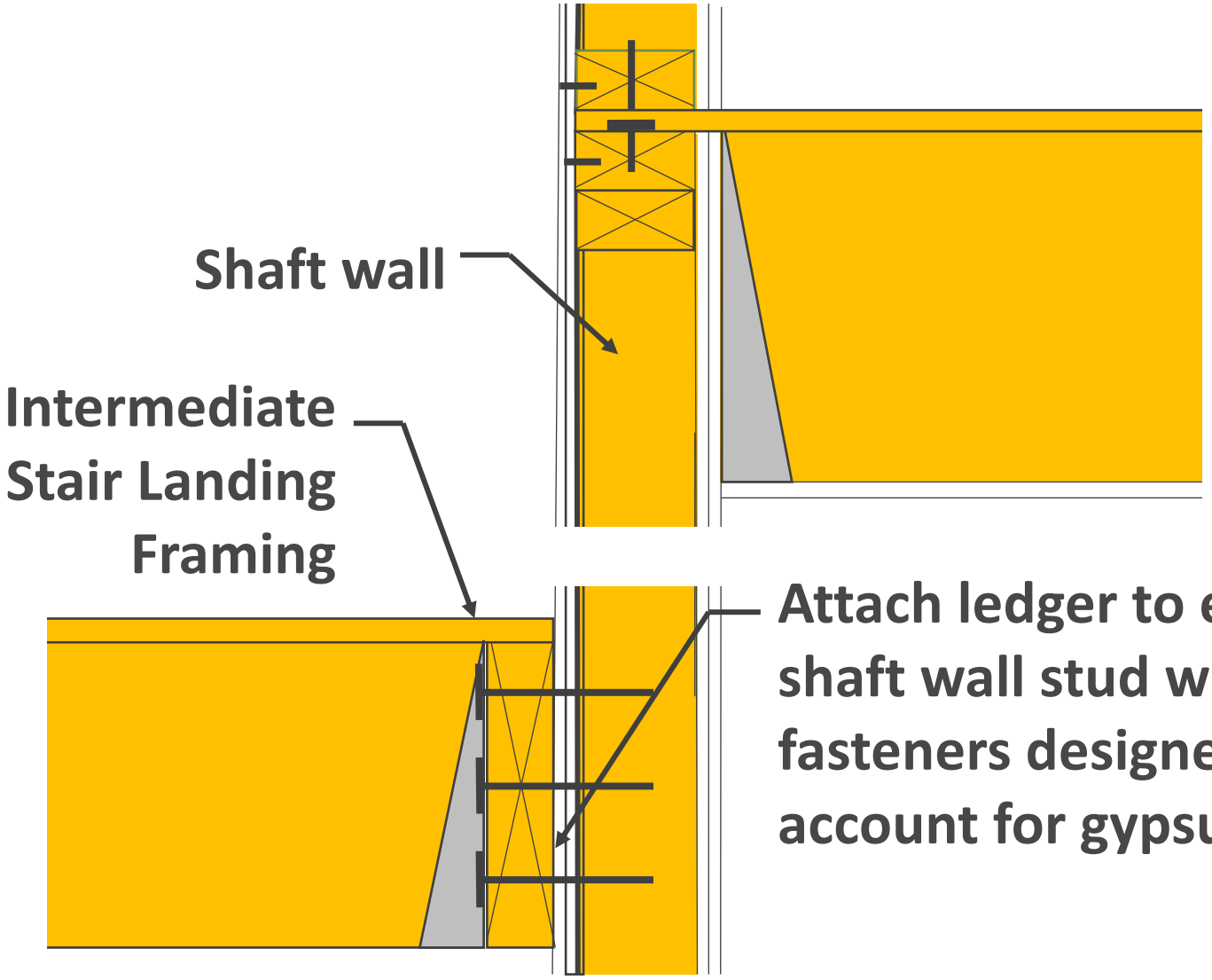
Stair, Elevator & MEP Shafts

Main Differences & Unique Design Constraints

- Stair Shafts – Stair Framing
- Elevator Shafts – Rail supports
- MEP Shafts – Small Size



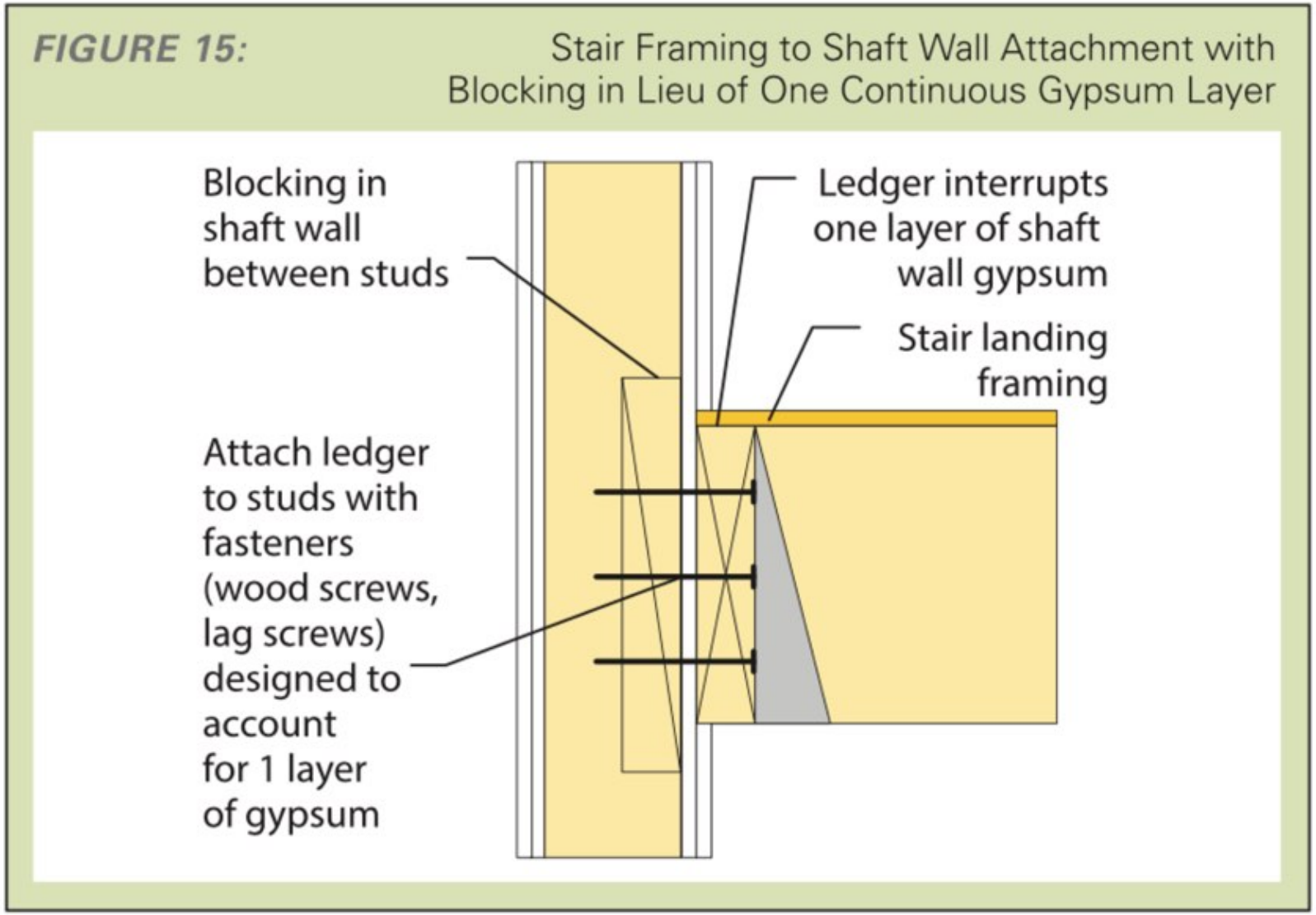
Stair Shafts



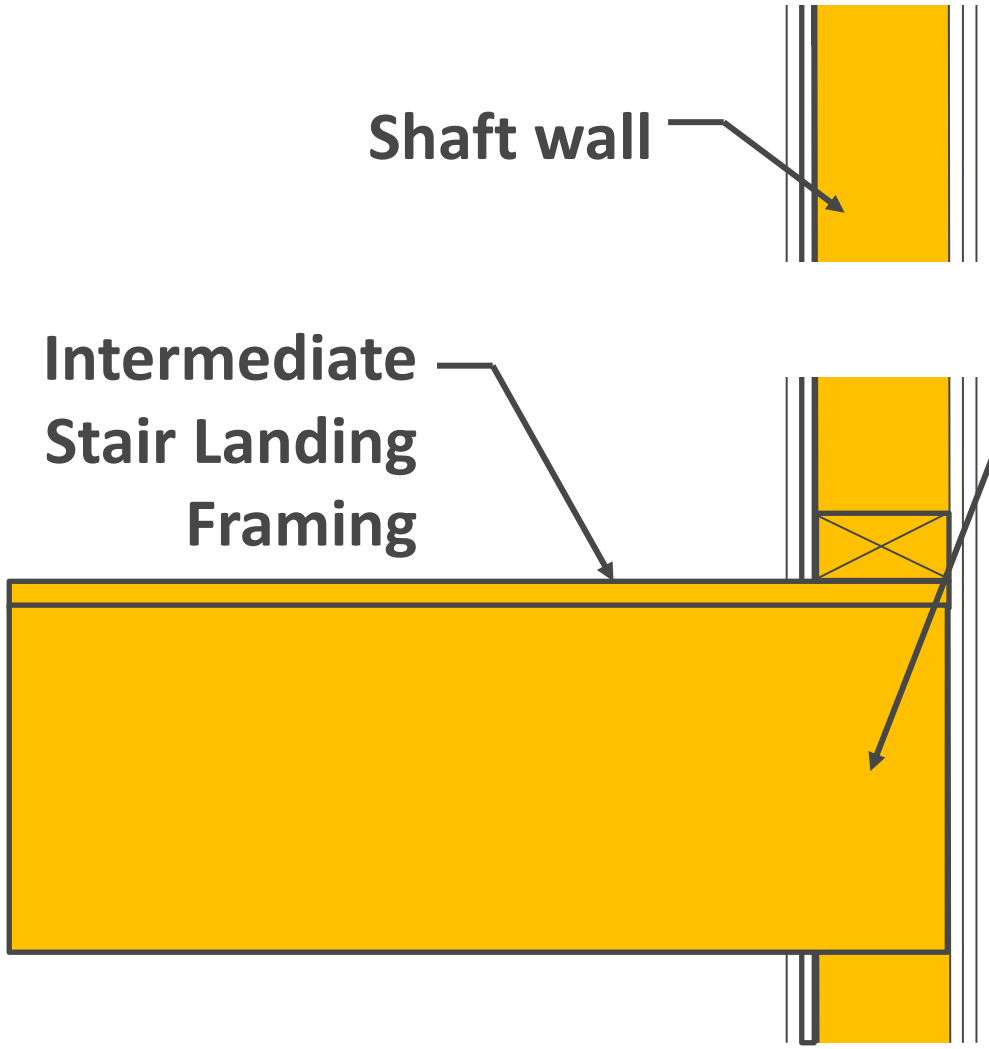

U.S. Patent No.

Stair Shafts

- Wood blocking in wall used to achieve 1 hour of continuity
- Alternatively – interrupt both gypsum layers and use 2 layers of blocking in wall
- Key to attach ledger to studs, not blocking



Stair Shafts



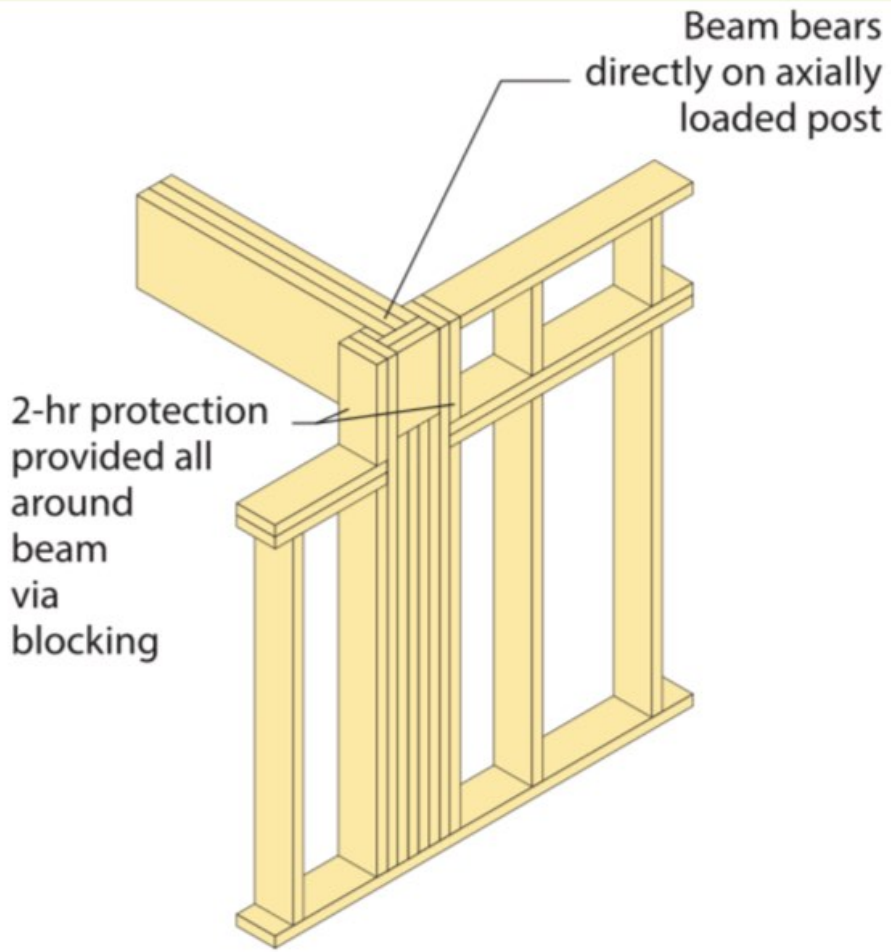
Intermediate Landing Beam Extends into Shaft Wall – Oversize to Provide 2 Hour Fire Protection Using Calculated Char Rates

Rationale for detail approval:

- Membranes on both side of wall provide fire resistance via their approved assembly; at floor cavity beam oversized to provide 2 hour char protection

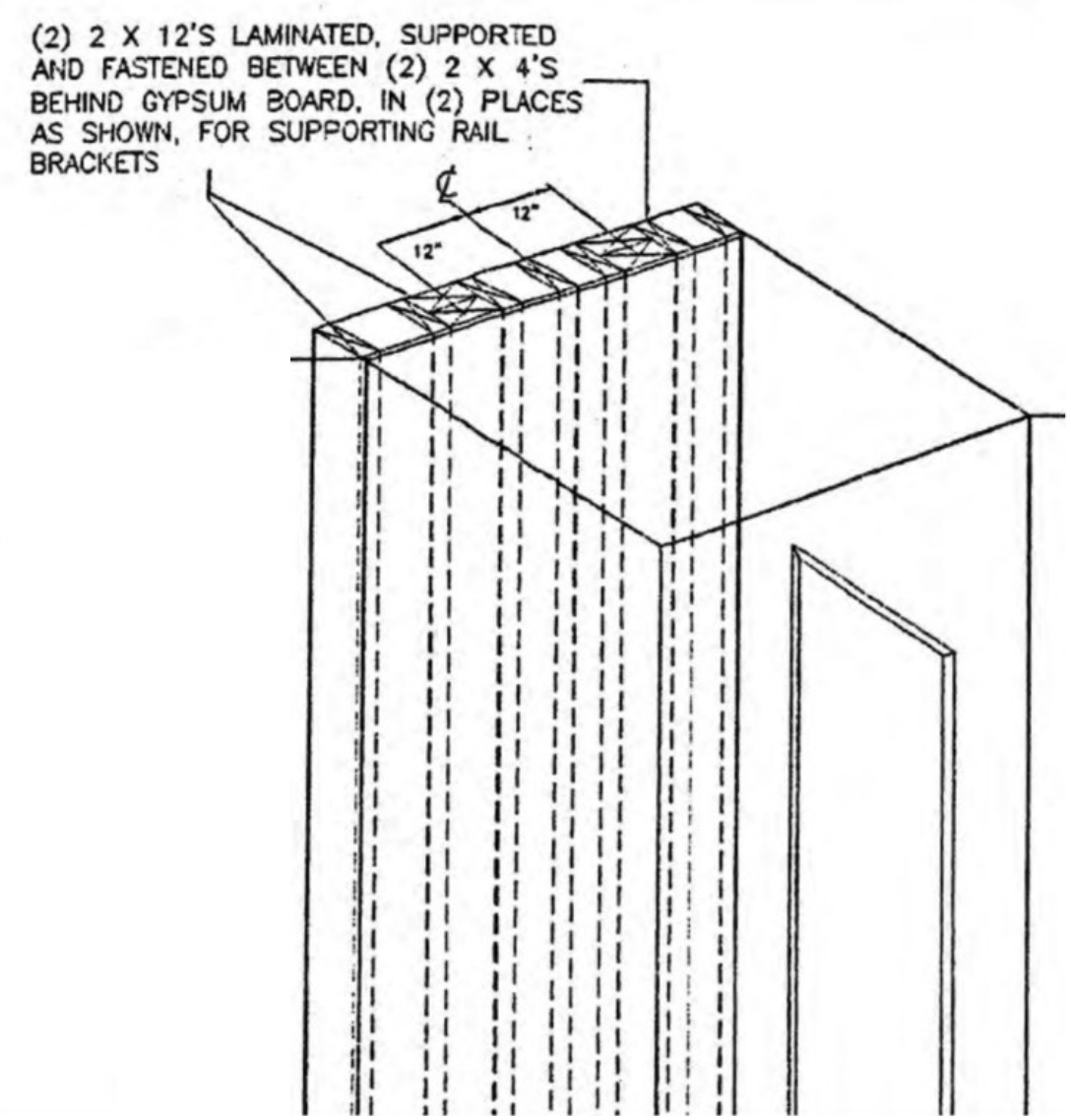
Stair Shafts

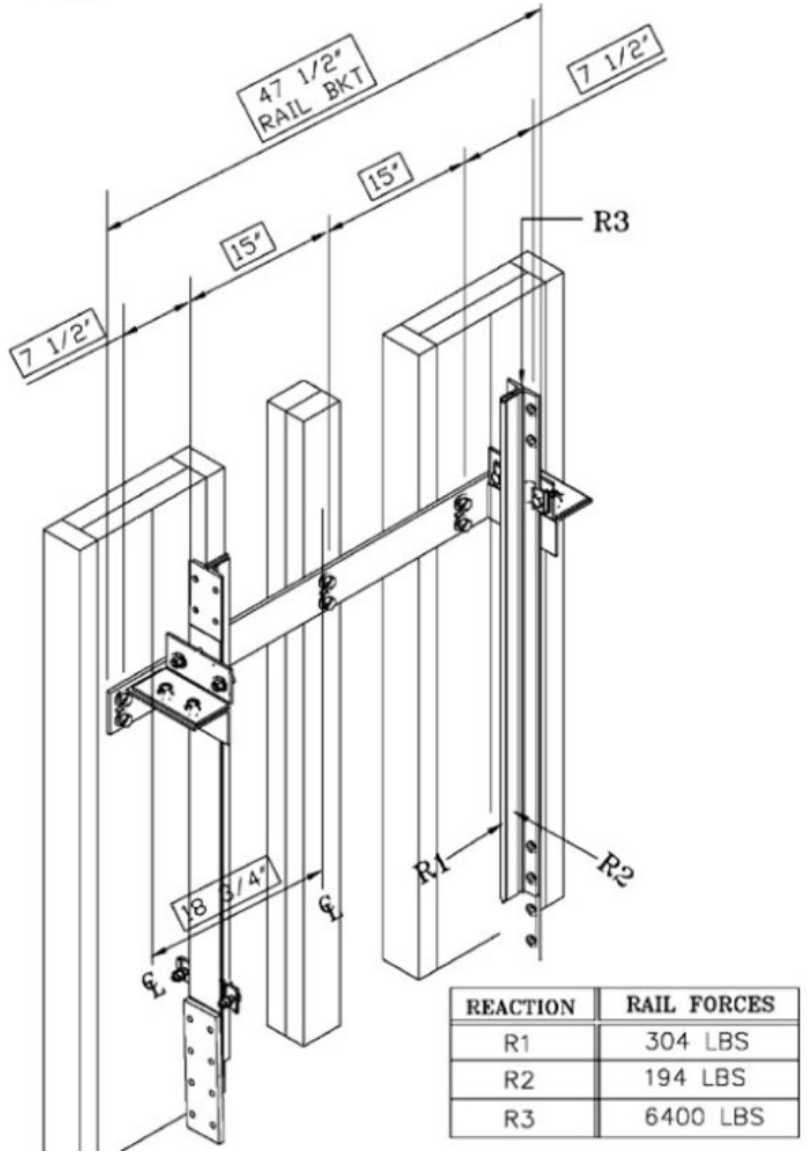
FIGURE 16: Stair Framing Beam in Protect Pocket in Shaft Wall



Elevator Shafts

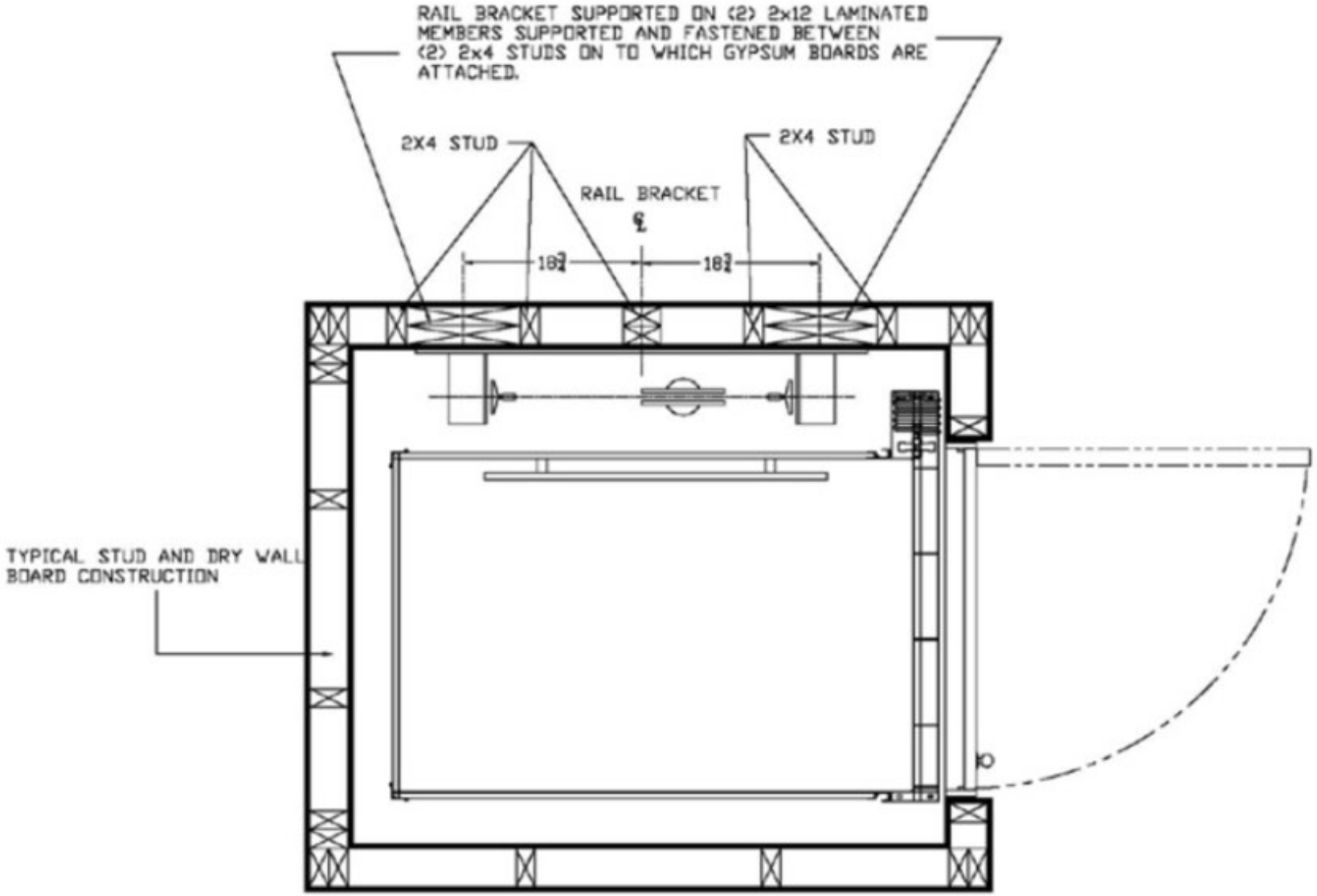
Elevator Shafts



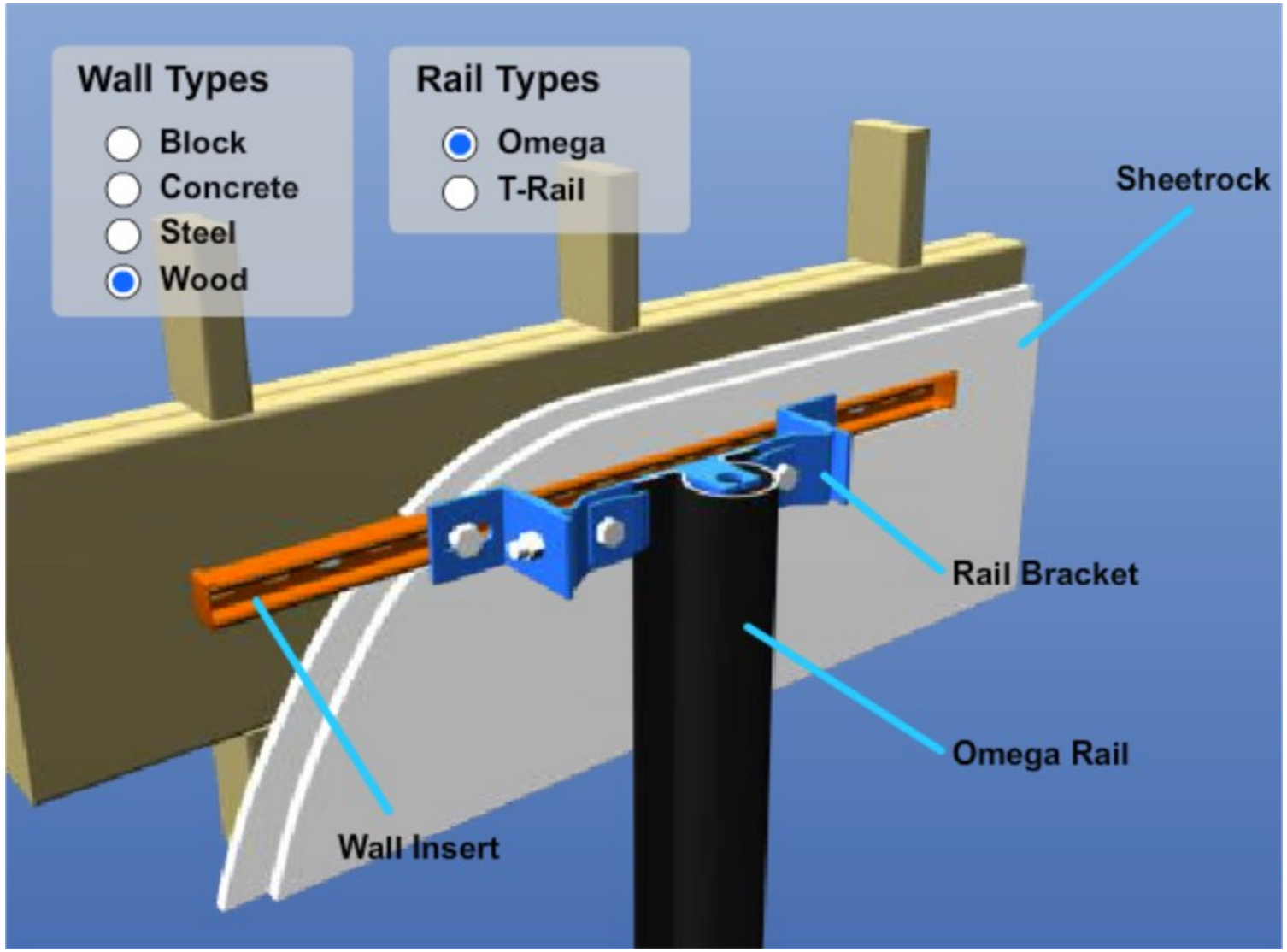


REACTION	RAIL FORCES
R1	304 LBS
R2	194 LBS
R3	6400 LBS

Elevator Shafts



Elevator Shafts



Elevator Shafts

- Elevator hoist beam can be wood
- Material compatibility
- Construction schedule & sequencing
- Consult elevator manufacturer for details, forces, location information

MEP Shafts

- Size of MEP shaft may require a solution with one or more sides being shaftliner panels
- Ability to get inside shaft to finish gypsum panels often the controlling factor in wall assembly selection

Non-Wood Shaft Walls

Masonry Shaft Walls

Mixing masonry shaft walls with wood floor framing can create several issues:

- Masonry shaft walls often become part of building's lateral force resisting system
- This increases seismic forces and adds mass
- Difference in stiffness between wood & masonry shear walls may need to be considered
- Differential shrinkage between wood and masonry needs to be considered
- Best practices include isolating masonry shaft walls, only tie wood floor to masonry shaft if/where required (i.e. at door threshold)

Masonry Shaft Walls

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

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements Are Specified	Response Modification Coefficient, R[a]	Overstrength Factor, Ω_0[g]	Deflection Amplification Factor, C_d[b]	Structural System Limitations Including Structural Height, h_n (ft) Limits[c] Seismic Design Category				
					B	C	D[d]	E[d]	F[e]
15. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance	14.5	6½	3	4	NL	NL	65	65	65
16. Special reinforced masonry shear walls	14.4	5½	2½	4	NL	NL	160	160	100
17. Intermediate reinforced masonry shear walls	14.4	4	2½	4	NL	NL	NP	NP	NP
18. Ordinary reinforced masonry shear walls	14.4	2	2½	2	NL	160	NP	NP	NP

Source: ASCE 7-10

Mass Matters:

8” CMU Wall, grout & reinforcing @ 48” o.c.: **44 psf**

2x6 wood wall w/2-layers of 5/8” gypsum each side: **16 psf**

Masonry Shaft Walls

12.2.3.3 R, C_d, and Ω_0 Values for Horizontal Combinations. The value of the response modification coefficient, R, used for design in the direction under consideration shall not be greater than the least value of R for any of the systems utilized in that direction. The deflection amplification factor, C_d, and the over-strength factor, Ω_0, shall be consistent with R required in that direction.

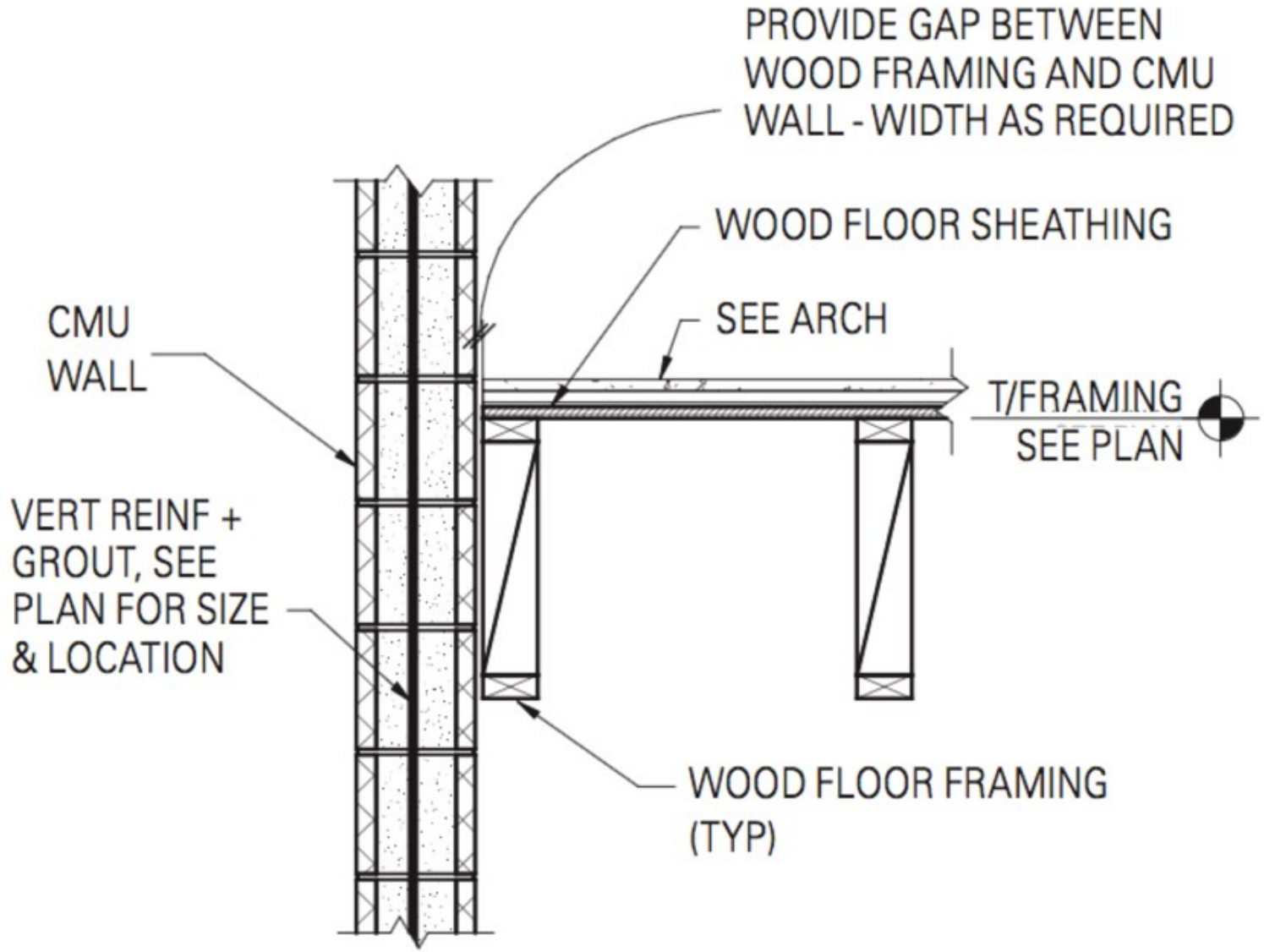
Source: ASCE 7-10

4.1.5 Wood Members and Systems Resisting Seismic Forces Contributed by Masonry and Concrete Walls

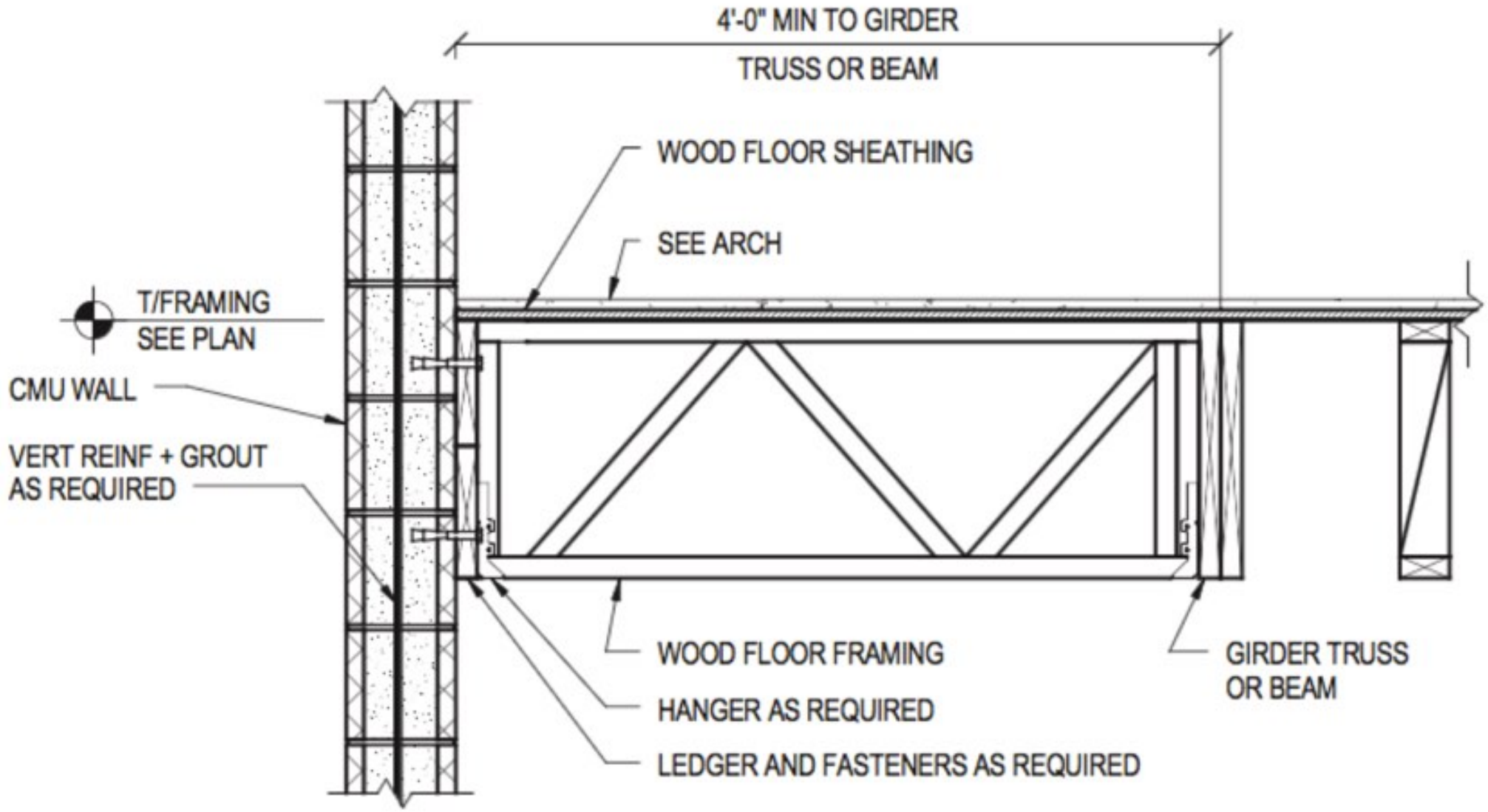
Wood-frame shear walls, wood-frame diaphragms, trusses, and other wood members and systems shall not be used to resist seismic forces contributed by masonry or concrete walls in structures over one story in height.

Source: SDPWS 2015

Masonry Shaft Walls



Masonry Shaft Walls



Resource for Material Movement

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Code provisions, detailing options, calculations and more for accommodating differential material movement in wood structures

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Accommodating Shrinkage in Multi-Story Wood-Frame Structures

Richard McLain, MS, PE, SE, Technical Director, WoodWorks • Doug Steimle, PE, Principal, Schaefer

In wood-frame buildings of three or more stories, cumulative shrinkage can be significant and have an impact on the function and performance of finishes, openings, mechanical/electrical/plumbing (MEP) systems, and structural connections. However, as more designers look to wood-frame construction to improve the cost and sustainability of their mid-rise projects, many have learned that accommodating wood shrinkage is actually very straightforward.

Wood is hygroscopic, meaning it has the ability to absorb and release moisture. As this occurs, it also has the potential to change dimensionally. Knowing how and where wood shrinks and swells helps designers detail their buildings to minimize related effects.

Wood shrinkage occurs perpendicular to grain, meaning that a solid sawn wood stud or floor joist will shrink in its cross-section dimensions (width and depth). Longitudinal shrinkage is negligible, meaning the length of a stud or floor joist will essentially remain unchanged. In multi-story buildings, wood shrinkage is therefore concentrated at the wall plates, floor and roof joists, and rim boards. Depending on the materials and details used at floor-to-wall and roof-to-wall intersections, shrinkage in light-frame wood construction can range from 0.05 inches to 0.5 inches per level.

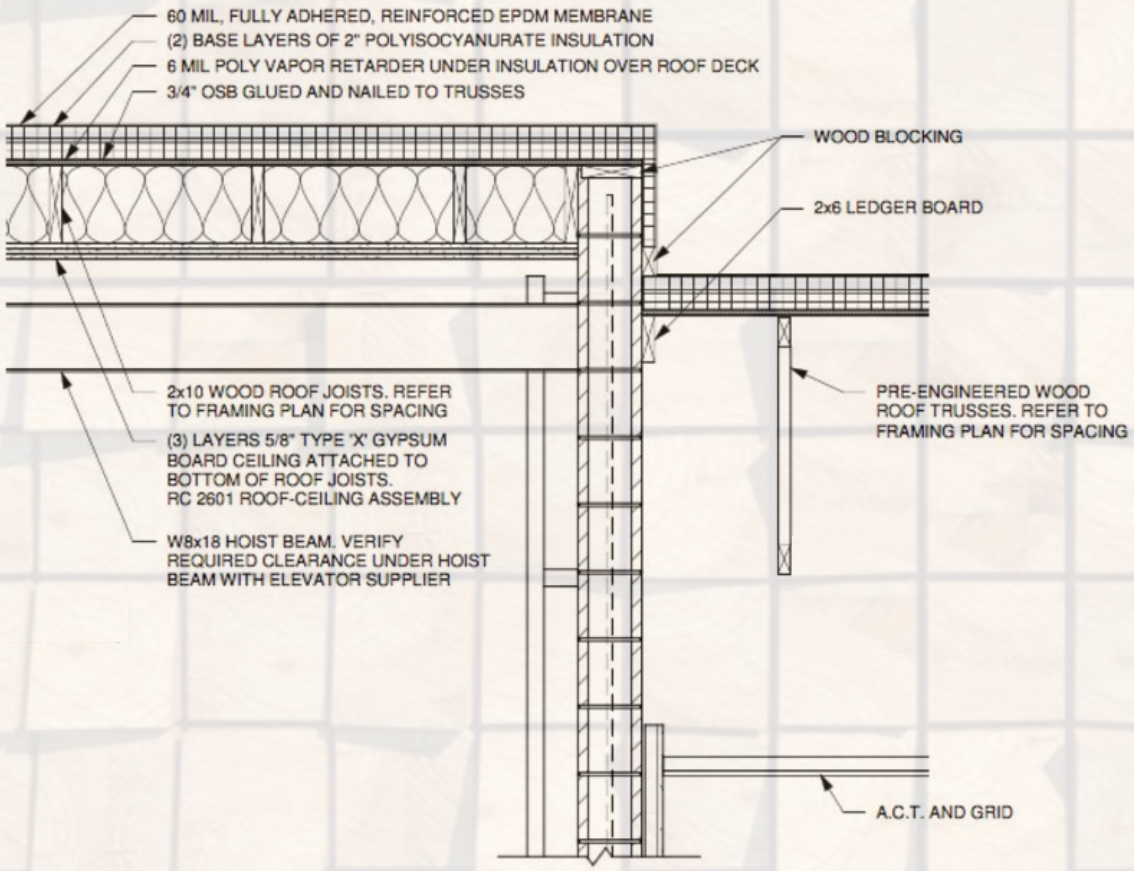
This publication will describe procedures for estimating wood shrinkage and provide detailing options that minimize its effects on building performance.

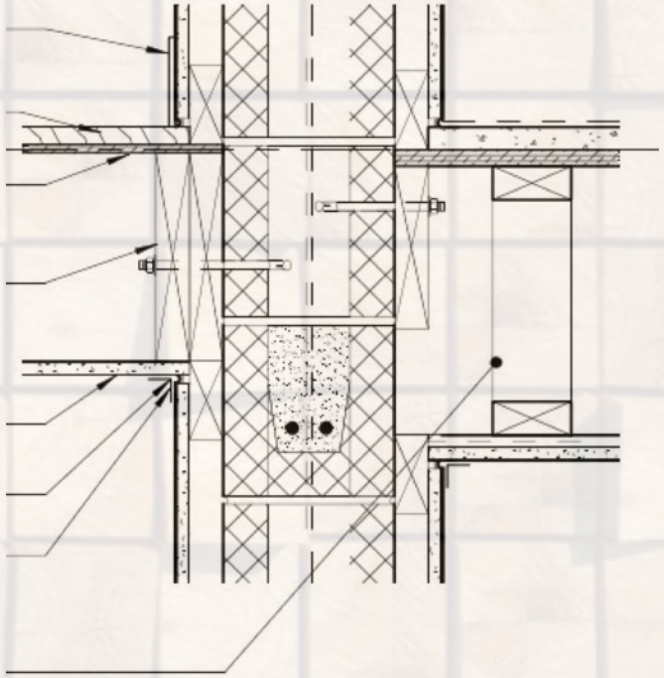
The Brooklyn Riverside
Jacksonville, Florida
Architect: Dwell Design Studio
Structural Engineer: M2 Structural Engineering

Photo: Pollack Shores, Matrix Residential

a longitudinal cell in the wood. Water can be free water stored in the straw cavity or bound water absorbed by the straw walls. At high moisture contents, water exists in both locations. As the wood dries, the free water is released from the cell cavities before the bound water is released from the cell walls. When wood has no free water and yet the

Shaft Wall Material Choice





Why introduce new materials for shaft walls?
They can be framed with wood!

Shaft Wall Resource

Code provisions, detailing options, project examples and more for light-frame wood and mass timber shaft walls

Free resource at woodworks.org

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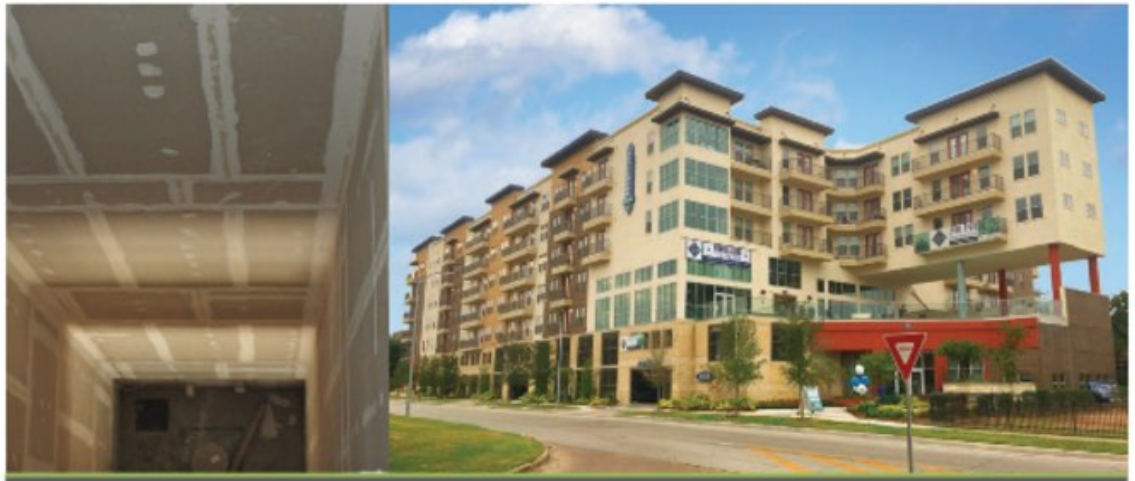
Shaft Wall Solutions For Wood-Frame Buildings

Richard McLain, MS, PE, SE • Technical Director • WoodWorks



Wood shaft walls can reduce costs and shorten the construction schedule.

It is fairly common for light wood-frame commercial and multi-family buildings to include shaft walls made from other materials. However, with the heavy use of wood structure in mid-rise construction, many designers and contractors have come to realize that wood-frame shaft walls are in fact a code-compliant means of reducing cost and shortening construction schedule.

A shaft is defined in Section 202 of the 2012 International Building Code (IBC) as "*an enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and roof.*" Therefore, shaft enclosure requirements apply to stairs, elevators, and MEP chases in multi-story buildings. While these applications might be similar in their fire design requirements, they often have different construction constraints and scenarios where assemblies and detailing may also differ.

This paper provides an overview of design considerations, requirements, and options for wood-frame shaft walls under the 2012 IBC. While some of the IBC-referenced section numbers may be different in different editions, none of the main shaft wall provisions have been modified in the 2015 IBC.

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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