

Type III Fire-Resistant Design and Detailing for Exterior Walls, Shafts, and Intersections

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1430 Q, The HR Group Architects, Buehler Engineering, Greg Folkins Photography

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



Course Description

A trend toward larger mid-rise wood-frame buildings increases the need for information on fire-resistant detailing and construction. This presentation will focus on common detailing issues and areas of misunderstanding related to exterior walls and their intersection with rated floor assemblies, and detailing for elevator, stair, and mechanical shafts. The discussion will focus on fire resistance-rated design parameters and other architectural and structural considerations related to exterior and shaft walls. Mid-rise wood-frame opportunities and code-specified building sizes will be reviewed, followed by a discussion about detailing code requirements, code compliance, and rationale for approval with an emphasis on constructability and practicality.

Learning Objectives

1. Review Type III construction with regard to cost, building size, and fire resistance per the International Building Code.
2. Review code requirements for exterior and shaft walls, emphasizing common questions, including the use of asymmetric assemblies, allowance of wood structural panels, and bearing vs. non-bearing requirements.
3. Examine a variety of floor-to-exterior wall and floor-to-shaft-wall details for use in wood-frame, Type III construction, and discuss code compliance paths and approval rationale for each.
4. Recognize structural design considerations for stair and elevator shafts.

Part 1: Outline

- » Context for Type III Construction
- » Definitions and Terminology
- » Fire Rating Requirements for Exterior Walls
- » Exterior Wall to Floor Intersections
- » Parapets



Landing Apartments, Russell Scott Steedle & Capione Architects, photo Gregory Folkins

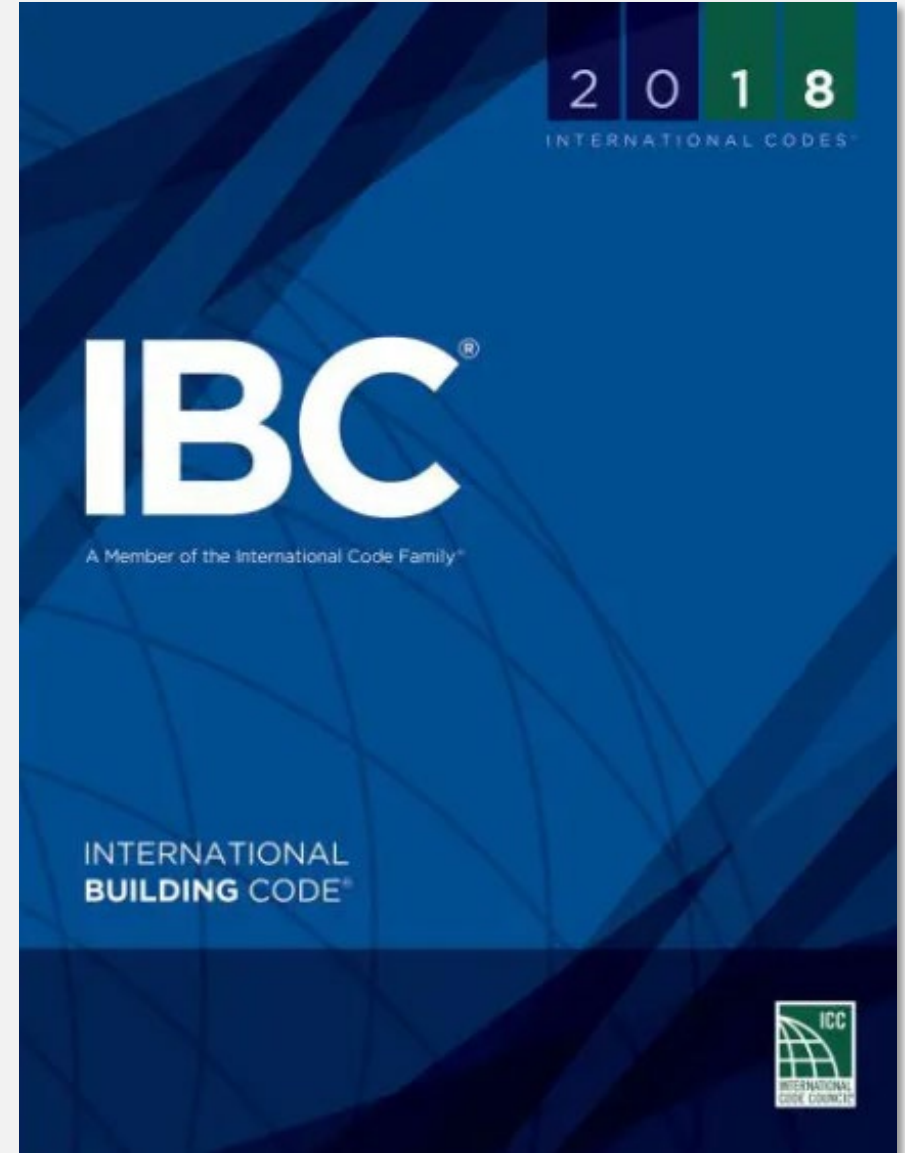
This Presentation References:



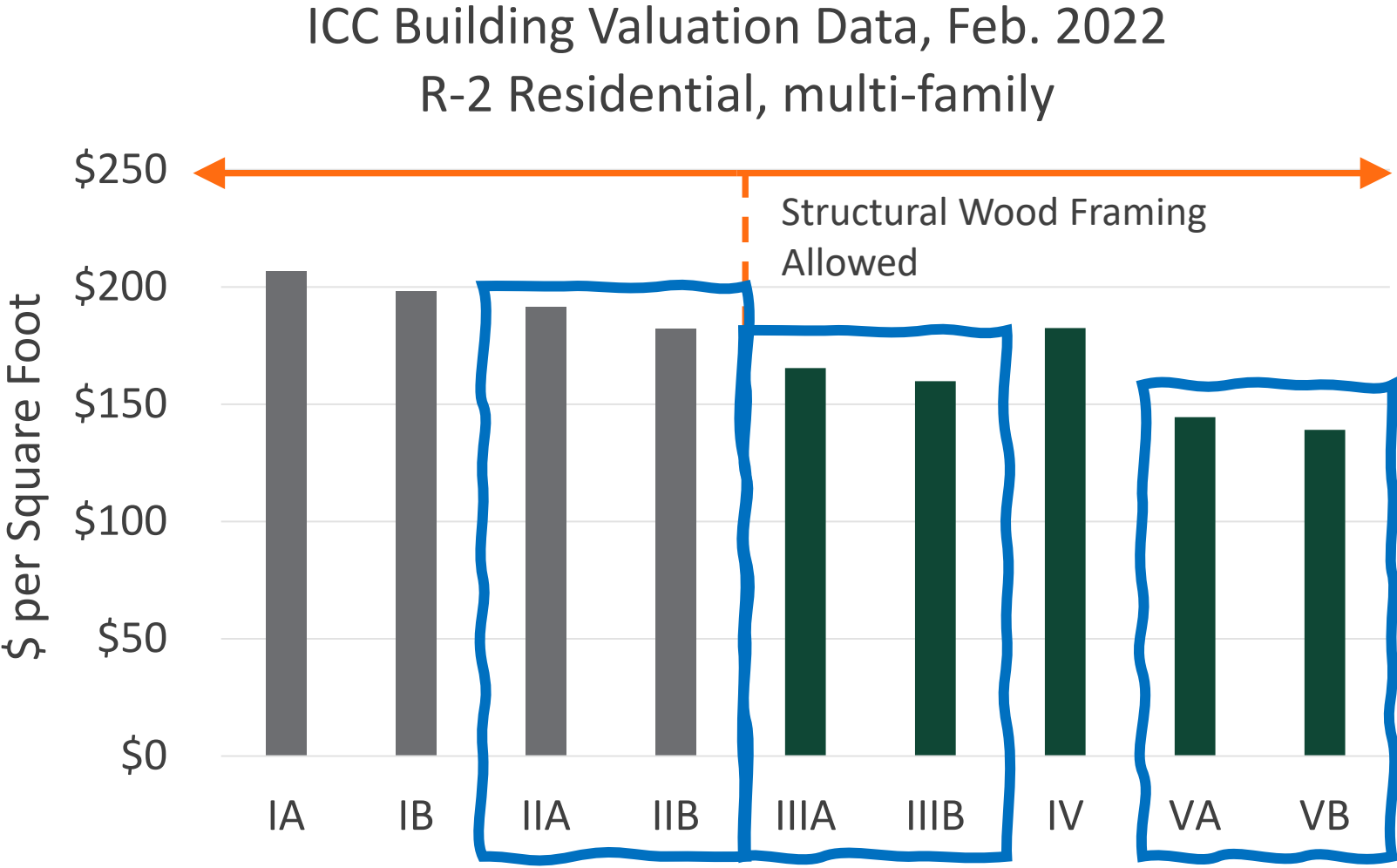
(Unless Otherwise Noted)

Part 1: Outline

➤ Context for Type III Construction



ICC Building Valuation Data



IBC Building Size Limits with Sprinkler

Residential (R1, R2, and R4) Occupancies

Type IIIA Construction Allowable Limit	NS	S13R	SM	Max Frontage
Stories	4	4	5	5
Height (ft)	65	60	85	85
Building Area/Story (ft ²)	24k	24k	72k	90k
Total Building Area* (ft ²)	72k	96k	216k	270k

* Assuming max stories built per IBC 506.4

** Maximum frontage increase possible

903.2.8 Group R

Automatic sprinkler systems installed in accordance with Section 903.3 shall be provided throughout all buildings with a Group R fire area

Type IIIA Construction Max. Height: 85ft

+ Mezzanine

5 stories Maximum
for Residential

+ Multi-Story (Type 1A)
Podium

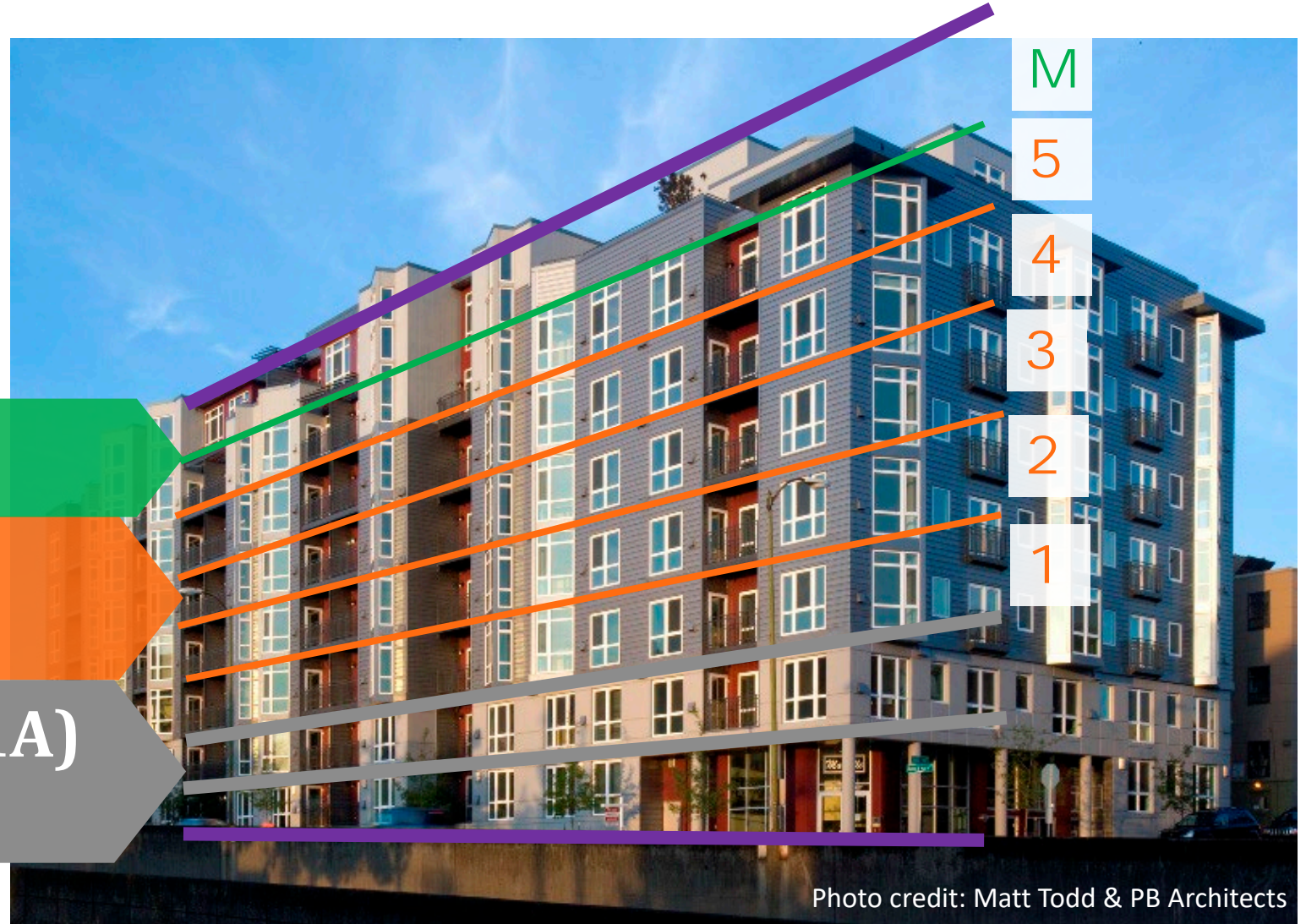


Photo credit: Matt Todd & PB Architects

Photo: Matt Todd/PB Architects



Seattle, WA

Photo: Matt Church



College Park , MD

Los Angeles, CA

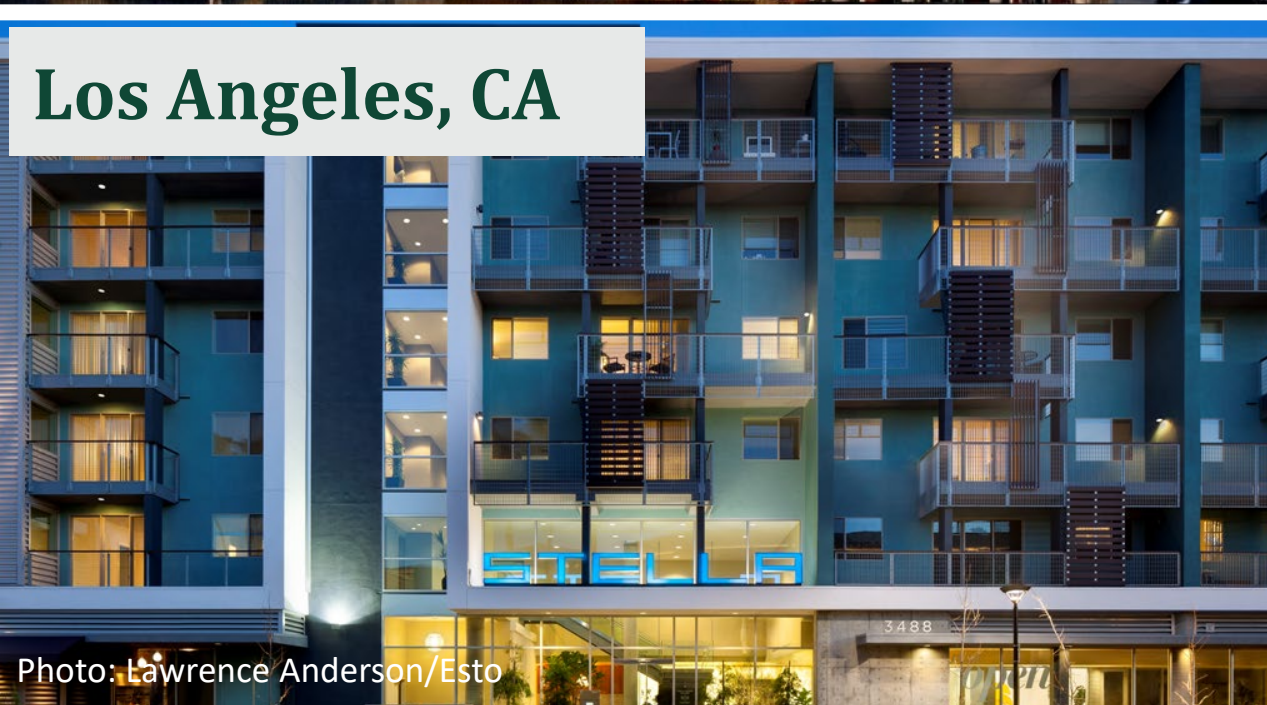
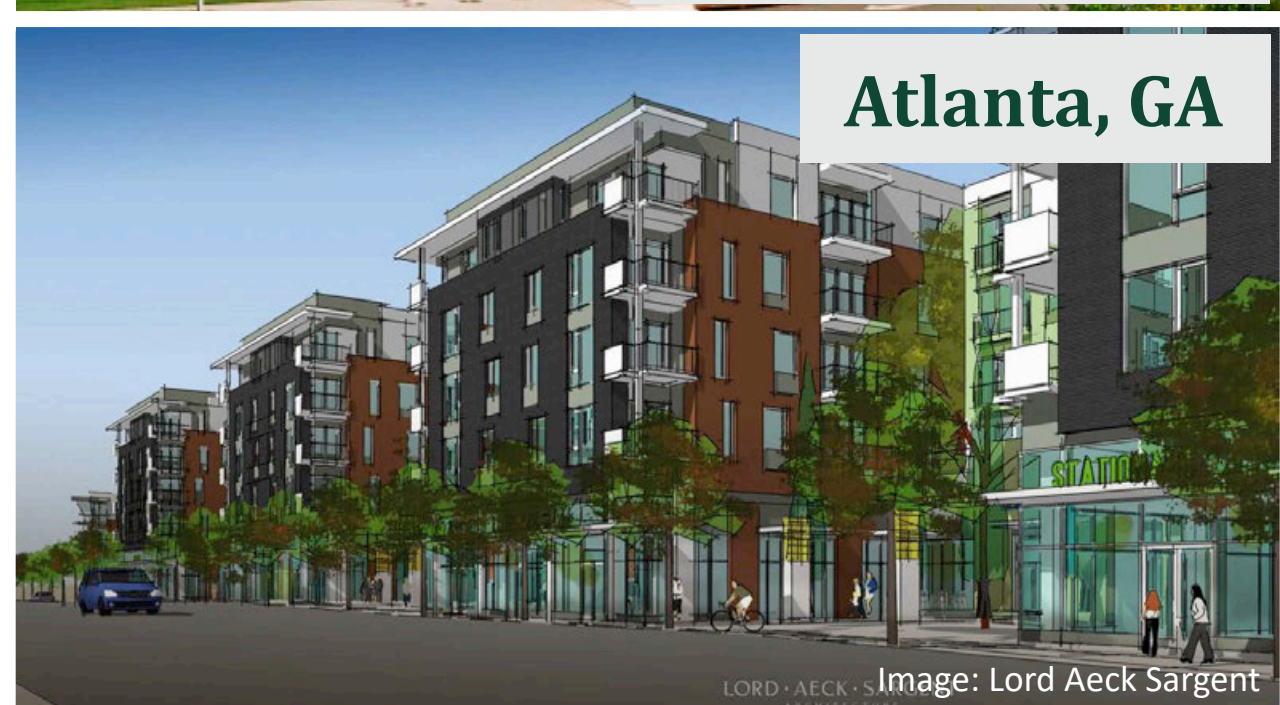


Photo: Lawrence Anderson/Esto

Atlanta, GA



LORD · AECK · SARGENT Image: Lord Aeck Sargent

Part 1: Outline

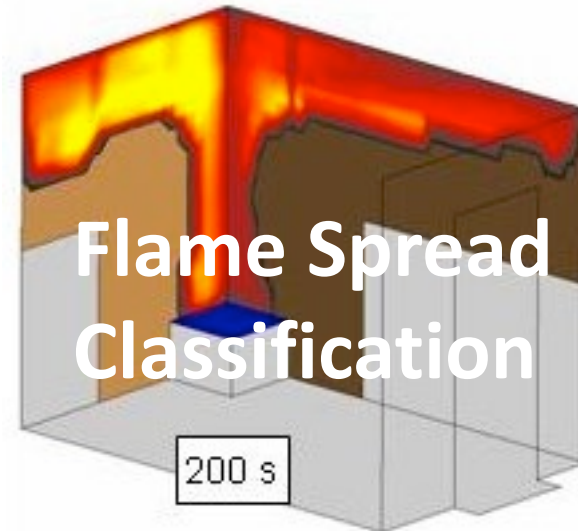
» Context for Type III Construction

➤ Definitions and Terminology



Landing Apartments, Russell Scott Steedle & Capione Architects, photo Gregory Folkins

Fire Performance



Fire Resistance-Rated Assemblies

Fire-Resistance Rating: The *period of time* a building element, component or assembly maintains the ability to:



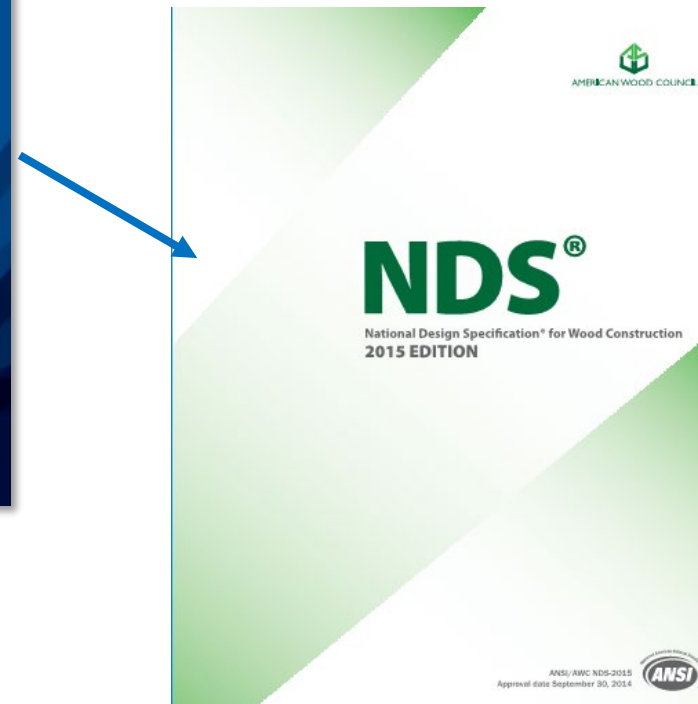
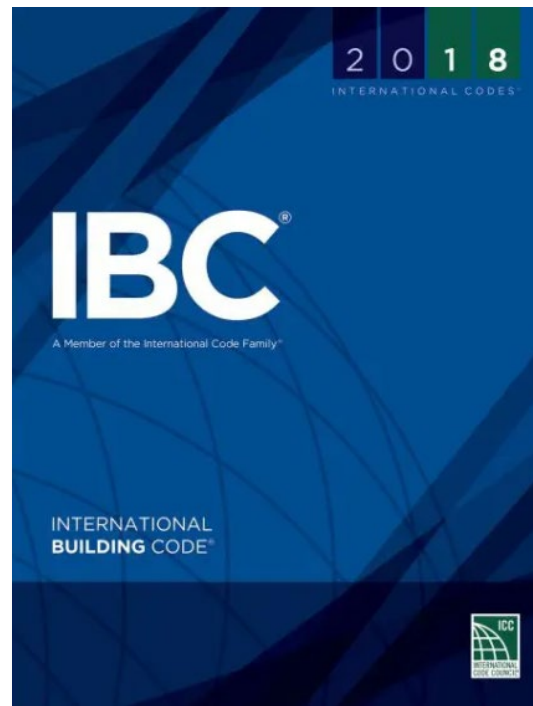
**Maintain Structural
Performance**



Provide Fire Confinement

Calculated Fire Resistance of Wood

IBC to NDS code compliance path



IBC 703.3

Methods for determining fire resistance

- Prescriptive designs per IBC 721.1
- **Calculations in accordance with IBC 722**
- Fire-resistance designs documented in sources
- Engineering analysis based on a comparison
- Alternate protection methods as allowed by 104.11



IBC 722

Calculated Fire Resistance

"The calculated *fire resistance* of exposed wood members and wood decking shall be permitted in accordance with **Chapter 16 of ANSI/AWC National Design Specification for Wood Construction (NDS)**



NDS Chapter 16

Fire Design of Wood Members

- Limited to calculating fire resistance up to 2 hours
- Char depth varies based on exposure time (i.e., fire-resistance rating), product type and lamination thickness. Equations and tables are provided.
- TR 10 and NDS commentary are helpful in implementing permitted calculations.

Equations for Calculating Fire Endurance

ACCOUNTS FOR
NON-CHARRED
STRENGTH RED'N

$$\beta_{eff} = \frac{1.2\beta_n}{t^{0.187}}$$

CHAR SLOWS
WITH TIME:
NONLINEAR

β_{eff} = Effective char rate (in/hr), adjusted
for exposure time, t

β_n = Nominal char rate (in/hr), linear char rate
based on a 1-hour exposure (1.5"/hr.)

t = Exposure time (hrs)

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)

NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION149

FIRE DESIGN OF WOOD MEMBERS

16.1 General150

16.2 Design Procedures for Exposed Wood Members150

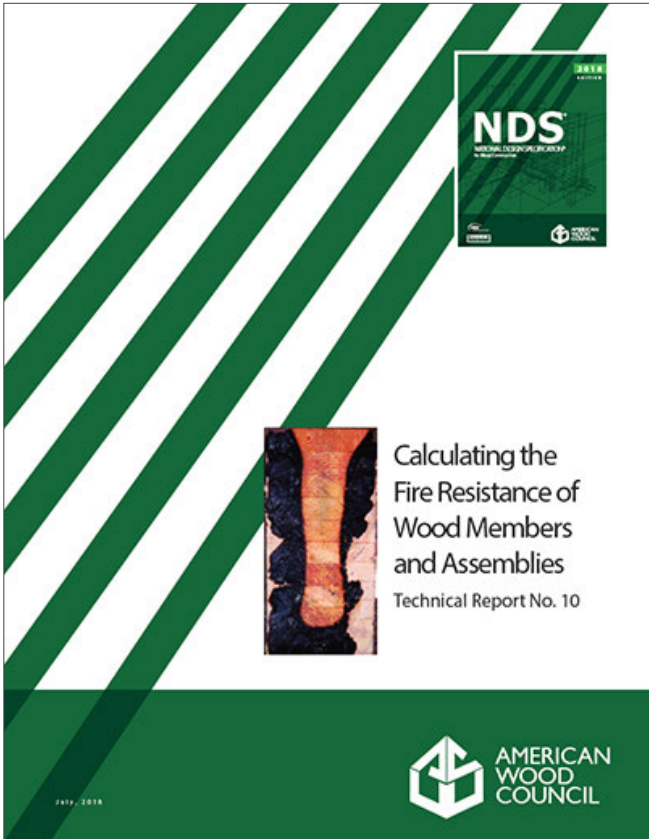
16.3 Wood Connections151

Table 16.2.1 Effective Char Rates and Char Layer Thicknesses (for $\beta_{\text{eff}} = 1.5 \text{ in./hr.}$)150

Table 16.2.2 Adjustment Factors for Fire Design151

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Part 1: Outline

» Context for Type III Construction

» Definitions and Terminology

➤ Fire Rating Requirements for Exterior Walls



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Fire Resistance-Rated Wall Assemblies

There are four basic types of fire-resistance rated wall assemblies:

1. Exterior Walls (IBC 705)
2. Fire Walls (IBC 706)
3. Fire Barriers (IBC 707)
4. Fire Partitions (IBC 708)

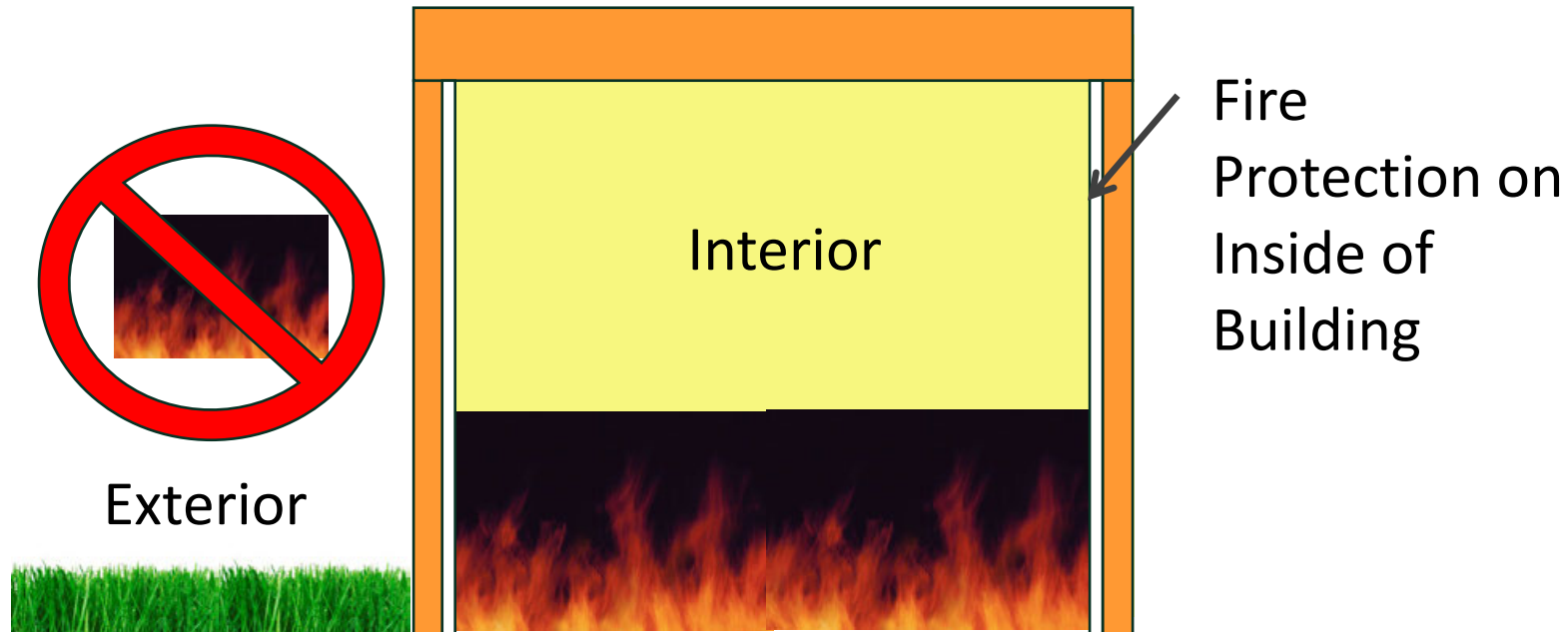
Unique to Exterior Walls

Exterior walls differ from other light frame fire assemblies in three basic ways:

- » Hourly rating requirements per Tables 601 vs 602
- » Structural stability requirements
- » Non-combustible exception

Exterior Walls – IBC 705

Basic assumption is that fires begin at the interior and rated wall assemblies are not required *from* the exterior unless close to another structure.



IBC 705 - Exterior Wall Fire Resistance

705.5 Fire Resistance Ratings: Exterior walls shall be fire-resistance rated in accordance with Tables 601 and 602 and this section...

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, b}	2 ^{a, b}	1 ^b	0	1 ^b	0	HT	1 ^b	0
Bearing walls									
Exterior ^{e, f}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 602								
Exterior									
Nonbearing walls and partitions									
Interior ^d	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	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	HT	1 ^{b, c}	0

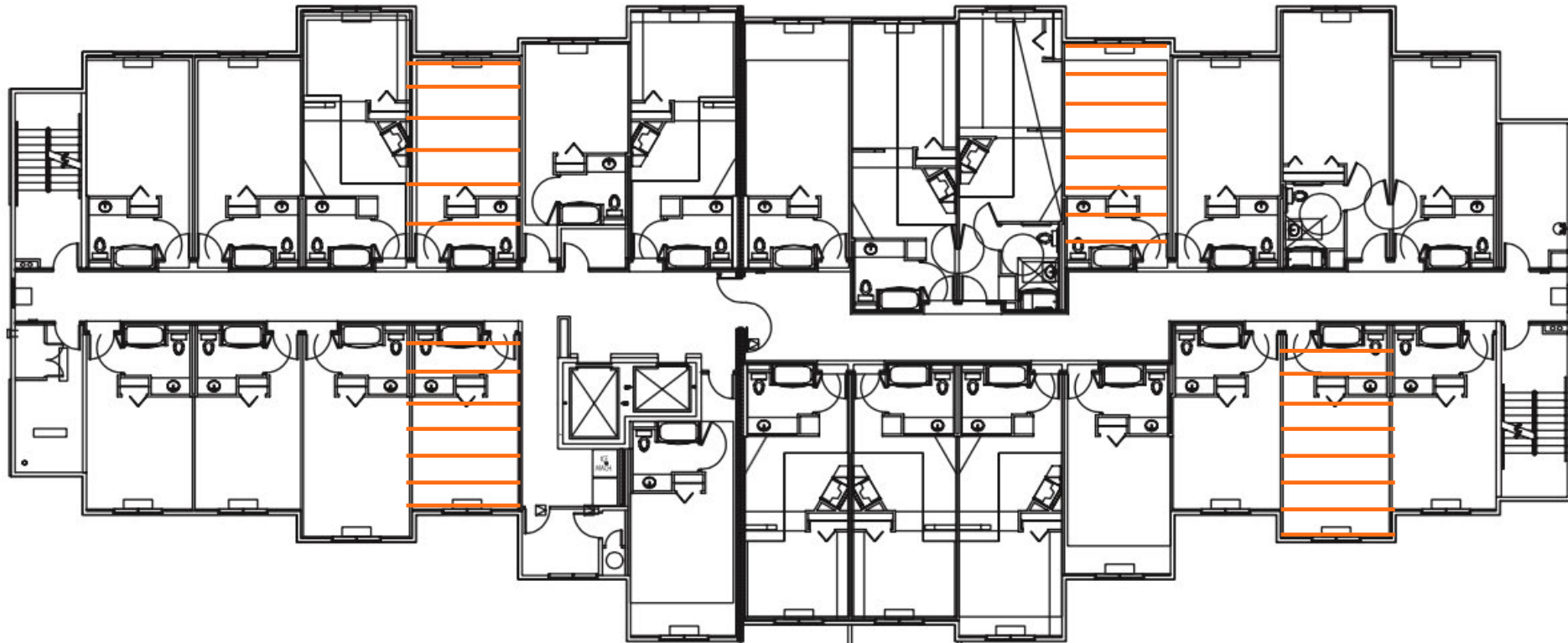
Exterior Walls – Bearing vs. Non-Bearing

IBC Chapter 2 definition:

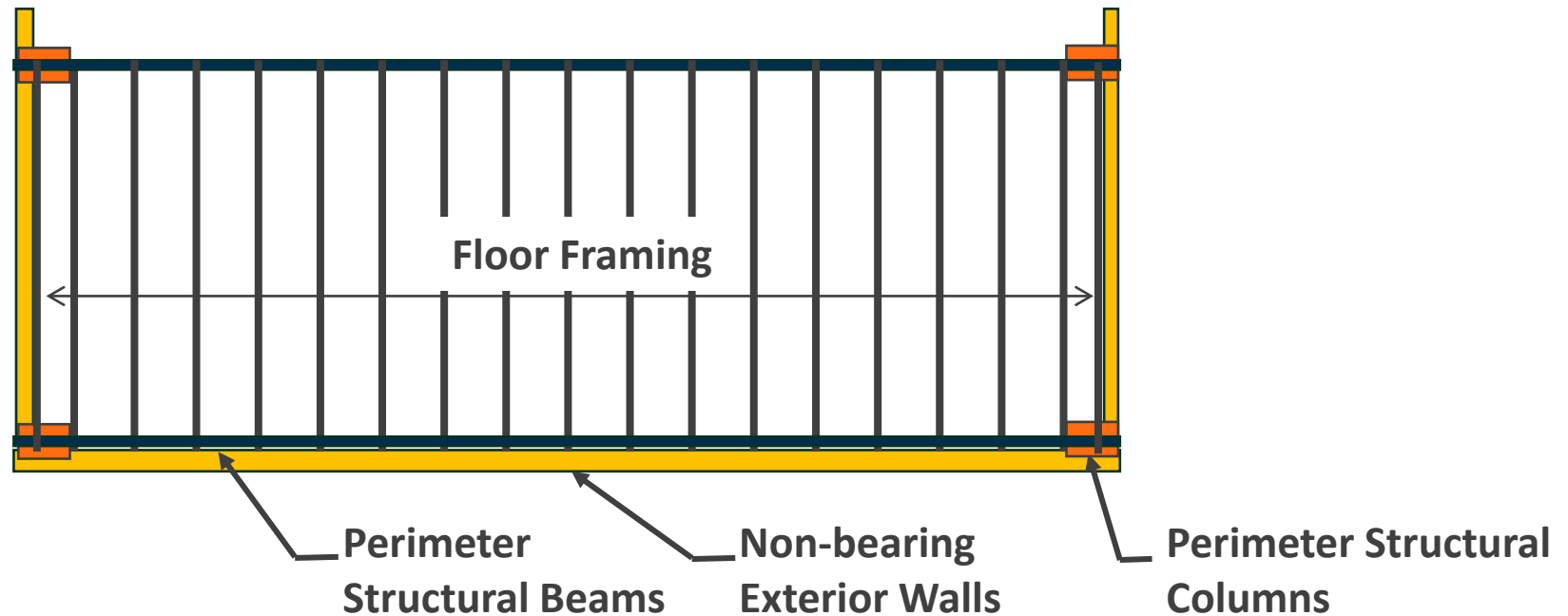
NON-LOAD BEARING WALL: Any wall that is not a load-bearing wall

LOAD BEARING WALL: Any metal or wood stud wall that supports more than 100 pounds per linear foot of vertical load in addition to its own weight.

Exterior Walls – Bearing vs. Non-Bearing



Exterior Walls – Bearing vs. Non-Bearing



Note: Beams & Columns will most likely be considered “Primary Structural Frame” & require individual encasement per IBC 704

IBC 705 - Exterior Wall Fire Resistance

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, b}	2 ^{a, b}	1 ^b	0	1 ^b	0	HT	1 ^b	0
Bearing walls									
Exterior ^{c, f}	3	2	1	0	2	2	2	1	0
Interior	3 ^a	2 ^a	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 602								
Exterior									
Nonbearing walls and partitions							See Section 2304.11.2		
Interior ^d	0	0	0	0	0	0		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)	1 ^{1/2} ^b	1 ^{b, c}	1 ^{b, c}	0 ^c	1 ^{b, c}	0	HT	1 ^{b, c}	0

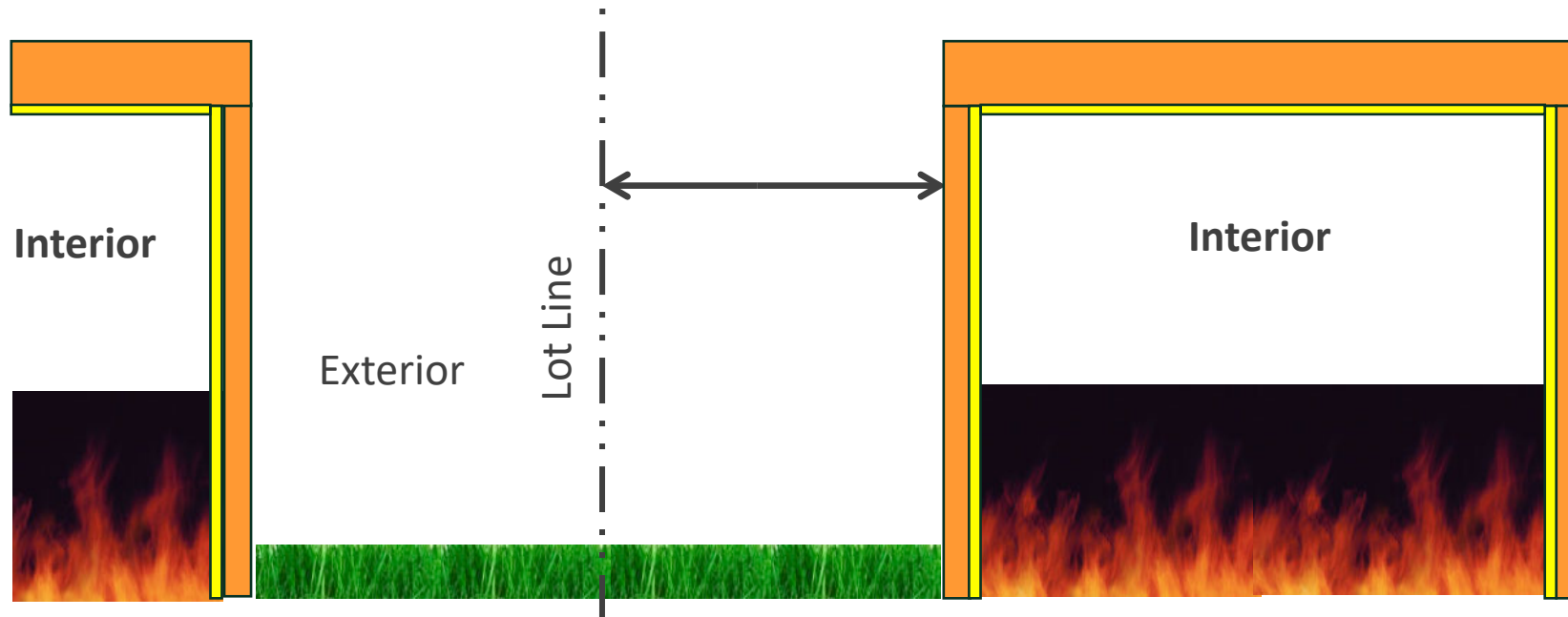
TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE^{a, d, g}

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H ^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 ≤ X < 10	IA	3	2	1
	Others	2	1	1
10 ≤ X < 30	IA, IB	2	1	1 ^c
	IIB, VB	1	0	0
	Others	1	1	1 ^c
X ≥ 30	All	0	0	0

(2021 IBC
Table 705.5)

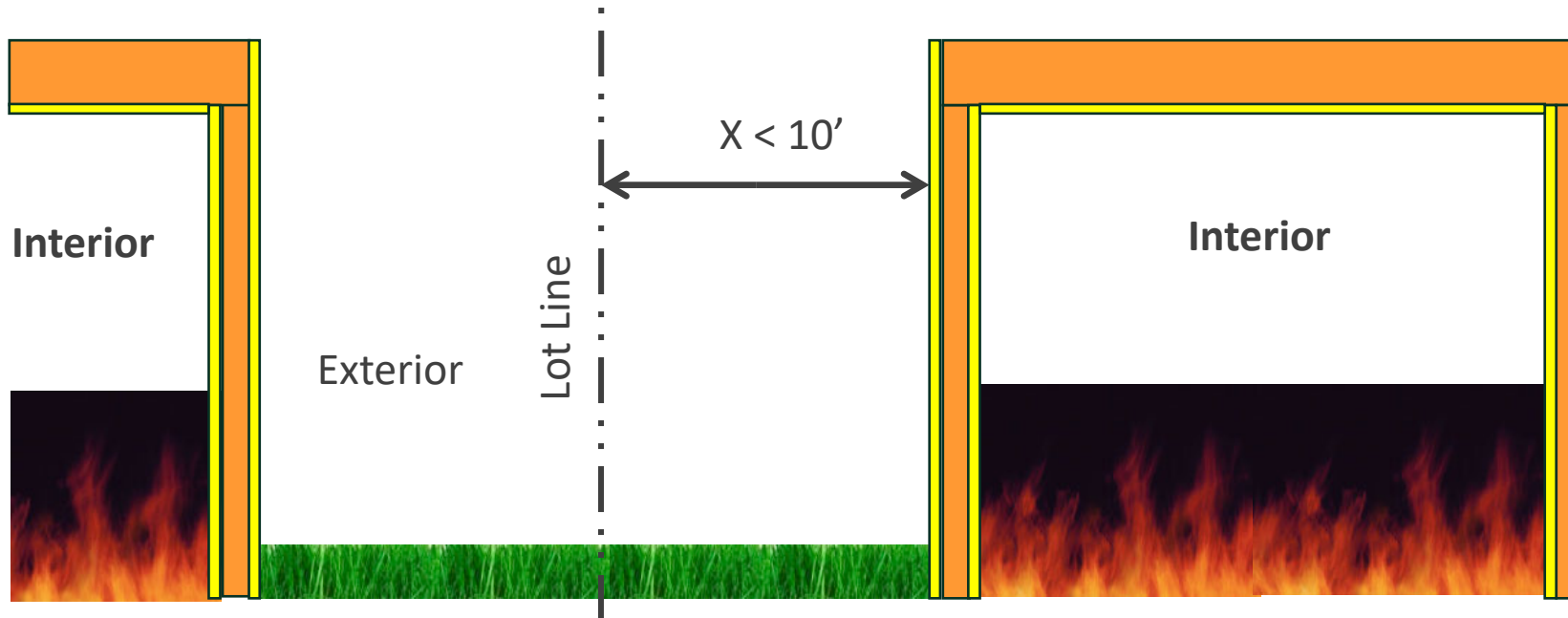
Exterior Walls – Fire Separation Distance

705.5 Fire Resistance Ratings: ...The required fire-resistance rating of exterior walls with a fire separation distance of greater than 10 feet shall be rated for exposure to fire from the inside.



Exterior Walls – Fire Separation Distance

705.5 Fire Resistance Ratings: ...The required fire-resistance rating of exterior walls with a fire separation distance of less than or equal to 10 feet shall be rated for exposure to fire from both sides.



Type III Exterior Walls: Fire Rating Requirements

Fire Rating of Structural Elements	IIIA		IIIB	
For occupancy groups A, B, E, F-2, I, R, S-2, U	Int. face of wall	Ext. face of wall	Int. face of wall	Ext. face of wall
FSD ≥ 30 ft				
Exterior bearing walls (hrs)	2	0	2	0
Exterior Nonbearing walls (hrs)	0	0	0	0
10 ft < FSD < 30 ft				
Exterior bearing walls (hrs)	2	0	2	0
Exterior Nonbearing walls (hrs)	1	0	0	0
FSD ≤ 10 ft				
Exterior bearing walls (hrs)	2	2	2	2
Exterior Nonbearing walls (hrs)	1	1	1	1

**How do we specify an asymmetric
assembly?**

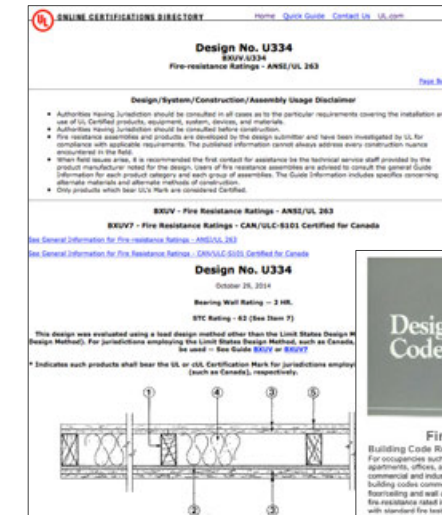
Choosing Fire Rated Assemblies

Common tested assemblies (ASTM E119) per IBC 703.2:

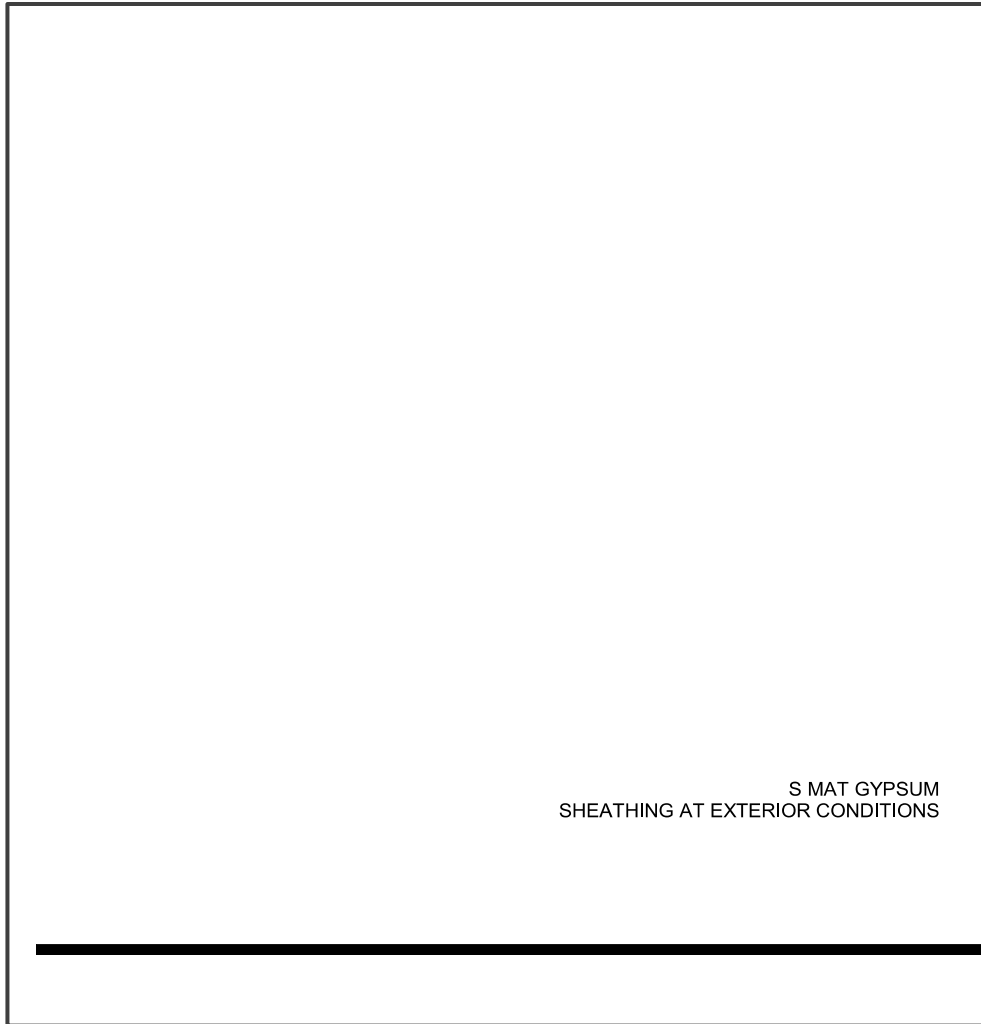
- » UL Listings
- » Gypsum Catalog
- » Proprietary Manufacturer Tests
- » Industry Documents: such as AWC's DCA3/DCA4

Alternate Methods per IBC 703.3

- » Prescriptive designs per IBC 721.1
- » Calculated Fire Resistance per IBC 722
- » Fire-resistance designs documented in sources
- » Engineering analysis based on a comparison
- » Fire-resistance designs certified by an approved agency



Exterior Walls – Asymmetry



Common issues with tested assemblies:

- Assembly asymmetry: separate assemblies for each side

Exterior Walls – 1-hr Int; 0-hr Ext

IBC Table 721.1(2)

16. Exterior walls rated for fire resistance from the inside only in accordance with Section 705.5.	16-1.1 ^a	2" × 4" wood studs at 16" centers with double top plates, single bottom plate; interior side covered with 5/8" Type X gypsum wallboard, 4" wide, applied horizontally unblocked, and fastened with 2 1/4" Type S drywall screws, spaced 12" on center, wallboard joints covered with paper tape and joint compound, fastener heads covered with joint compound. Exterior covered with 3/8" wood structural panels, applied vertically, horizontal joints blocked and fastened with 6d common nails (bright) — 12" on center in the field, and 6" on center panel edges. Cavity to be filled with 3 1/2" mineral wool insulation. Rating established for exposure from interior side only.	—	—	—	4 1/2
	16-1.2 ^a	2" × 6" wood studs at 16" centers with double top plates, single bottom plate; interior side covered with 5/8" Type X gypsum wallboard, 4" wide, applied horizontally or vertically with vertical joints over studs and fastened with 2 1/4" Type S drywall screws, spaced 12" on center, wallboard joints covered with paper tape and joint compound, fastener heads covered with joint compound, exterior side covered with 7/16" wood structural panels fastened with 6d common nails (bright) spaced 12" on center in the field and 6" on center along the panel edges. Cavity to be filled with 5 1/2" mineral wool insulation. Rating established from the gypsum-covered side only.	—	—	—	6 9/16
	16-1.3 ^a	2" × 6" wood studs at 16" centers with double top plates, single bottom plates; interior side covered with 5/8" Type X gypsum wallboard, 4" wide, applied vertically with all joints over framing or blocking and fastened with 2 1/4" Type S drywall screws spaced 7" on center. Joints to be covered with tape and joint compound. Exterior covered with 3/8" wood structural panels, applied vertically with edges over framing or blocking and fastened with 6d common nails (bright) at 12" on center in the field and 6" on center on panel edges. R-19 mineral fiber insulation installed in stud cavity. Rating established from the gypsum-covered side only.	—	—	—	6 1/2

Exterior Walls – 1-hr Int; 0-hr Ext

Design No. U348

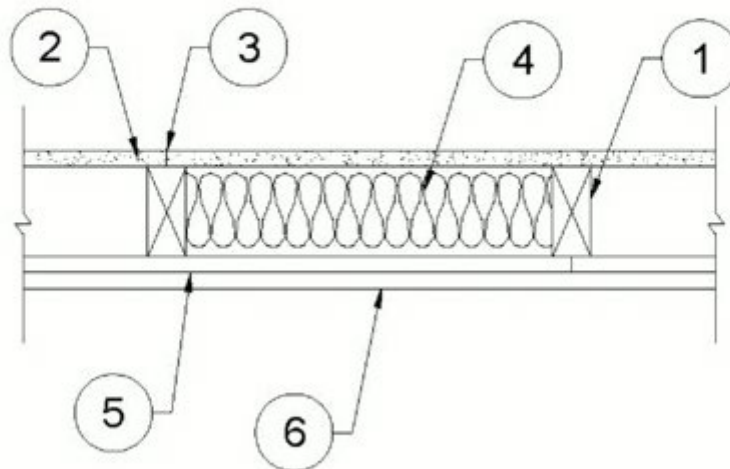
April 01, 2013

Bearing Wall Rating — 1 Hr

(EXPOSED TO FIRE ON INTERIOR FACE ONLY)

Finish Rating — 23 min

1-HOUR
(FIRE FROM INTERIOR ONLY)



Exterior Walls – 2-hr Int; 0-hr Ext

Design No. U349

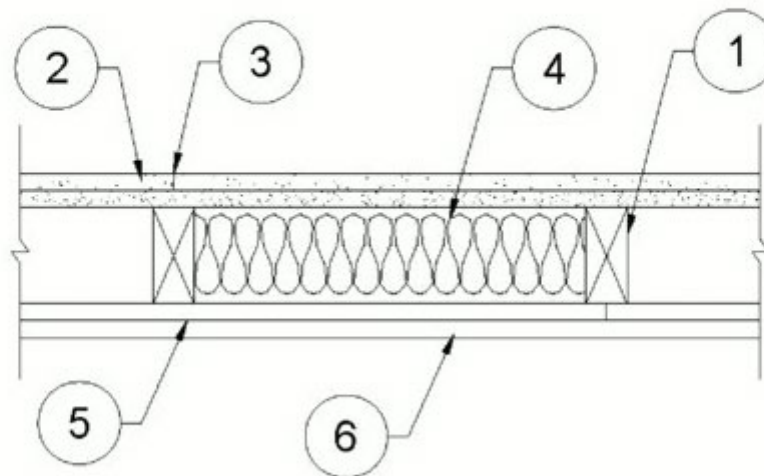
August 21, 2013

Bearing Wall Rating — 2 Hr


(EXPOSED TO FIRE ON INTERIOR FACE ONLY)

For Wood Studs, Finish Rating — 55 min

2-HOUR
(FIRE FROM INTERIOR ONLY)



Exterior Walls – Using FRT Studs

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BXUV.GuideInfo
Fire Resistance Ratings - ANSI/UL 263

[View Listings](#) [Page Bottom](#)

[Guide Information for Fire](#)

The Design Information S

- I. INTRODUCTION
- II. GENERAL
- III. FLOOR-CEILING
- IV. BEAMS
- V. COLUMNS**
- VI. WALLS AND PARTITIONS

“Wood stud walls may contain fire-retardant-treated studs as well as untreated wood studs. The use of fire-retardant-treated plywood (wood structural panels) may be used in Designs that contain use of untreated plywood when all other specified attributes are equivalent to the wood structural panel used in the Design.”

Exterior Walls – Addition of Wood Structural Panel

Can include WSP in assemblies which were tested without them:

- » ESR 2586
- » AWC's DCA4
- » Gypsum Association Manual

ESR 2586:

4.7 Fire-resistive Construction:

Structural-use panels may be installed between the fire protection and the wood studs on either the interior or exterior side of fire-resistance-rated wood frame wall and partition assemblies described in the applicable code, provided the length of fasteners is adjusted for the added thickness of the panel.

GA Fire Resistance Design Manual
Item 23, Section 1 of the General
Explanatory Notes:

“When not specified as a component of a fire- resistance rated wall or partition system, wood structural panels shall be permitted to be added to one or both sides.”



Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Resistance

Part 1: Outline

- » Context for Type III Construction
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- » Fire Rating Requirements for Exterior Walls
- Exterior Wall to Floor Intersections



Landing Apartments, Russell Scott Steedle & Capione Architects, photo Gregory Folkins

Intersection of Assemblies – Ratings

Key Differences in Fire Ratings for Construction Types			
	IIIA	IIIB	VA
Exterior bearing wall fire rating	2 hr	2 hr	1 hr
Floor assembly fire rating	1 hr	0 hr	1 hr

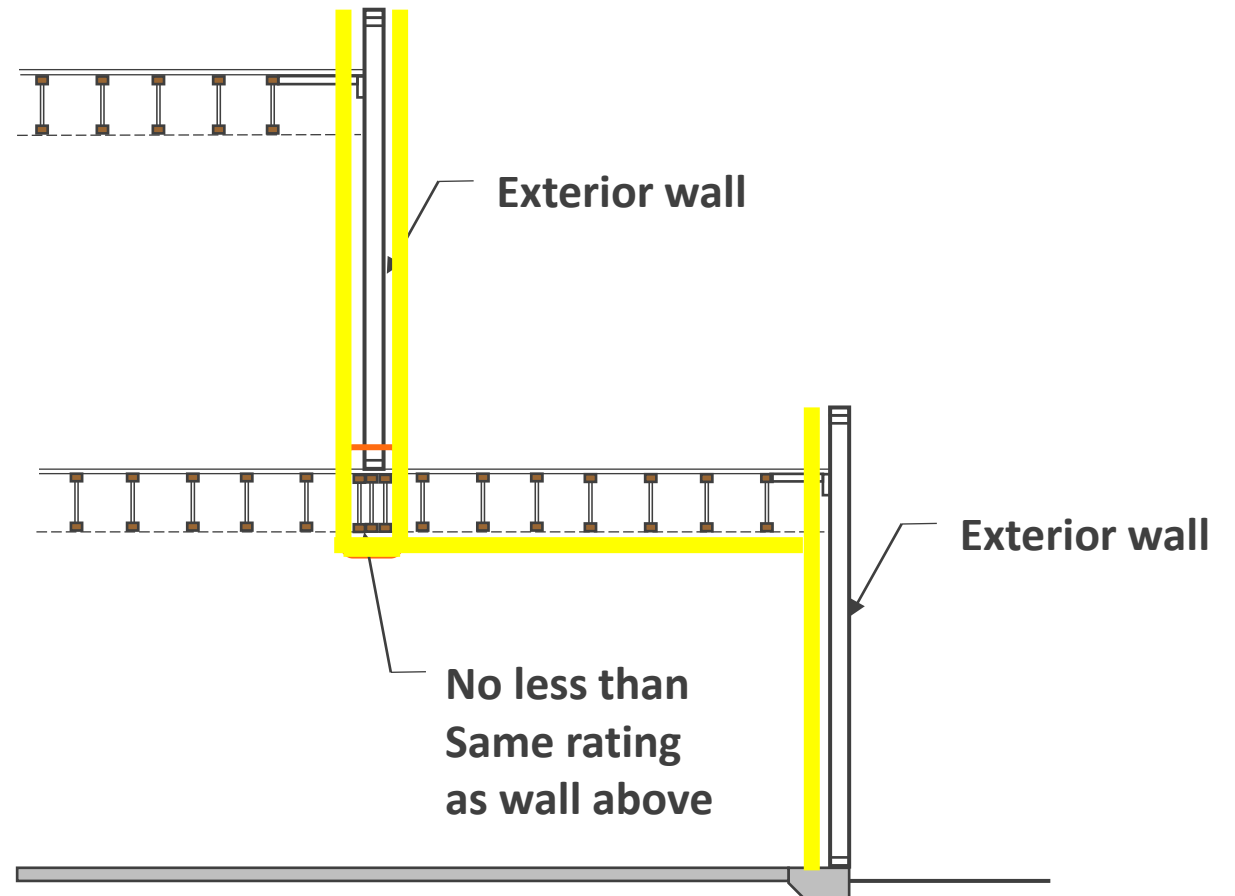
IBC Table 601

Note:  = Fire Retardant Treated (FRT)

Exterior Walls – Vertical Offsets

There is no requirement for an exterior wall to extend to the foundation in a stepped building.

Structural members, that support a rated wall must be fire-resistance rated not less than the rating of the supported wall (IBC 704.1)



IBC 2018 - Exterior Walls: Structural Stability

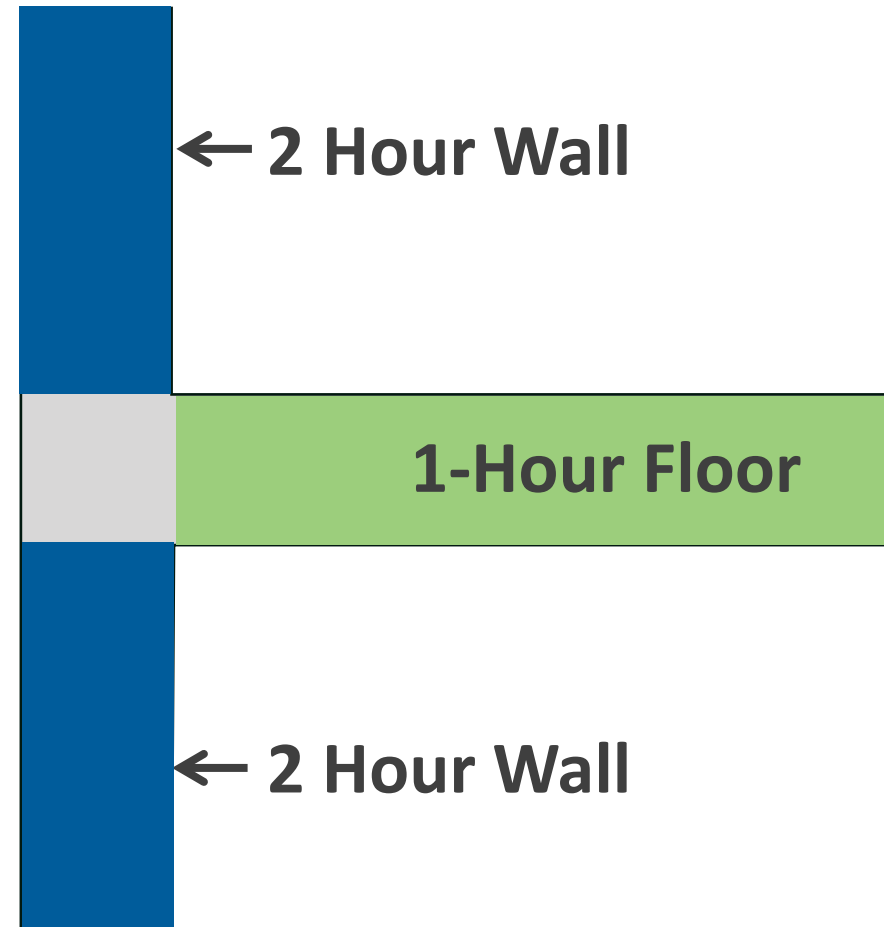
IBC 705.6 Structural Stability: (Relocated to 705.7 in 2024 IBC)

Exterior walls shall extend to the height required by 705.11. Interior structural elements that brace the exterior wall but that are not located within the plane of the exterior wall shall have the minimum fire resistance rating required in Table 601 for that structural element.

Structural elements that brace the exterior wall but are located outside of the exterior wall or within the plane of the exterior wall shall have the minimum fire resistance rating required in Tables 601 or 602 for the exterior wall.

Intersection of Tested Assemblies

- » Many options are available for fire resistance tested floor assemblies and wall assemblies
- » No tested intersection details exist



IBC 2024 Changes: Floor to Wall Intersections

705.7.1 Floor assemblies in Type III construction.

In Type III construction where a floor assembly supports gravity loads from an *exterior wall*, the *fire-resistance rating* of the portion of the floor assembly that supports the *exterior wall* shall be not less than the *fire-resistance rating* required for the *exterior wall* in Table 601. The *fire-resistance rating* provided by the portion of the floor assembly supporting and within the plane of the *exterior wall* shall be permitted to include the contribution of the ceiling membrane when considering exposure to fire from the inside. Where a floor assembly supports gravity loads from an *exterior wall*, the *building elements* of the floor construction within the plane of the *exterior wall*, including but not limited to rim joists, rim boards and blocking, shall be in accordance with the requirements for interior *building elements* of Type III construction.

IBC 2024 Changes: Floor to Wall Intersections

705.7.1 Floor assemblies in Type III construction.

In Type III construction where a floor assembly supports gravity loads from an *exterior wall*, the *fire-resistance rating* of the portion of the floor assembly that supports the *exterior wall* shall be not less than the *fire-resistance rating* required for the *exterior wall* in Table 601. The *fire-resistance rating* provided by the portion of the floor assembly supporting and within the plane of the *exterior wall* shall be permitted to include the contribution of the ceiling membrane when considering exposure to fire from the inside. Where a floor assembly supports gravity loads from an *exterior wall*, the *building elements* of the floor construction within the plane of the *exterior wall*, including but not limited to rim joists, rim boards and blocking, shall be in accordance with the requirements for interior *building elements* of Type III construction.

**Interior building elements (floor construction)
in Type III are not required to be FRTW**

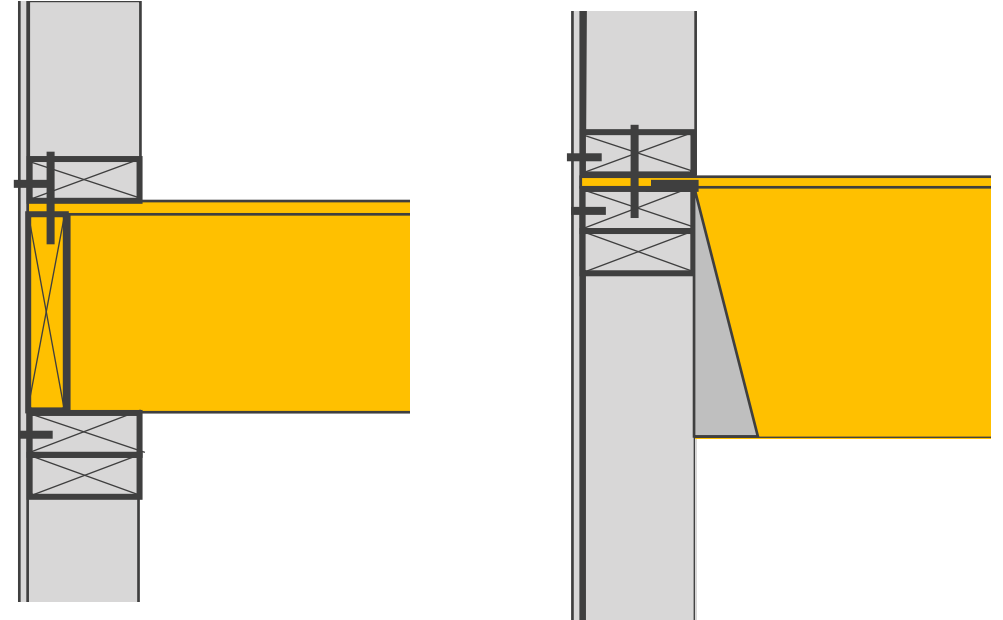
Type III Exterior Walls – FRT

Type III and IV Construction - IBC Section 602.3:

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

What does this FRTW requirement include?

- » Wall Framing (Studs & Plates) – **Yes**
- » Wall Sheathing – **Yes**
- » Floor sheathing – **No**
- » Rim Joist – **No**
- » Floor Joists – **No**



Exterior Walls – Intersecting Floors

AWC's DCA3 provides floor to wall intersection detailing options

Addresses both continuity provisions and requirements for FRT elements in exterior wall plane



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.

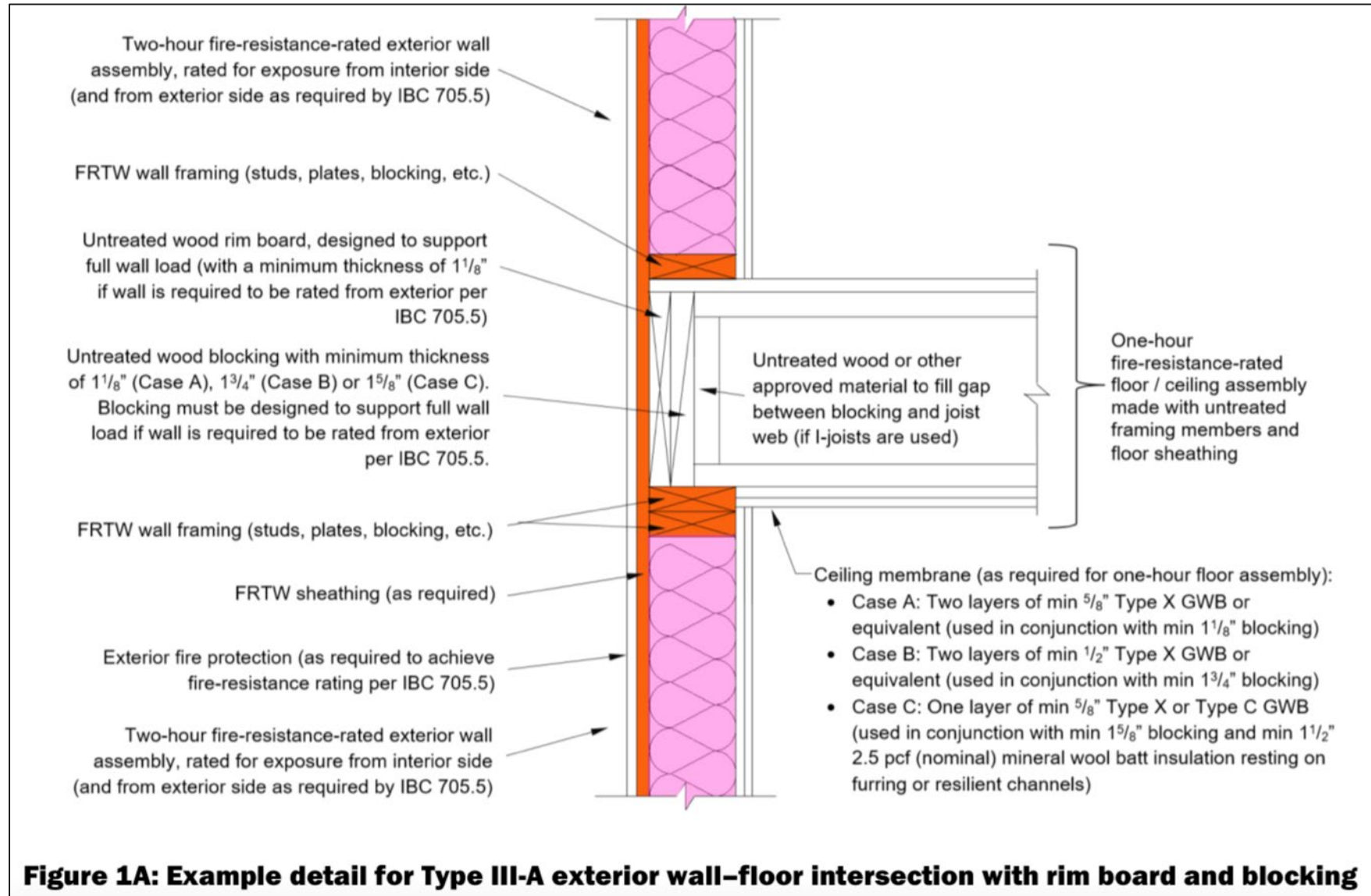
Depending on the application, wall assemblies may need to be fire-resistance-rated for exposure from either one side or both sides. Exterior walls are required to be rated for both interior and exterior fire exposure where the wall has a fire separation distance of 10 feet or less. For exterior walls with a fire separation distance of greater than 10 feet, the required fire-resistance-rating applies only to exposure from the interior. The designer should note that some state and local building code amendments may require fire resistance rating for exposure from both sides of exterior walls, regardless of fire separation distance; however, the solutions and example details provided in this doc-

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-rated wall assemblies. Lumber shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with the *American Softwood Lumber Standard (PS 20)*. The fire-resistance-rated assemblies described in this document, as well as those listed in other sources are not species- or grade-specific unless specifically noted as such.

Descriptions of successfully tested I-joist floor as-

Exterior Walls – Intersecting Floors (AWC's DCA3)



Exterior Walls – Intersecting Floors

Methodology:

Fire-resistance for exposure from interior side:

- Case A: Minimum $1\frac{1}{8}$ -inch-thick inner rim board plus two layers of minimum $\frac{5}{8}$ 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 $\frac{5}{8}$ in. Type X GWB (per IBC Table 722.6.2(1)).
- Case B: Minimum $1\frac{3}{4}$ -inch-thick inner rim board plus two layers of minimum $\frac{1}{2}$ 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 $\frac{1}{2}$ in. Type X GWB (per IBC Table 722.6.2(1)).
- Case C: Minimum $1\frac{5}{8}$ -inch-thick inner rim board plus one layer of minimum $\frac{5}{8}$ in. Type X GWB in the ceiling membrane plus minimum $1\frac{1}{2}$ -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 $\frac{5}{8}$ 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 $1\frac{1}{8}$ -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.

IBC 2024 Changes: Floor to Wall Intersections

705.6 Continuity.

The *fire-resistance rating* of exterior walls shall extend from the top of the foundation or floor/ceiling assembly below to one of the following:

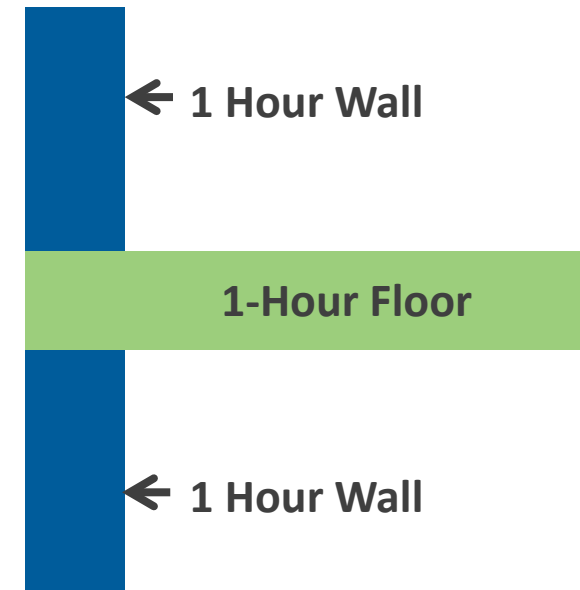
1. The underside of the floor sheathing, roof sheathing, deck or slab above.
2. The underside of a floor/ceiling or roof/ceiling assembly having a *fire-resistance rating* equal to or greater than the *exterior wall* and the *fire separation distance* is greater than 10 feet.

705.7 Structural stability. (Relocated)

Example 1:

Type VA Construction, Group R-2

1 hour exterior wall, 1 hour floor



IBC 2024 Changes: Floor to Wall Intersections

705.6 Continuity.

The *fire-resistance rating* of exterior walls shall extend from the top of the foundation or floor/ceiling assembly below to one of the following:

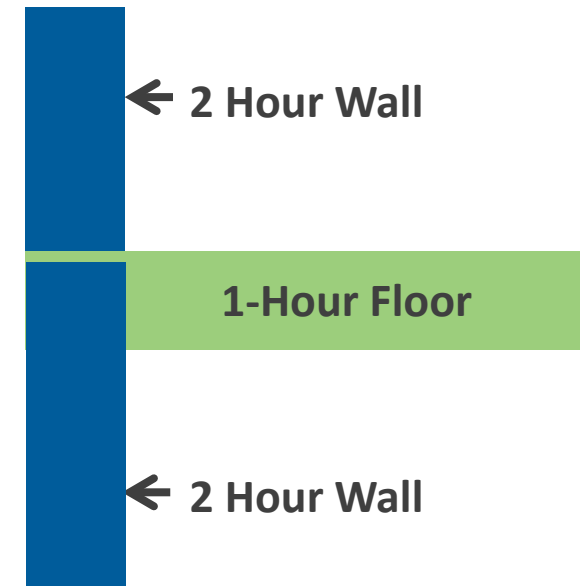
1. The underside of the floor sheathing, roof sheathing, deck or slab above.
2. The underside of a floor/ceiling or roof/ceiling assembly having a *fire-resistance rating* equal to or greater than the *exterior wall* and the *fire separation distance* is greater than 10 feet.

705.7 Structural stability. (Relocated)

Example 2:

Type IIIA Construction, Group R-2

2 hour exterior wall, 1 hour floor



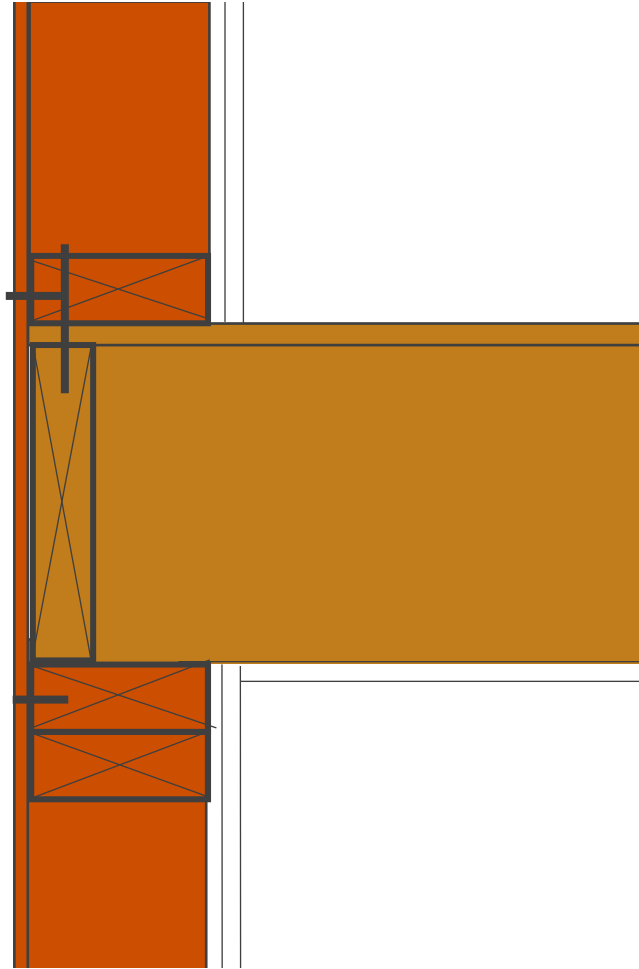
Exterior Walls – Intersecting Floors: **DISCLAIMER**

Please note that the following details are examples of what we have seen used on projects and do not necessarily represent details that will be accepted and applicable in all jurisdictions and to all projects.

These details are not intended as recommendations for universally accepted details. Local product availability and manufacturer specifications should also be considered for each project.

The Architect of Record and Engineer of Record should verify acceptance of the details used on their project with all provisions of the building code, including local amendments, with the local Authority Having Jurisdiction.

Platform Framing



Structural

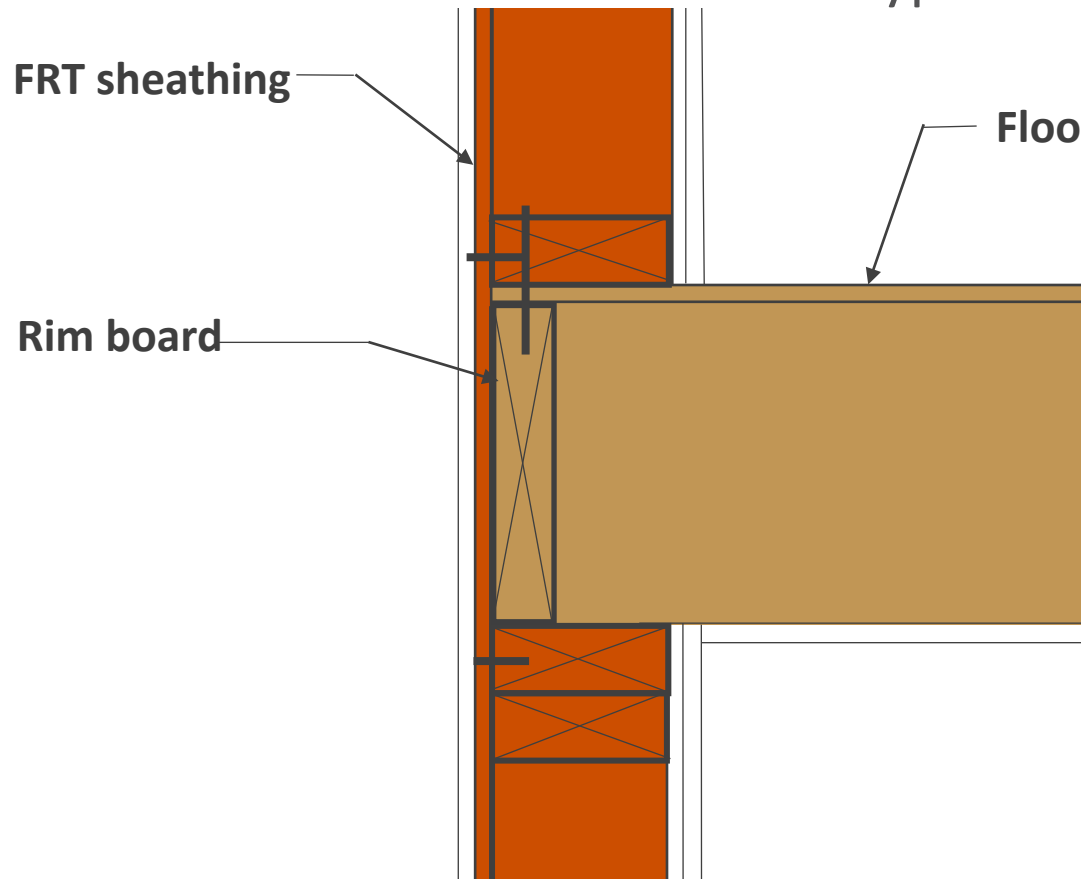
- » Direct bearing/no additional hardware
- » May require load transfer blocking for concentrated loads from above
- » Wall sill/sole plate and floor sheathing crushing may need to be considered

Constructability

- » Framing can be completed before drywall and insulation are installed
- » Common length studs

Exterior Walls – Intersecting Floors

Type III Construction: 2-hr Wall, 1-hr Floor
Typical Platform Framing



Floor Joist Options:

- Solid Sawn
- Trusses
- I-Joists

Legend



Untreated
or FRT



FRT Wood

Considerations:

» Shrinkage of rim, plates, joists

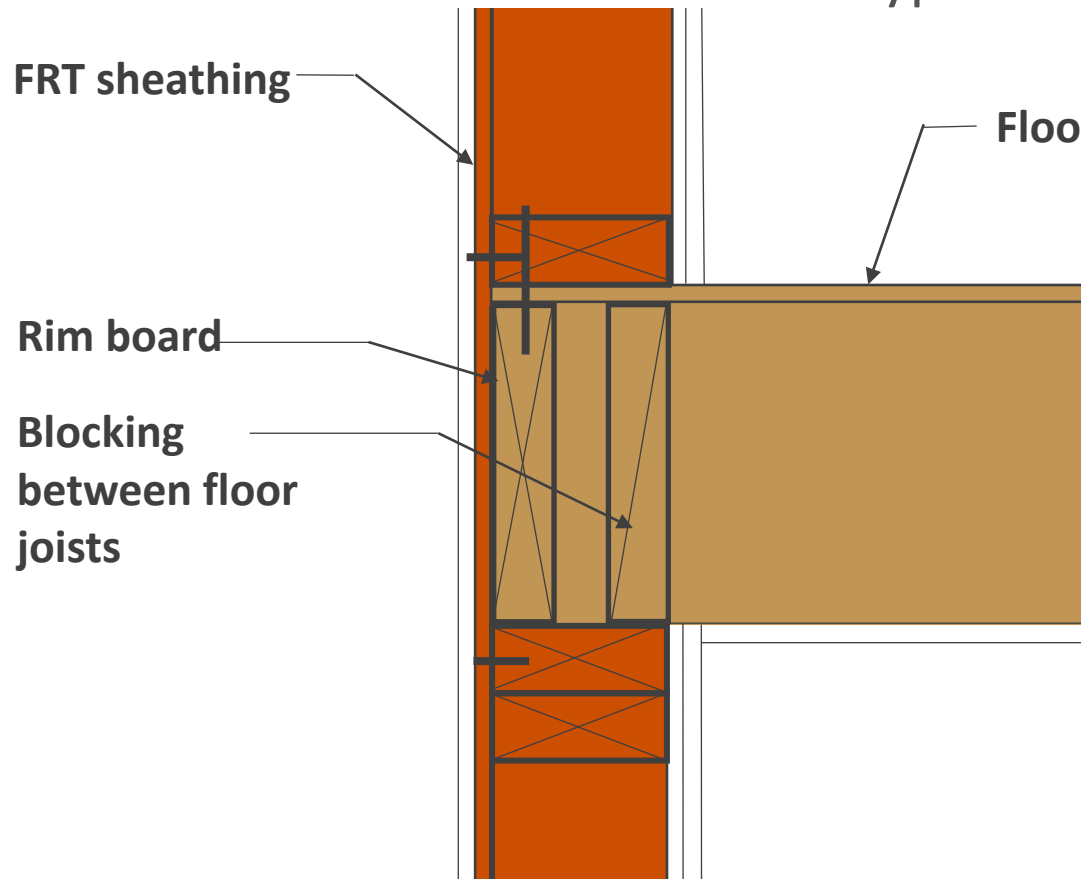
» Protection of rim for fire

Rationale for detail approval:

» Intersection of rated assemblies (wall & floor) considered sufficient

Exterior Walls – Intersecting Floors

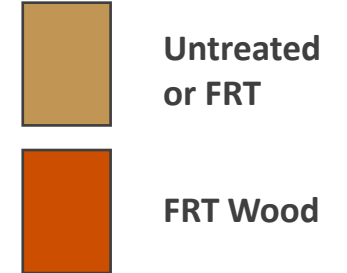
Type III Construction: 2-hr Wall, 1-hr Floor
Typical Platform Framing



Floor Joist Options:

- Solid Sawn
- Trusses
- I-Joists

Legend



Considerations:

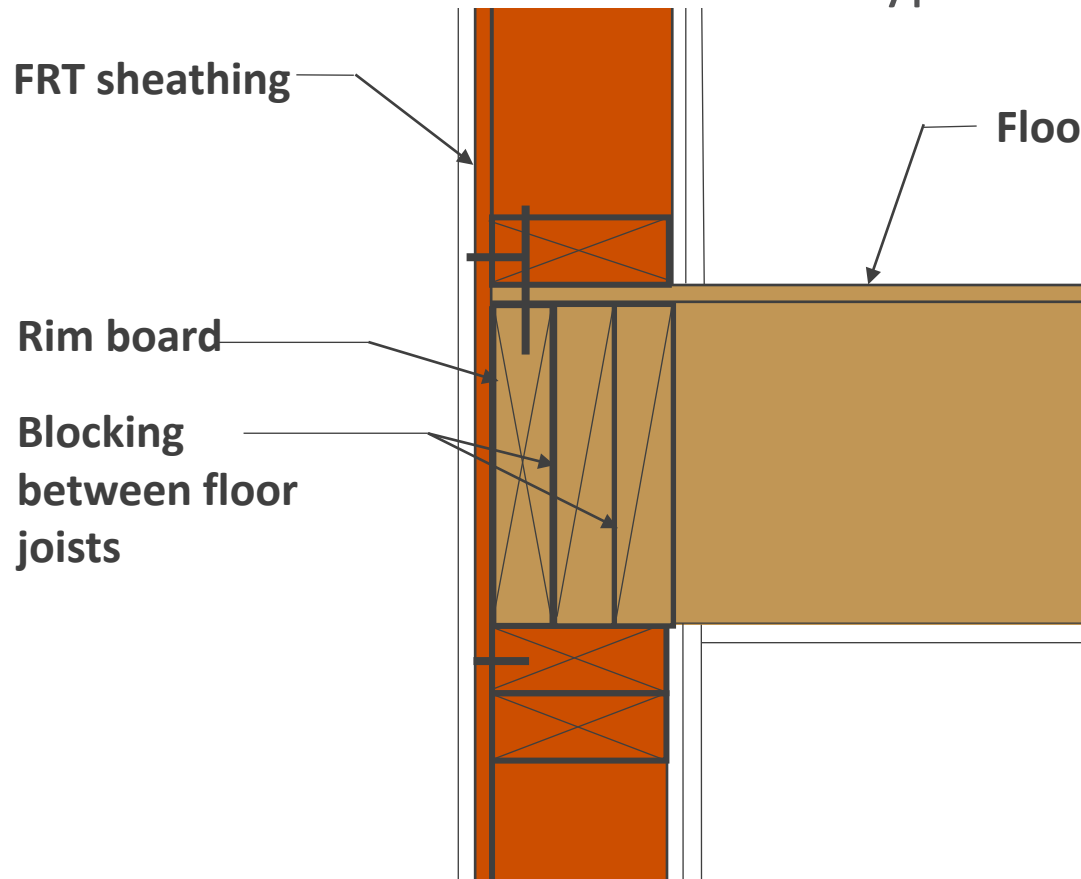
» Shrinkage of rim, plates, joists

Rationale for detail approval:

- » Membranes on both side of wall provide fire resistance via their approved assembly
- » At floor cavity, ceiling provides 1 hour
- » 1 layer of blocking provides 2nd hr through char calculations

Exterior Walls – Intersecting Floors

Type III Construction: 2-hr Wall, 1-hr Floor
Typical Platform Framing



Floor Joist Options:

- Solid Sawn
- Trusses
- I-Joists

Legend



Untreated
or FRT



FRT Wood

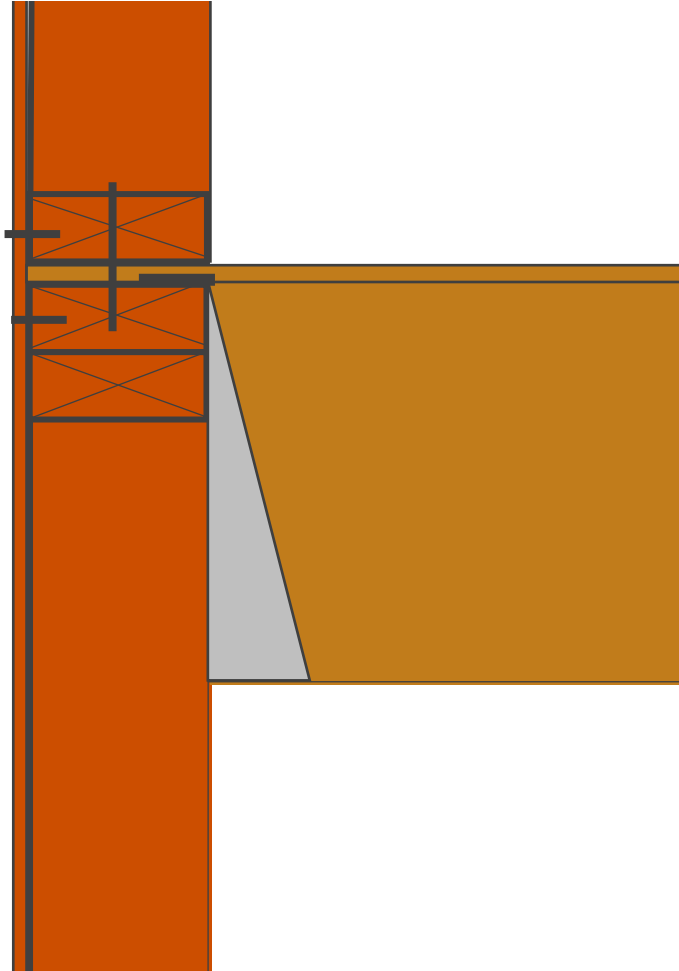
Considerations:

» Shrinkage of rim, plates, joists

Rationale for detail approval:

- » Membranes on both side of wall provide fire resistance via their approved assembly
- » At floor cavity, 2 layers of blocking provide 2-hr protection through char calculations

Semi-balloon Framing



Structural

- » Additional hardware/no direct bearing
- » No load transfer blocking required

Rated Assemblies

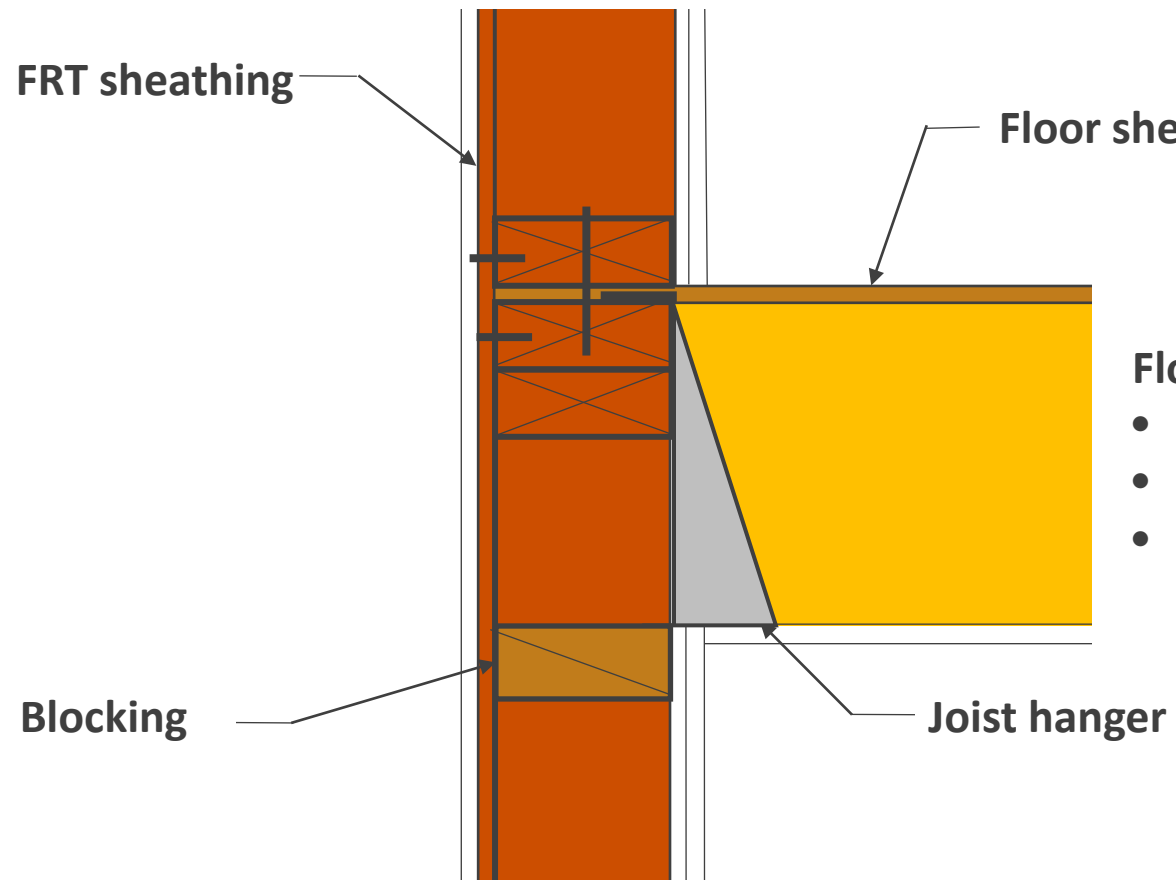
- » May accommodate continuity in exterior walls in type III construction

Constructability

- » Framing can be completed before drywall and insulation are installed
- » Custom length studs
- » Can help minimize building shrinkage

Exterior Walls – Intersecting Floors

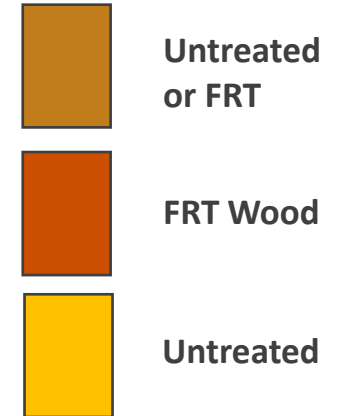
Type III Construction: 2-hr Wall, 1-hr Floor
Semi-Balloon Framing



Floor Joist Options:

- Solid Sawn
- Trusses
- I-Joists

Legend

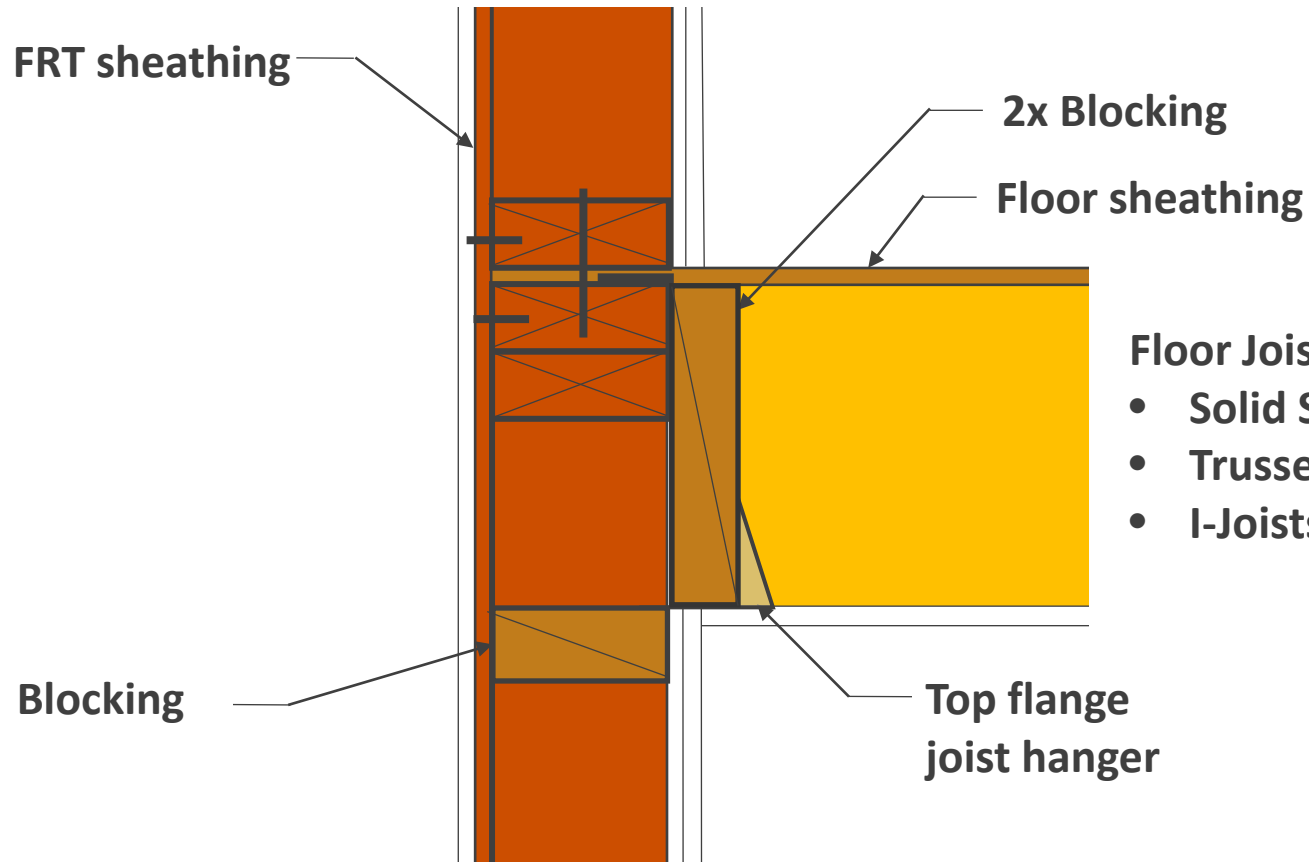


Rationale for detail approval:

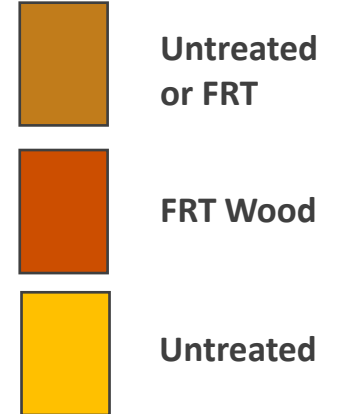
- » Intersection of rated assemblies (wall & floor) considered sufficient

Exterior Walls – Intersecting Floors

Type III Construction: 2-hr Wall, 1-hr Floor
Semi-Balloon Framing



Legend

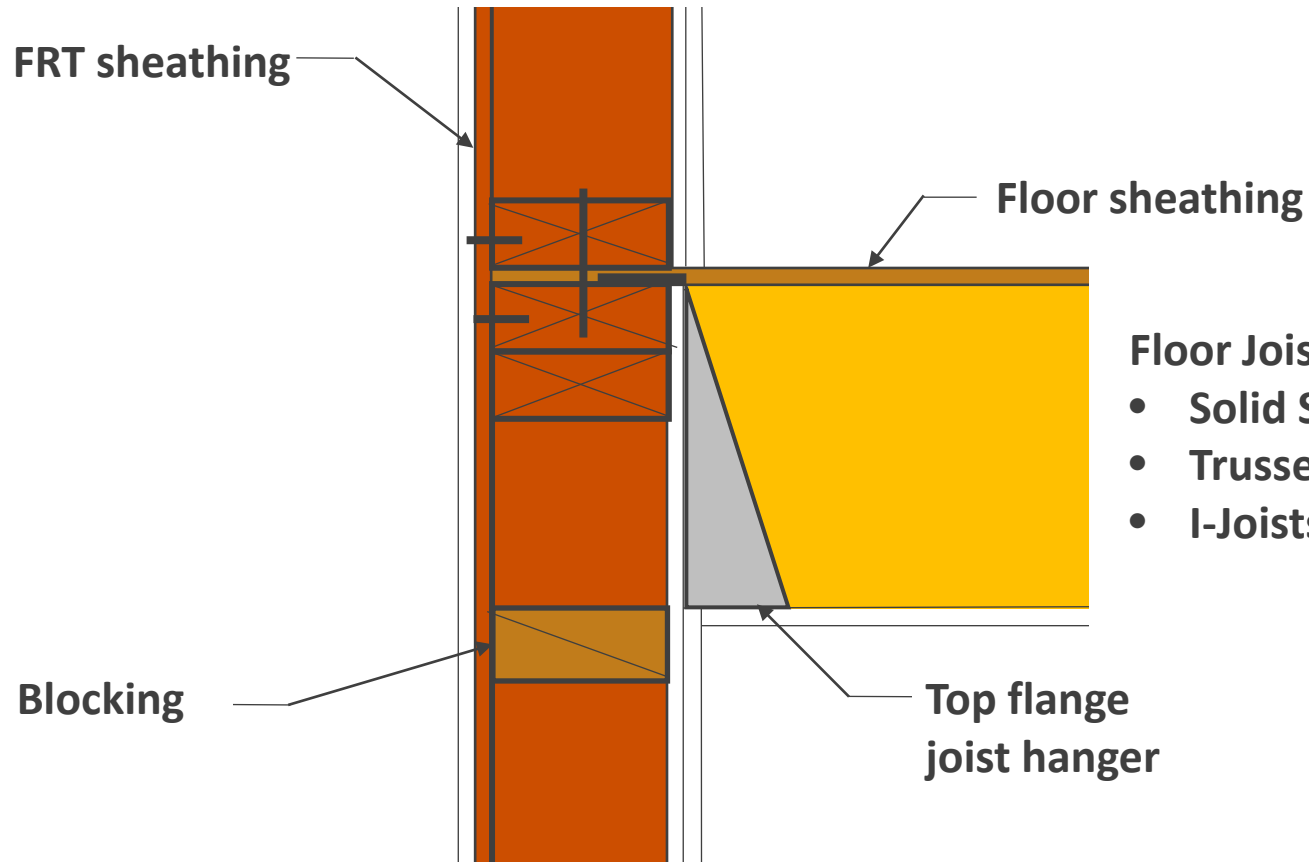


Rationale for detail approval:

- » Ceiling membrane provides 1-hr protection
- » Blocking between joists provides 2nd hr through char calculations

Exterior Walls – Intersecting Floors

Type III Construction: 2-hr Wall, 1-hr Floor
Semi-Balloon Framing



Floor Joist Options:

- Solid Sawn
- Trusses
- I-Joists

Legend

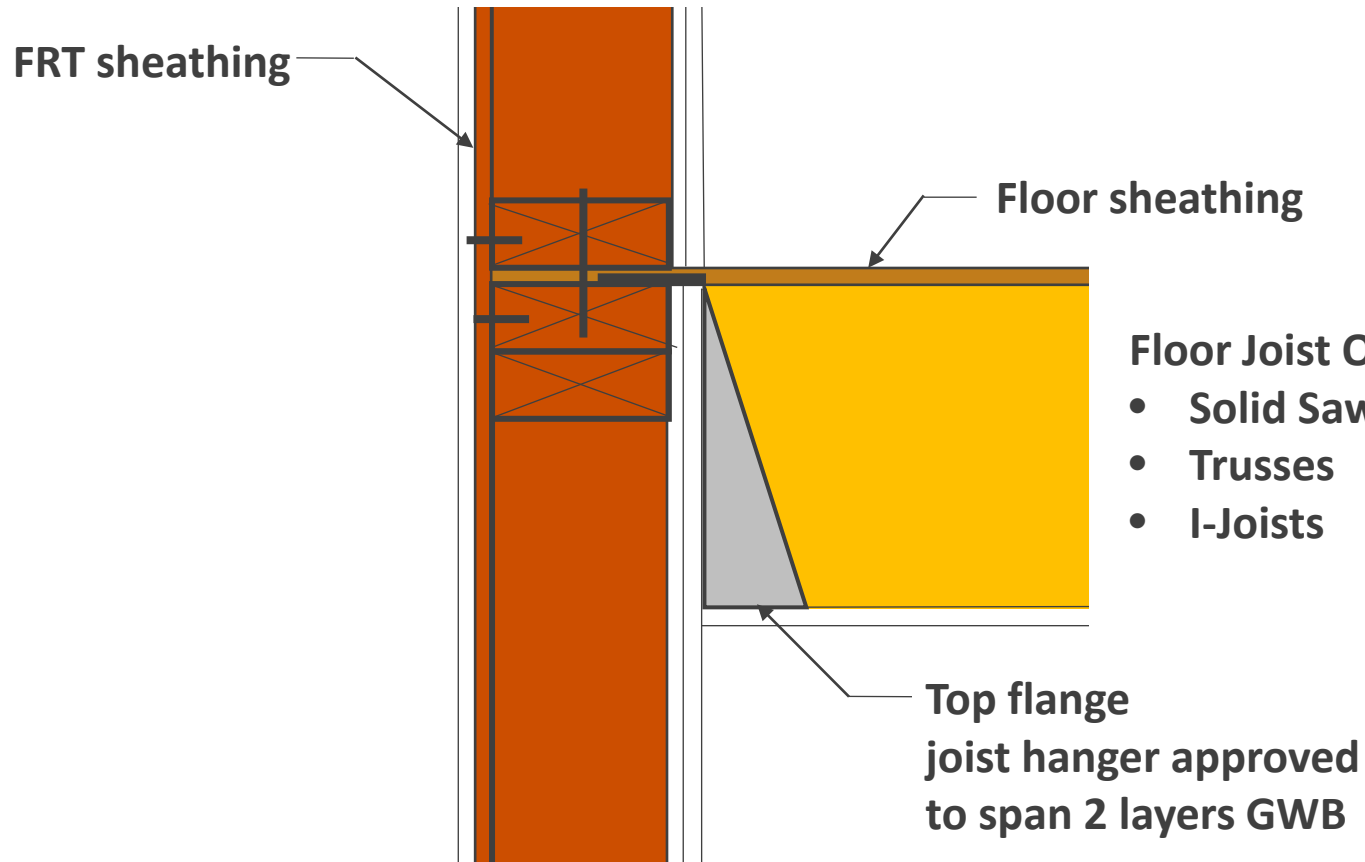


Rationale for detail approval:

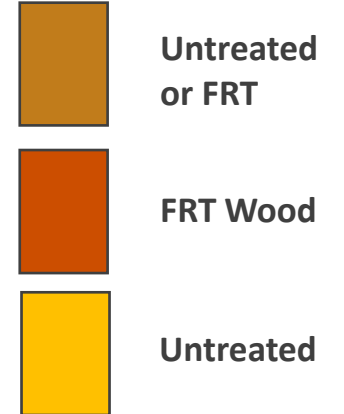
- » Ceiling membrane provides 1-hr protection
- » 1 layer of wall membrane provides 2nd hr

Exterior Walls – Intersecting Floors

Type III Construction: 2-hr Wall, 1-hr Floor
Semi-Balloon Framing



Legend

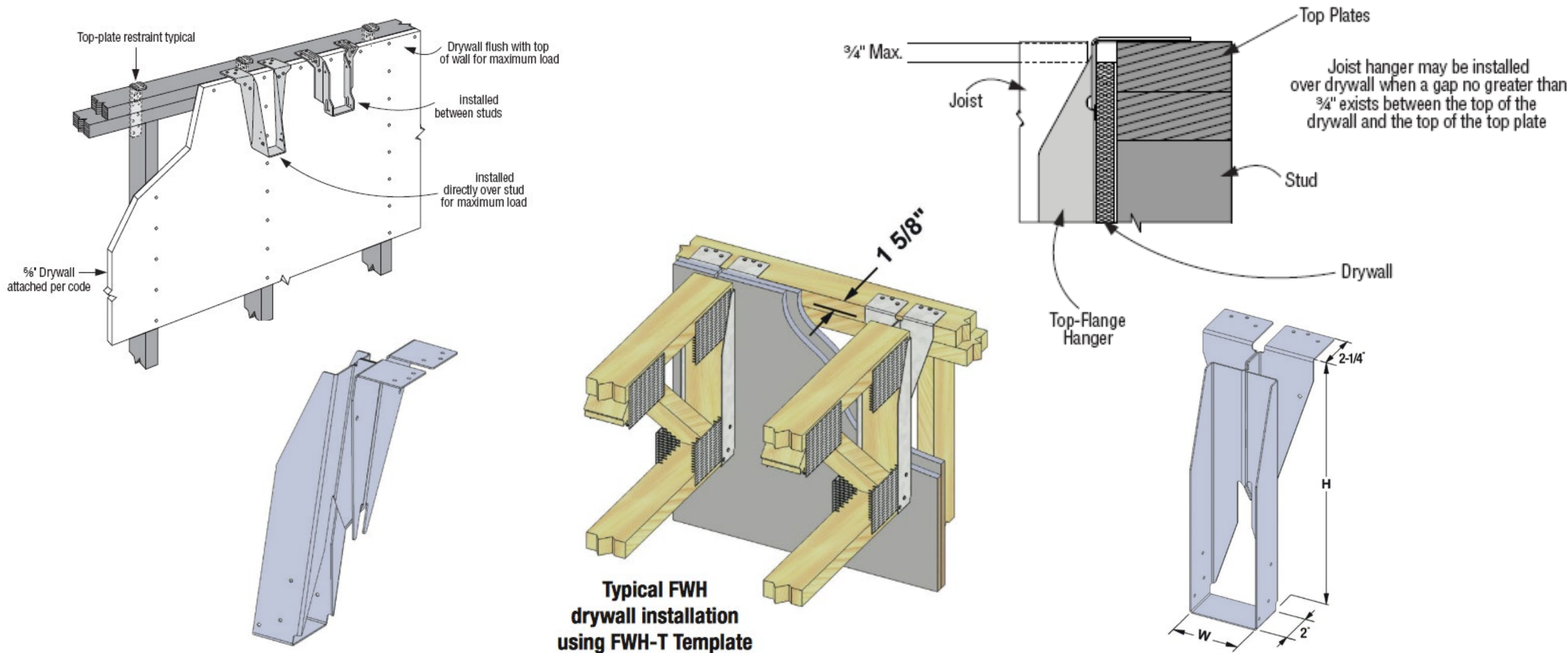


Rationale for detail approval:

- » Membranes on both side of wall provide fire resistance via their approved assembly

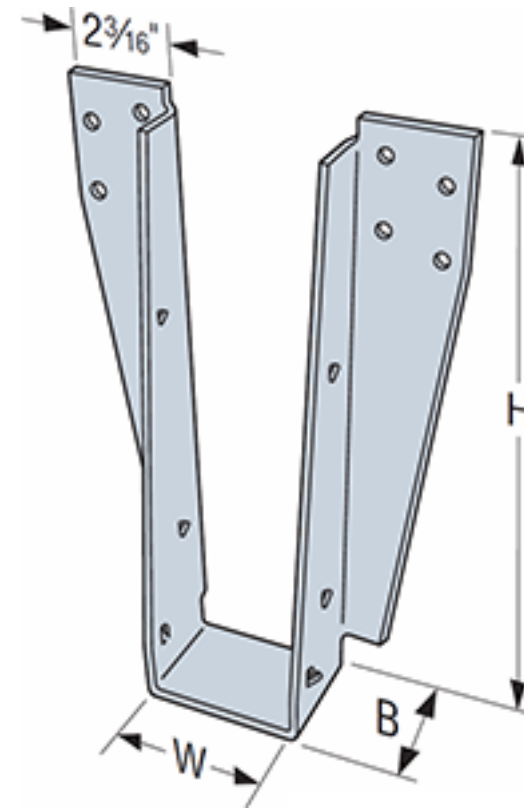
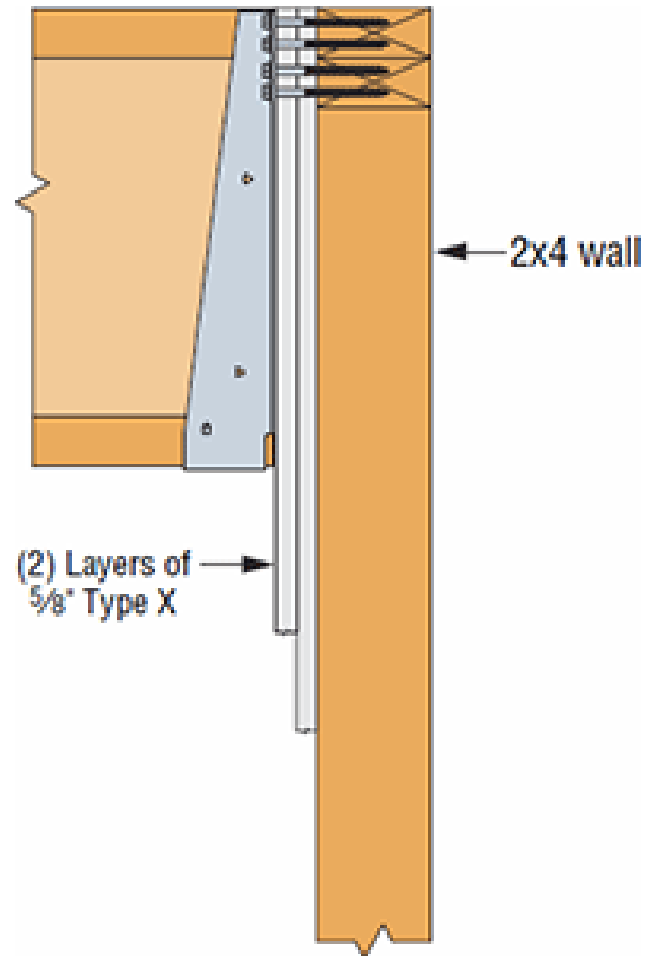
Over Gypsum Hangers

Commonly called Fire Wall or Drywall Hangers



Over Gypsum Hangers

Top Flange Hangers & Face Mount Hangers Available



Part 1: Outline

- » Context for Type III Construction
- » Definitions and Terminology
- » Fire Rating Requirements for Exterior Walls
- » Exterior Wall to Floor Intersections

➤ Parapets



Landing Apartments, Russell Scott Steedle & Capione Architects, photo Gregory Folkins

Parapets – IBC 705.11

Parapets shall be provided on exterior walls of buildings.

Exceptions:

1. The wall is not required to be fire rated per Table 602
2. Floor area is ≤ 1000 sf on each floor
3. Walls terminate at a roof that is rated for 2-hr or more – OR -

Where roof and supporting construction are non-combustible

4. 1-hr rated exterior walls that terminate at the underside of the roof sheathing where:
 - » Framing parallel to wall is not less than 1-hr rated for 4' for Group R/U and 10' for other occupancies
 - » Framing perpendicular to wall is 1-hr rated for entire span
 - » Openings are not located within 5' of the exterior wall for Group R/U and 10' for other occupancies.
 - » Entire building has class B roofing
5. Groups R-2 and R-3 where roofing is Class C, 1-hr rated exterior walls that terminate at the underside of the roof sheathing where:
 - » Sheathing is FRT for 4' OR
 - » 5/8" Type X gyp on underside of deck for 4'
6. Exterior wall is permitted to have >25% unprotected openings

Parapets – IBC 705.11.1

Parapets, where required, shall have:

- » The same fire resistance as the supporting wall
- » Minimum height of 30" above roof surface

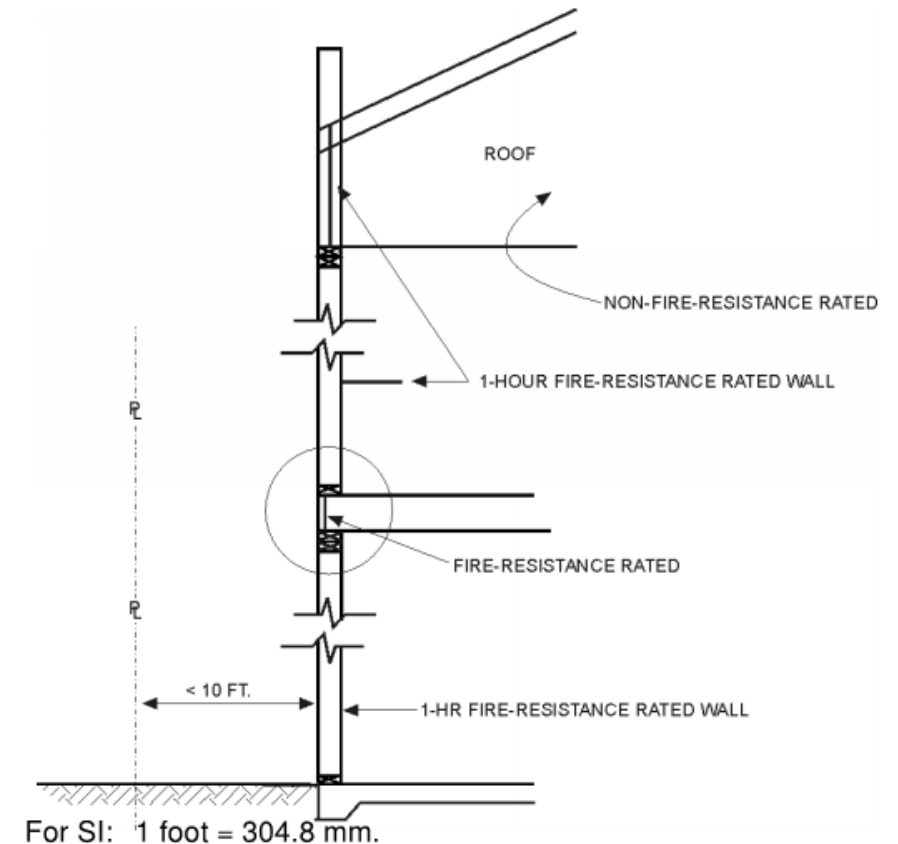


Figure 705.6
TYPE IIB AND VB EXTERIOR
FIRE-RESISTANCE-RATED WALL
CONTINUITY AND STRUCTURAL STABILITY

Code Commentary – 2018 IBC 705.11.1

Do the parapets need to be framed with FRTW?

❖ Parapet wall construction shall be of combustible or noncombustible material depending on the exterior wall requirements of the type of construction. The parapet shall be of fire-resistance-rated construction as required for the exterior wall. The interior surface of the parapet facing the roof, including the flashing, shall be noncombustible to a height of 18 inches above the roof. The required height of the parapet shall be 30 inches (762 mm) above the roof unless the roof slopes upward away from the building with a pitch of 2 in 12 or greater. In some cases, part of this section requires a higher parapet height depending on the FSD. When the slope of the roof is 2 in 12, the parapet shall extend to a height equal to the height of the roof at the point determined as follows:

“Parapet wall construction shall be of combustible or noncombustible material depending on the exterior wall requirements of the type of construction and shall be of fire-resistance-rated construction as required for the exterior wall.”

2024 IBC Changes - Parapets

705.12.1 Parapet construction.

Required parapets shall have the same *fire-resistance rating* as that required for the supporting wall, and on any side adjacent to a roof surface, shall have noncombustible faces for the uppermost 18 inches (457 mm), including counterflashing and coping materials. The height of the parapet shall be not less than 30 inches (762 mm) above the point where the roof surface and the wall intersect.

Where the roof slopes toward a parapet at a slope greater than 2 units vertical in 12 units horizontal (16.7-percent slope), the parapet shall extend to the same height as any portion of the roof within a *fire separation distance* where protection of wall openings is required, but the height shall be not less than 30 inches (762 mm).

705.6 Continuity.

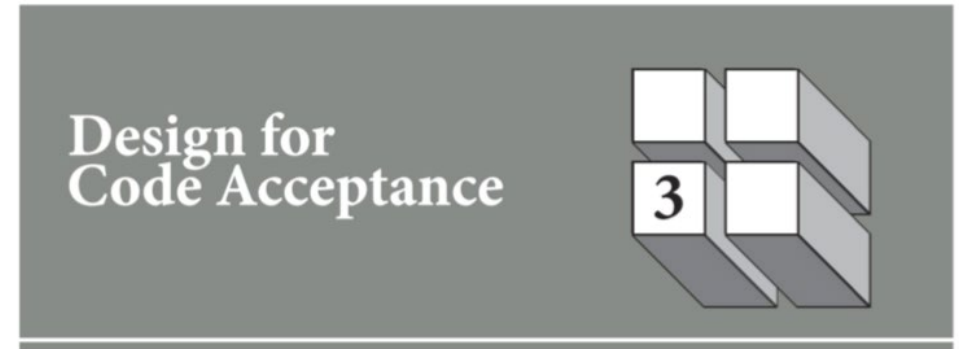
The *fire-resistance rating of exterior walls* shall extend from the top of the foundation or floor/ceiling assembly below to one of the following:

1. The underside of the floor sheathing, roof sheathing, deck or slab above.
2. The underside of a floor/ceiling or roof/ceiling assembly having a *fire-resistance rating* equal to or greater than the *exterior wall* and the *fire separation distance* is greater than 10 feet.

Exterior Wall – Roof Intersection

The floor-wall intersection principles discussed previously apply here too - DCA 3 details could be applied to this condition

Discussion with Building Official to determine their interpretation and requirements is often warranted



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 exposure where the wall has a fire separation distance of 10 feet or less. For exterior walls with a fire separation distance of greater than 10 feet, the required fire-resistance-rating applies only to exposure from the interior. The designer should note that some state and local building code amendments may require fire resistance rating for exposure from both sides of exterior walls, regardless of fire separation distance; however, the solutions and example details provided in this doc-

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-rated wall assemblies. Lumber shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with the *American Softwood Lumber Standard (PS 20)*. The fire-resistance-rated assemblies described in this document, as well as those listed in other sources are not species- or grade-specific unless specifically noted as such.

Descriptions of successfully tested I-joint floor as-



What is being enforced in jurisdictions you are working in?

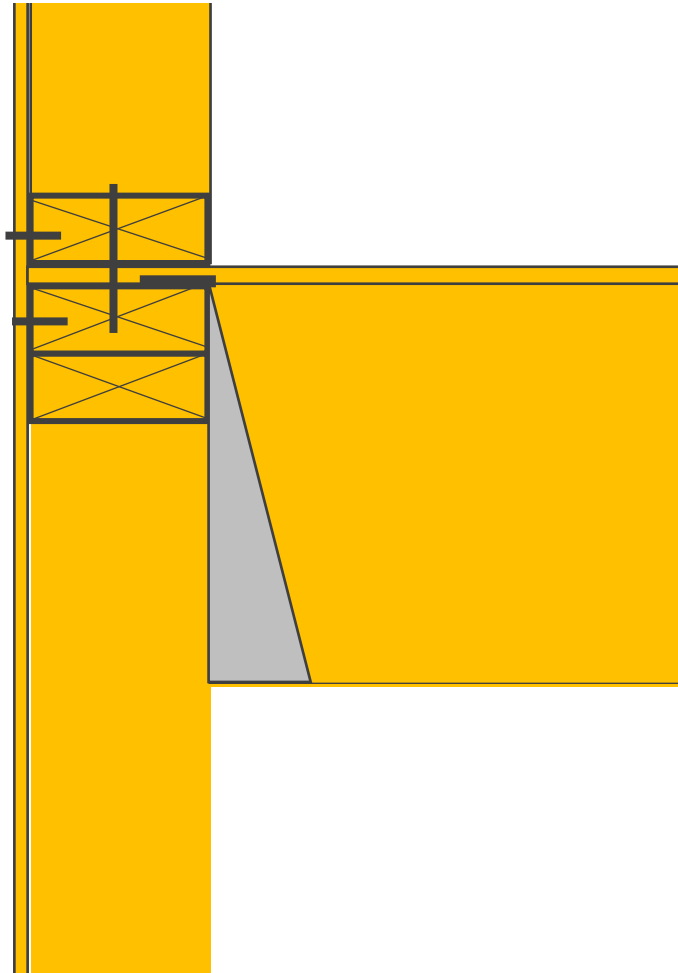
Part 2: Outline

- » Shaft Wall vs. Exterior Wall
- » Shaft Wall Fire Rating Requirements and Materials
- » Shaft wall to Floor Intersections
- » Penetrations
- » Stair, Elevator, & Mechanical Shaft Considerations

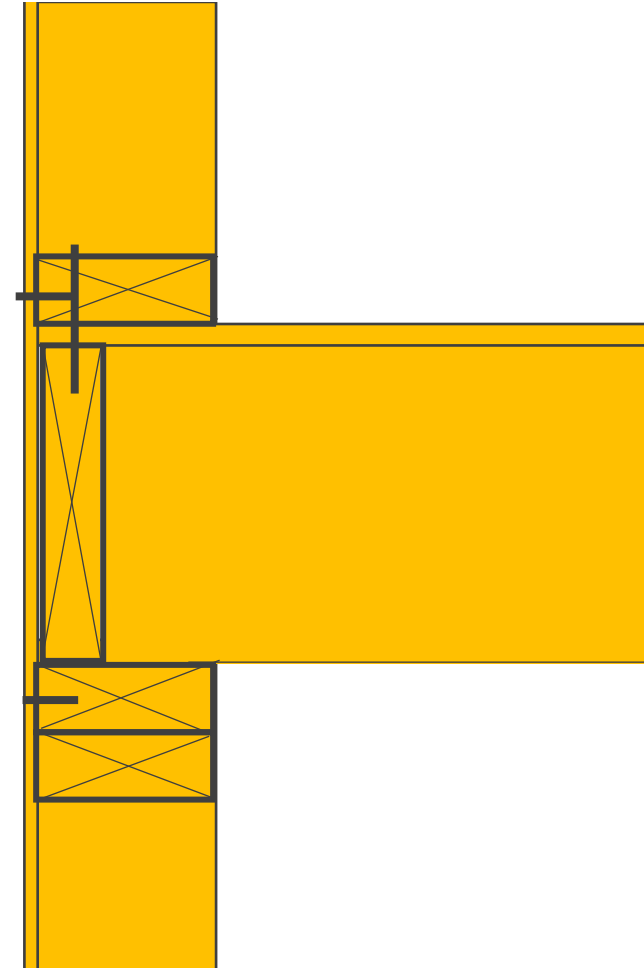


Photo: Avesta Housing

Floor to Shaft Wall Detailing



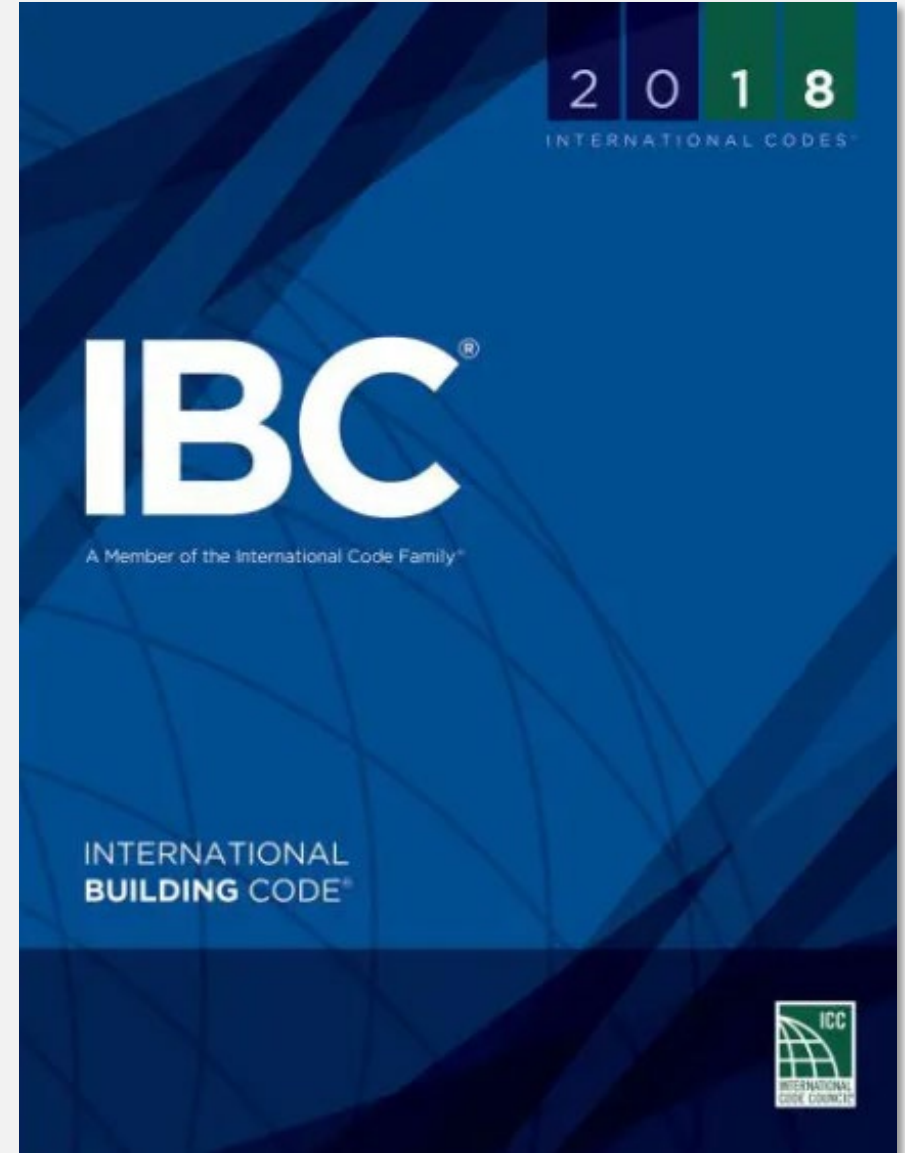
Semi-Balloon Framing



Platform Framing

Part 2: Outline

➤ Shaft Wall vs. Exterior Wall

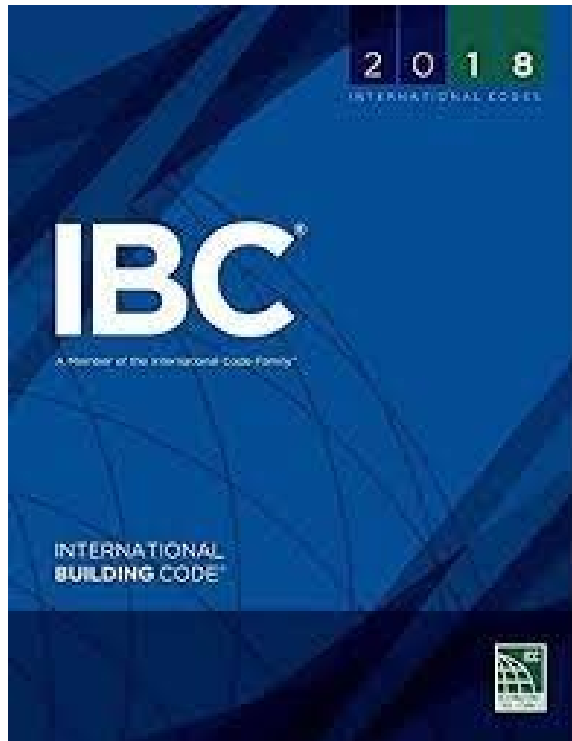


Types of Shaft Walls

1. Elevator
2. Stair
3. Mechanical

Some points of shaft wall construction and detailing apply to all types of shafts, while some are unique to each type of shaft.

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

Defining Shaft Wall Requirements

Code requirements for shaft enclosures contained in IBC Section 713:

SECTION 713 SHAFT ENCLOSURES

- » **IBC 713.1:** The provisions of this section shall apply to shafts required to protect opening and penetrations through floor ceilings and roof assemblies. Interior exit stair-ways and ramps shall be enclosed in accordance with Section 1023.
- » **IBC 713.2:** Shaft Walls shall be constructed as **Fire Barriers**

Fire Resistance-Rated Wall Assemblies

There are four basic types of fire-resistance rated wall assemblies:

1. Exterior Walls (IBC 705)
2. Fire Walls (IBC 706)
3. **Fire Barriers (IBC 707)**
4. Fire Partitions (IBC 708)

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

Section 713: Shaft Enclosures

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.

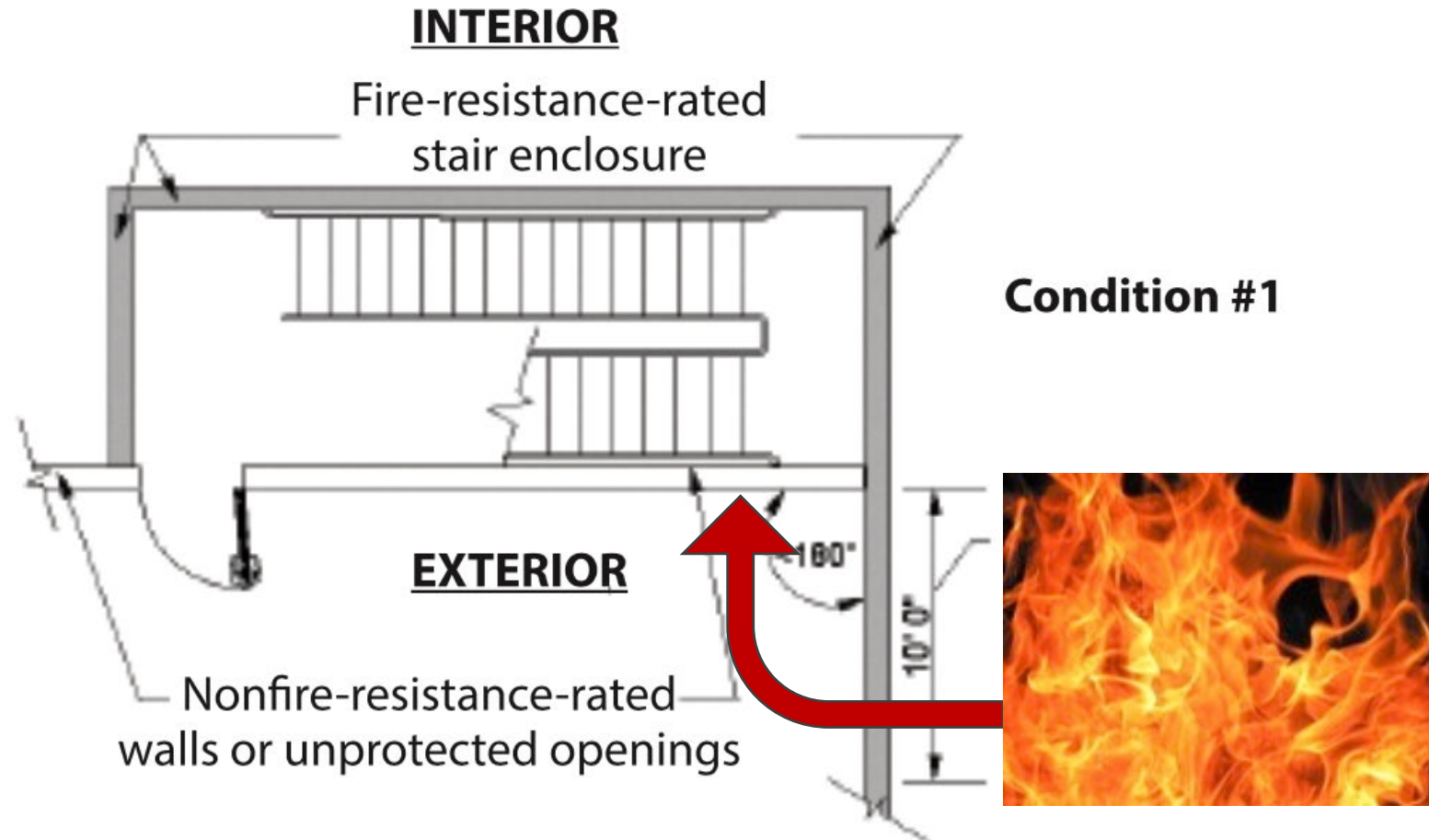
Exception: Exterior walls required to be fire-resistance rated in accordance with Section 1021.2 for exterior egress balconies, Section 1023.7 for interior exit stairways and ramps and Section 1027.6 for exterior exit stairways and ramps.

Shaft Walls that are also Exterior Walls

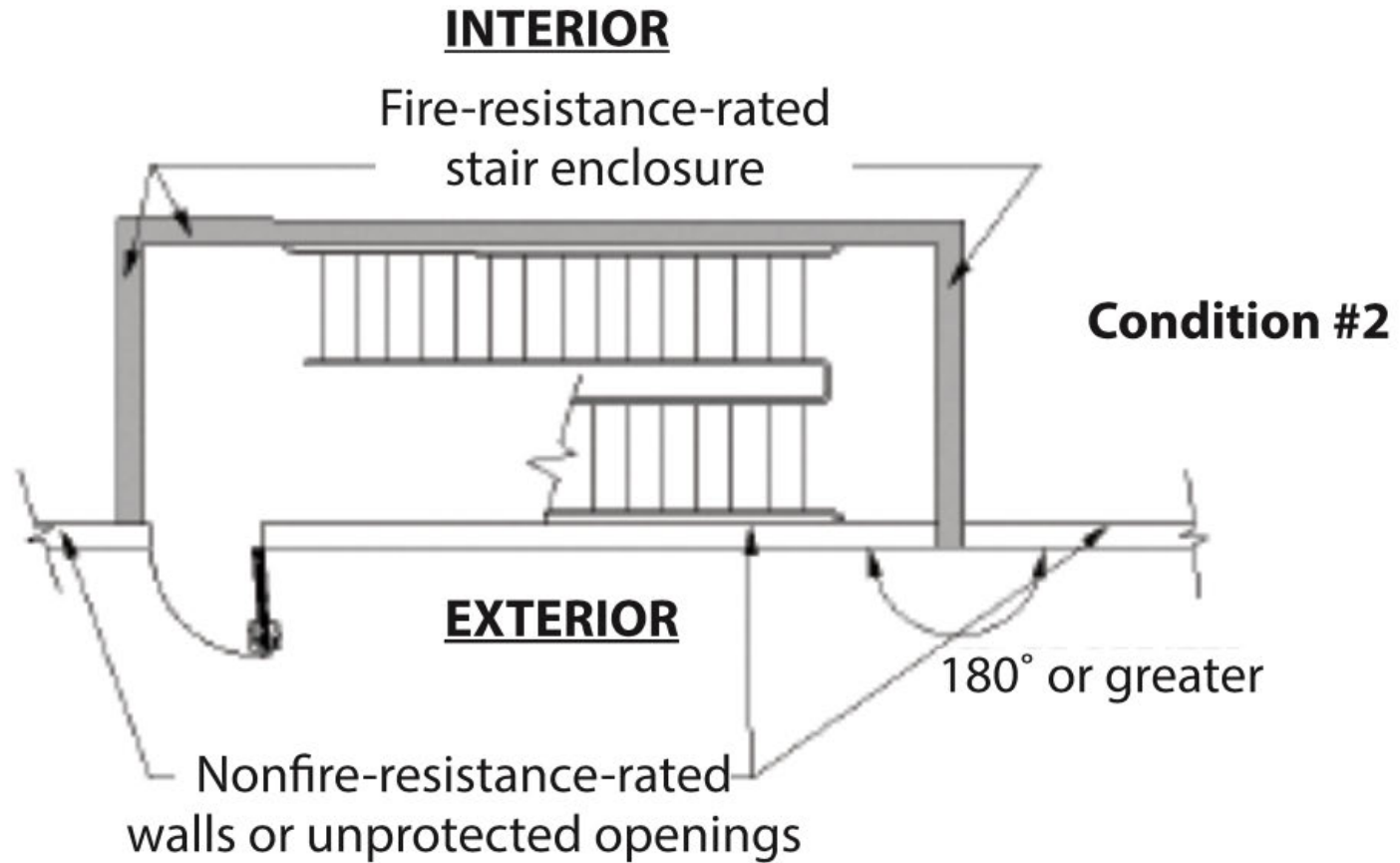
1023.7 Interior exit stairway and ramp exterior walls.

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.

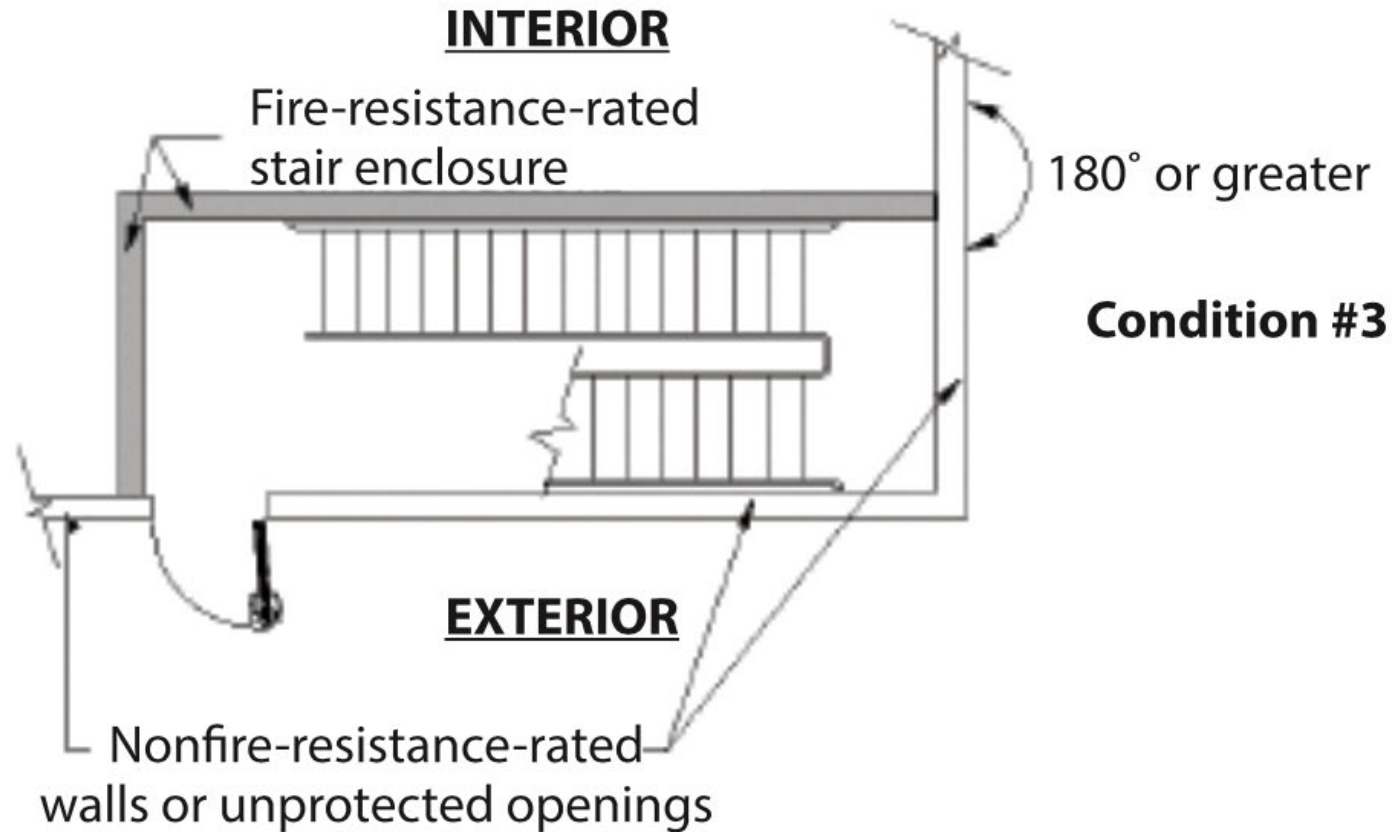
Shaft Walls that are also Exterior Walls – IBC 1023.7



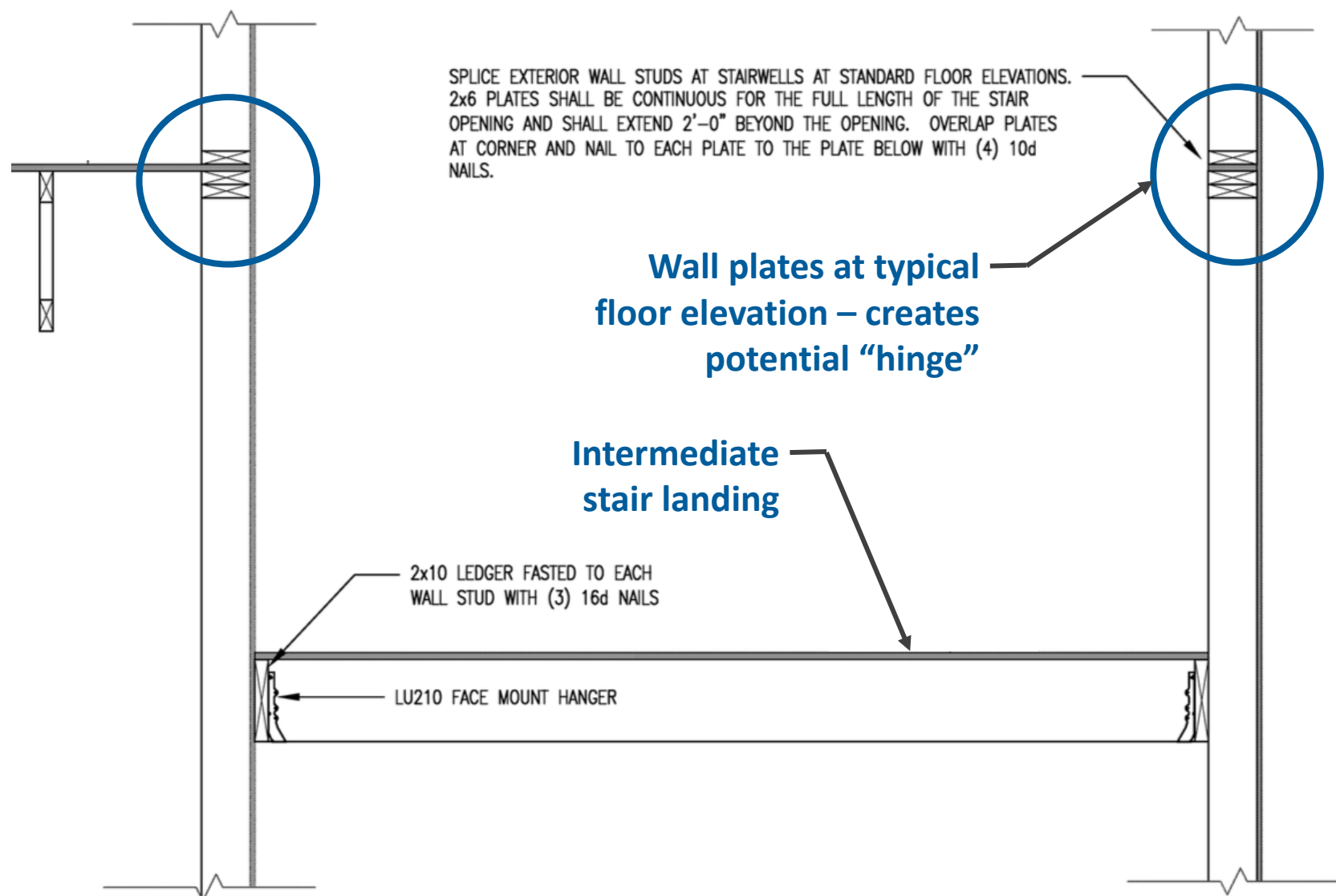
Shaft Walls that are also Exterior Walls – IBC 1023.7



Shaft Walls that are also Exterior Walls – IBC 1023.7

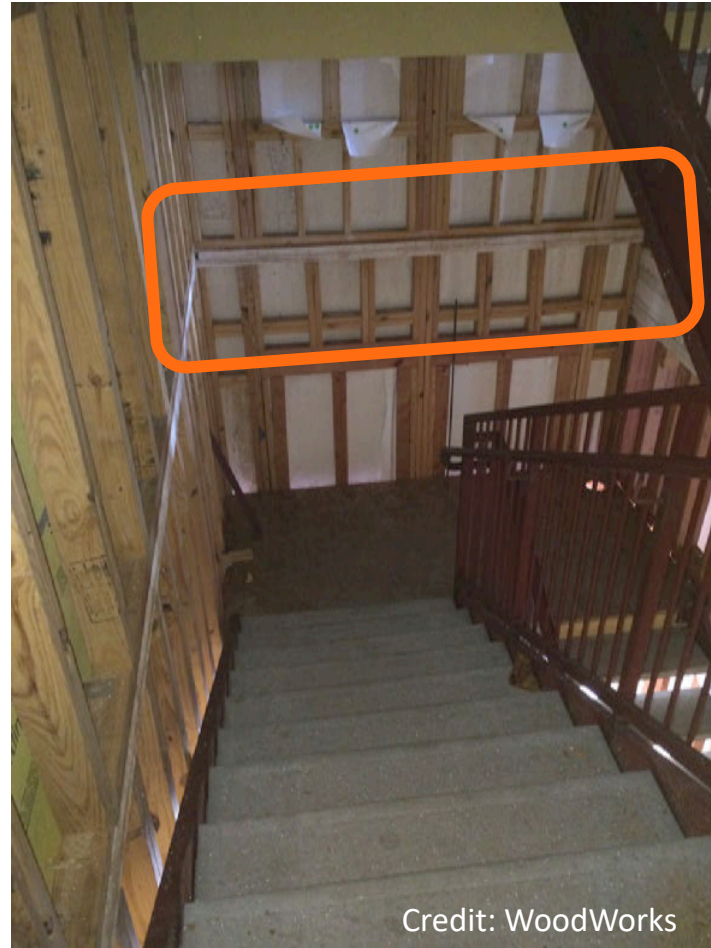
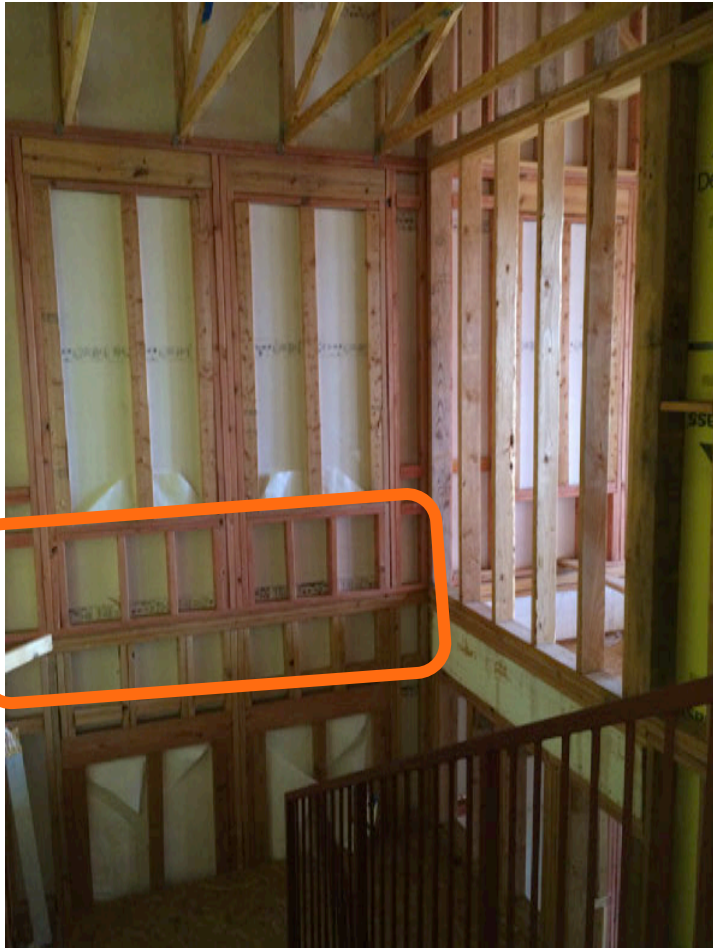


Shaft Walls that are also Exterior Walls

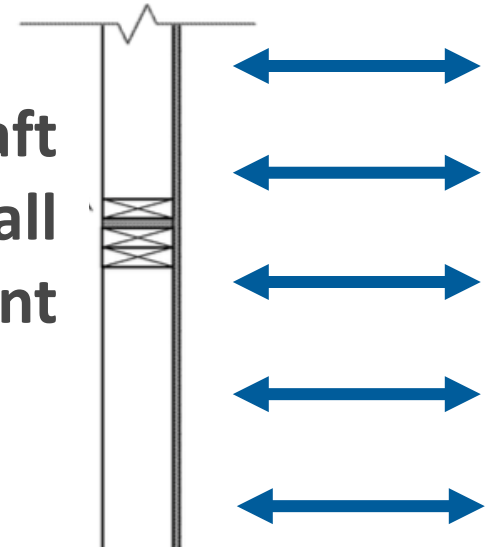


Shaft Walls that are also Exterior Walls

Structural Considerations



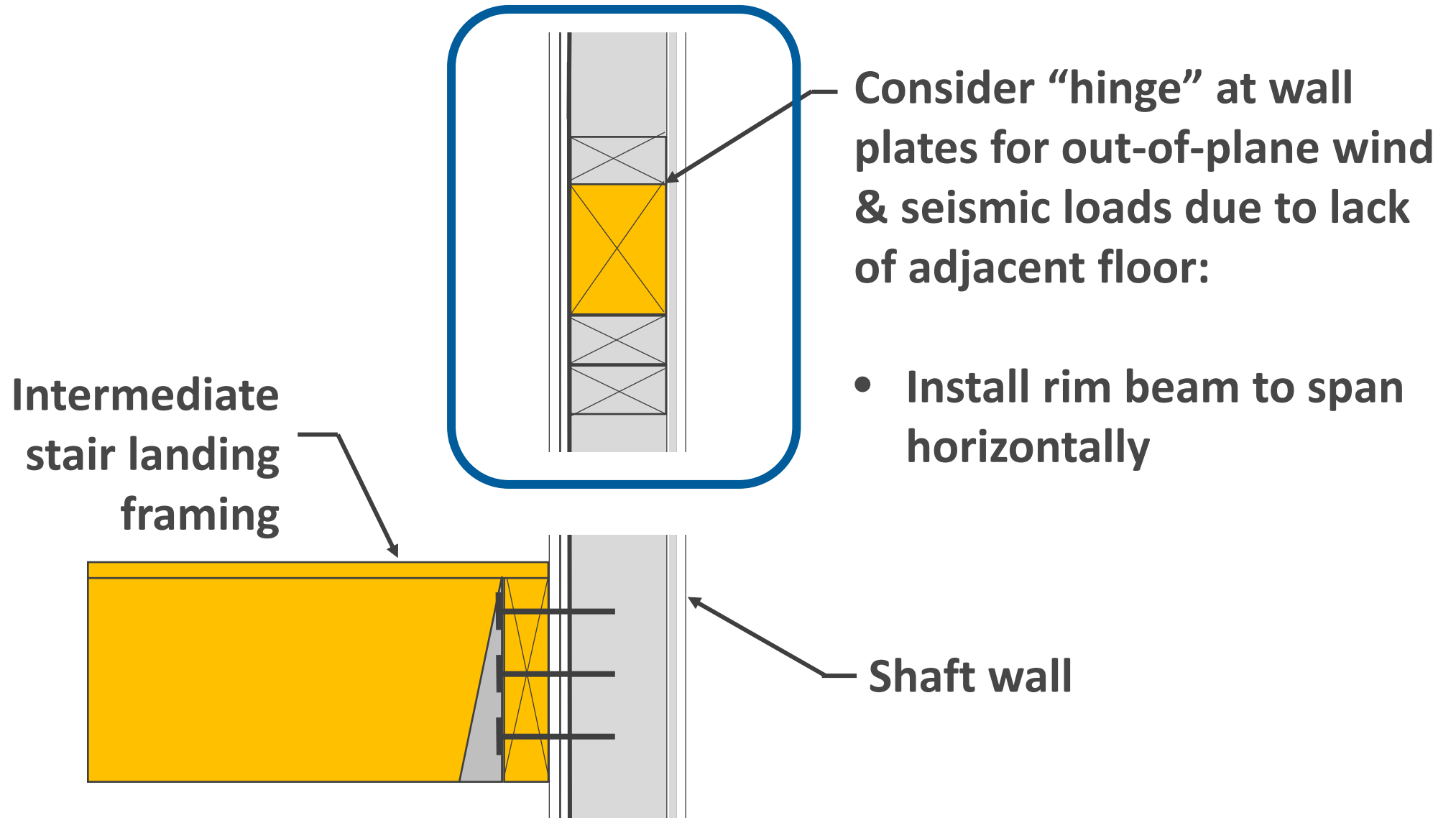
No floor at shaft
to brace wall
joint



Wind/Seismic loads
on exterior wall

Credit: WoodWorks

Shaft Walls that are also Exterior Walls





Part 2: Outline

» Shaft Wall vs. Exterior Wall

➤ Shaft Wall Fire Rating Requirements and Materials



Photo: Avesta Housing

Fire Resistance-Rated Assemblies

Fire-Resistance Rating: The *period of time* a building element, component or assembly maintains the ability to:



**Maintain Structural
Performance**



Provide Fire Confinement

Shaft Wall Hourly Rating

Section 713: Shaft Enclosures

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**

Shaft Wall Materials

707.2 Materials.

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

	Type III	Type IV-HT	Type V
Interior Shaft Walls	Any code-permitted wood framing	Heavy timber or any code-permitted, 1-hr wood framing	Any code-permitted wood framing
Exterior Shaft Walls	Fire-retardant treated wood	Fire-retardant treated wood or CLT	Any code-permitted wood framing

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

Shaft Wall Materials



Photo: WoodWorks



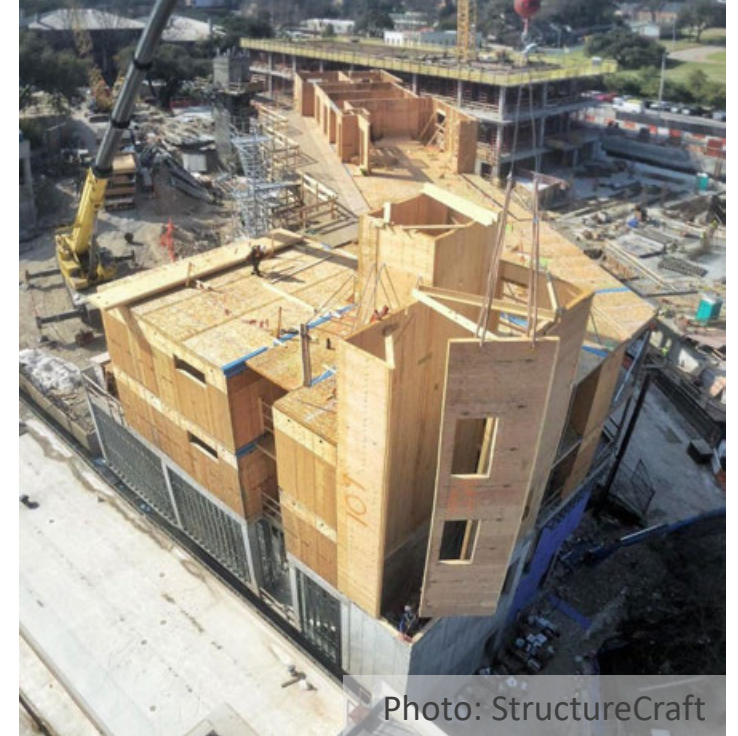
Photo: WoodWorks



Photo: Quality Contractors

Shaft Wall Materials – Mass Timber

- » Cost?
- » Construction Schedule?
- » Material Compatibility (movement & lateral load resistance)?
- » Can double as architectural feature
- » Successful fire tests for 2 Hr mass timber shaft walls exist (exposed and protected)



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**



Richard McLain, PE, SE
Senior Technical Director – Tall Wood
WoodWorks – Wood Products Council

Shaft Wall Solutions for Light-Frame and Mass Timber Buildings

An overview of design considerations, detailing options and code requirements

It is fairly common for mid-rise wood buildings to include shaft walls made from other materials. However, wood shaft walls are a code-compliant option for both light-frame and mass timber projects—and they typically have the added benefits of lower cost and faster installation.

A shaft is defined in Section 202 of the 2018 International Building Code¹ (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 mechanical-engineering-plumbing (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 light wood-frame and mass timber shaft walls under the 2018 and 2021 IBC, and considerations related to non-wood shaft walls in wood buildings.

Fire Resistance

Fire Barrier Construction

Shaft enclosures are specifically addressed in IBC Section 713. However, because shaft enclosure walls need to be constructed as fire barriers per Section 713.2, many shaft wall requirements directly reference provisions of fire barriers found in Section 707.

Provisions addressing materials permitted in shaft wall construction are given in both the shaft enclosures section (713.3) and fire barriers section (707.2). These



Hotel Magdalena in Austin, TX

Credit: StructureCraft

CONTENTS

Fire Resistance – Page 1
Fire Barrier Construction, Continuity, Supporting Construction, Joint vs. Intersecting Assemblies, Structural Shaft Wall Penetrations, Shaft Walls That Are Also Exterior Walls, Shaft Enclosure Tops

Assembly Options – Page 6
Assemblies and Intersections, Height Limitations on Walls with Shaftliner Panels

Detailing Floor-to-Wall Intersections – Page 9
Shaft Wall Applications, Other Shaft Design Considerations, Masonry Shaft Walls, Cold-Formed Steel Shaft Wall Components

Mass Timber – Page 18
Shafts in Mass Timber Buildings, Mass Timber Shafts in Other Building Types

Shaft Wall Materials – Light-Frame Wood

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



Credit: WoodWorks

Shaft Wall Assemblies

Assembly selection considerations:

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



Photo: WoodWorks

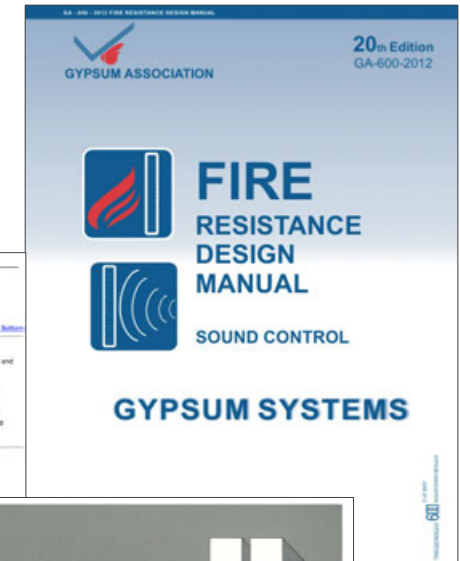
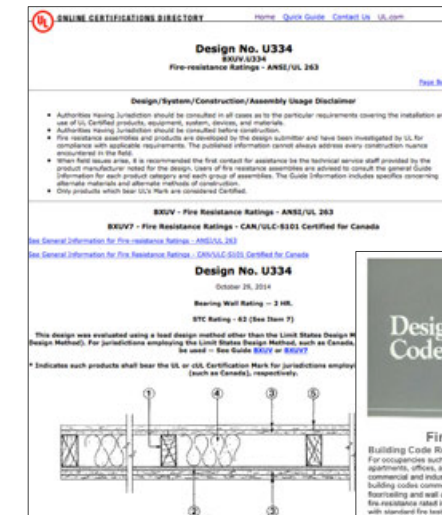
Choosing Fire Rated Assemblies

Common tested assemblies (ASTM E119) per IBC 703.2:

- » UL Listings
- » Gypsum Catalog
- » Proprietary Manufacturer Tests
- » Industry Documents: such as AWC's DCA3/DCA4

Alternate Methods per IBC 703.3

- » Prescriptive designs per IBC 721.1
- » Calculated Fire Resistance per IBC 722
- » Fire-resistance designs documented in sources
- » Engineering analysis based on a comparison
- » Fire-resistance designs certified by an approved agency



Part 2: Outline

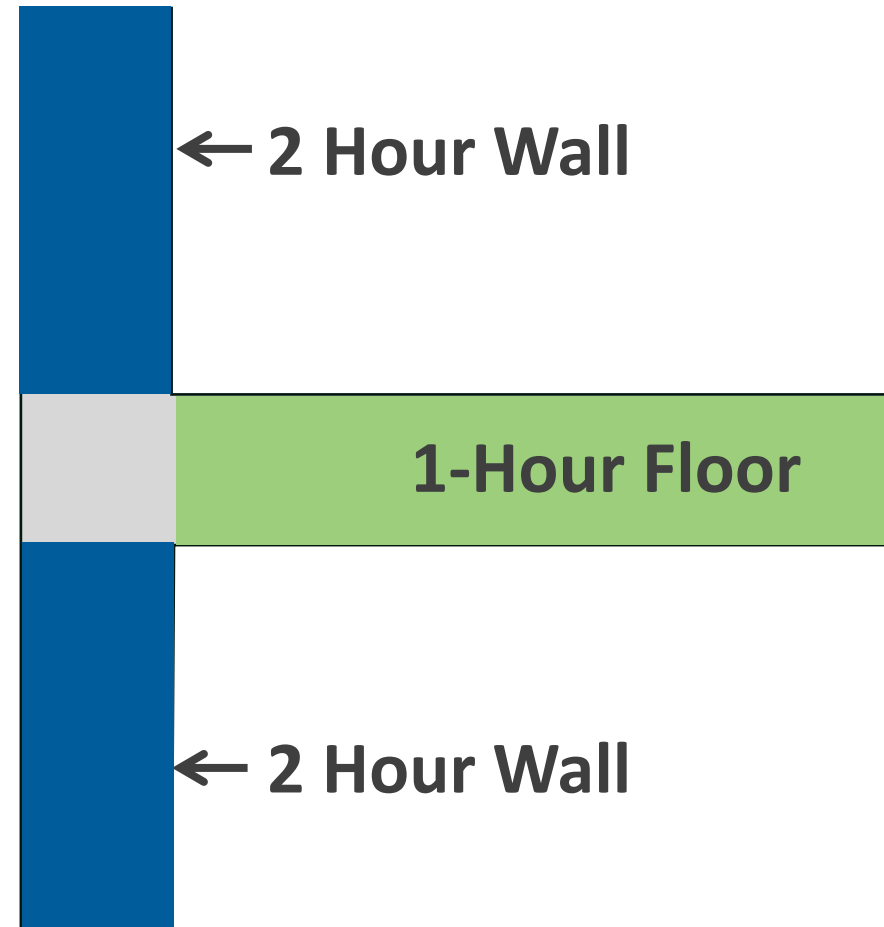
- » Shaft Wall vs. Exterior Wall
- » Shaft Wall Fire Rating Requirements and Materials
- Shaft wall to Floor Intersections



Photo: Avesta Housing

Intersection of Tested Assemblies

- » Many options are available for fire resistance tested floor assemblies and wall assemblies
- » No tested intersection details exist



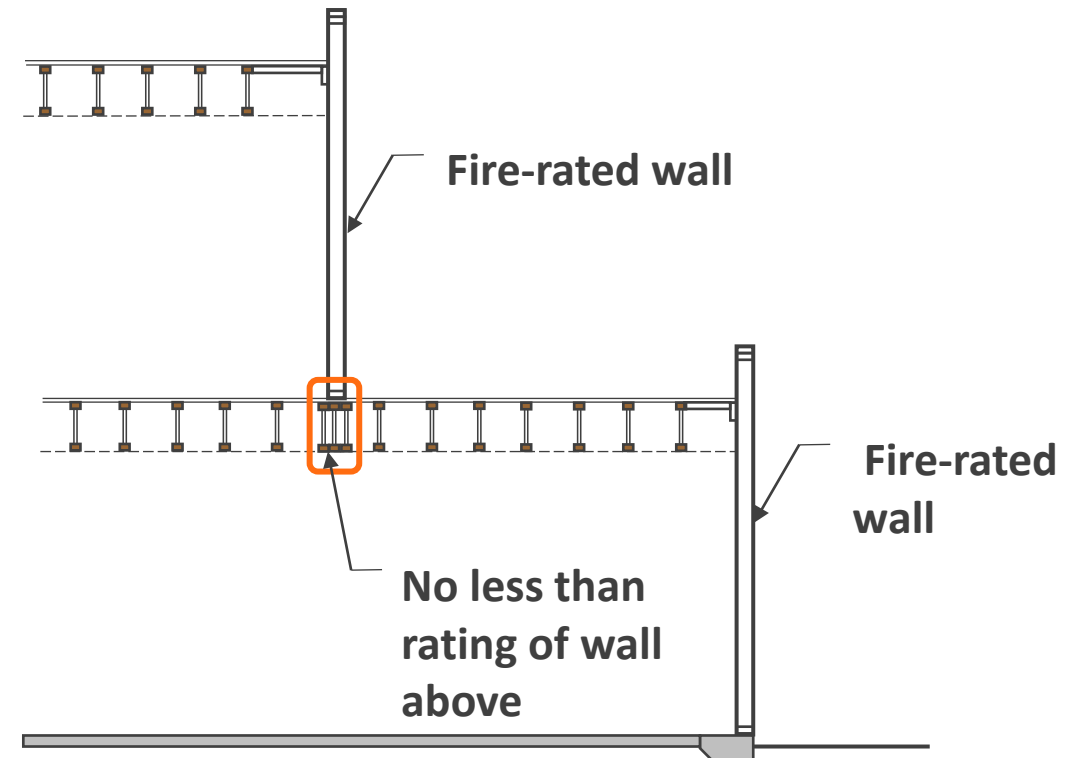
Supporting Construction Provisions

Section 707: Fire Barriers

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.

Ex., shaft walls that are not continuous to lowest level



Continuity Provisions

Section 713: Shaft Enclosures

713.5 Continuity.

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

Section 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?

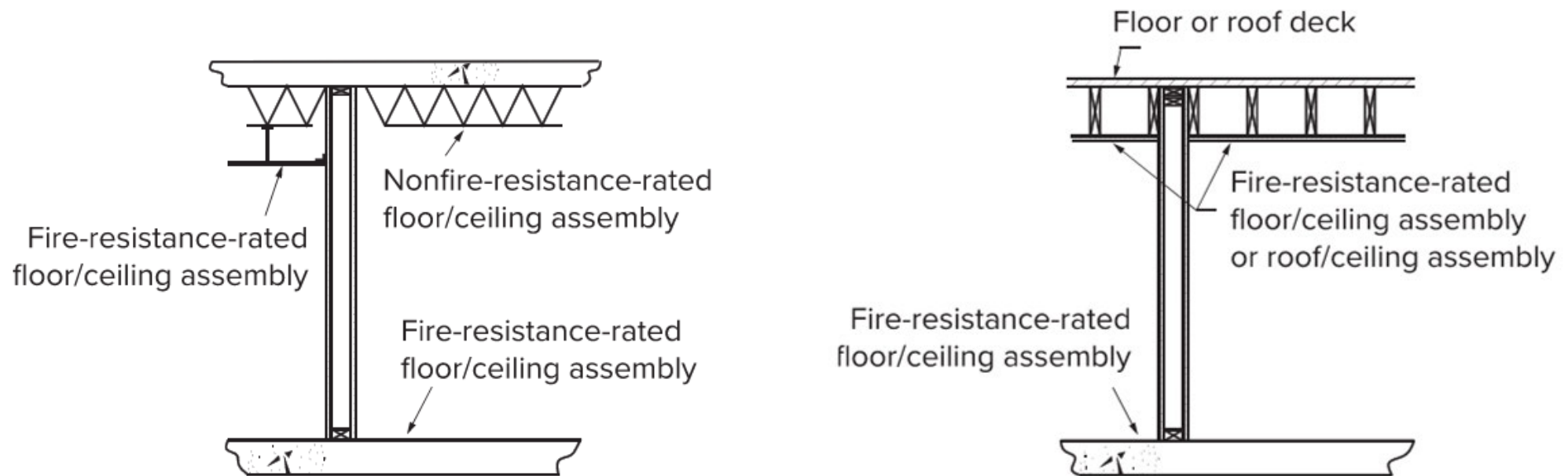


FIGURE 1: IBC Commentary Figure 707.5 – Continuity of fire barriers

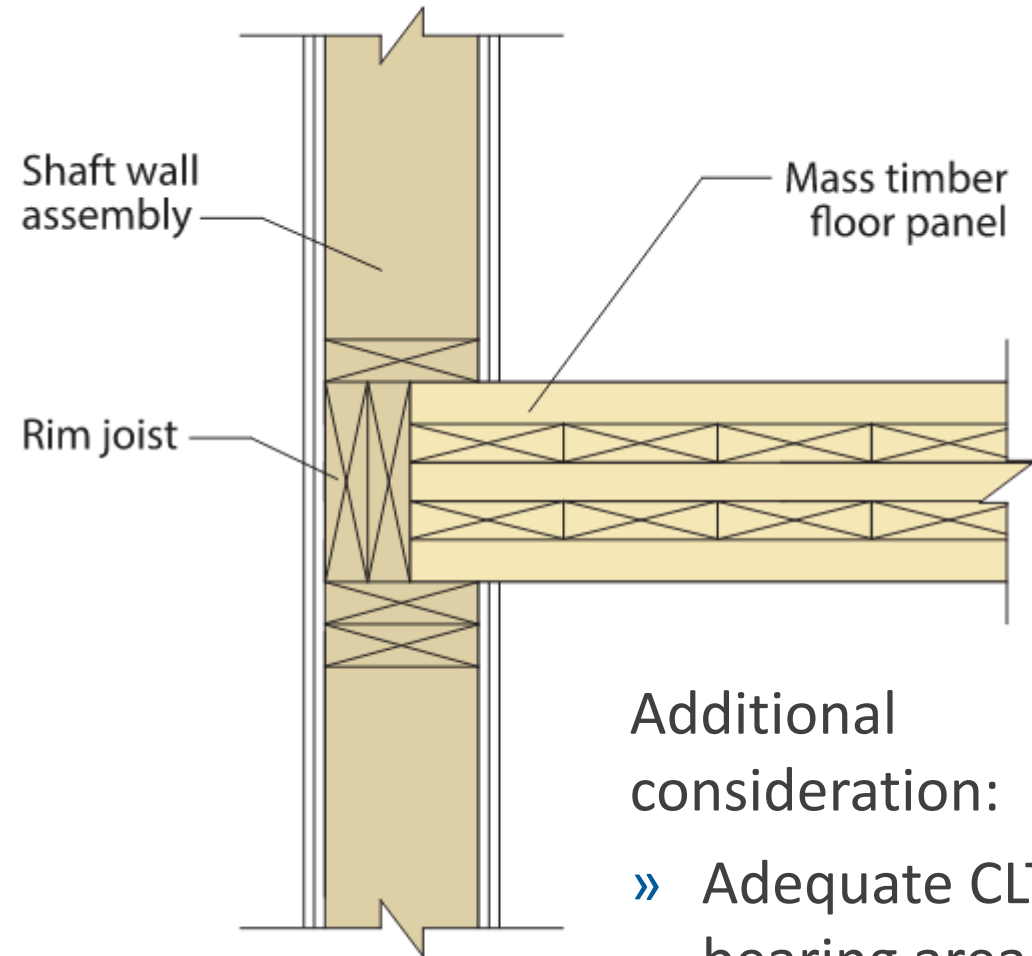
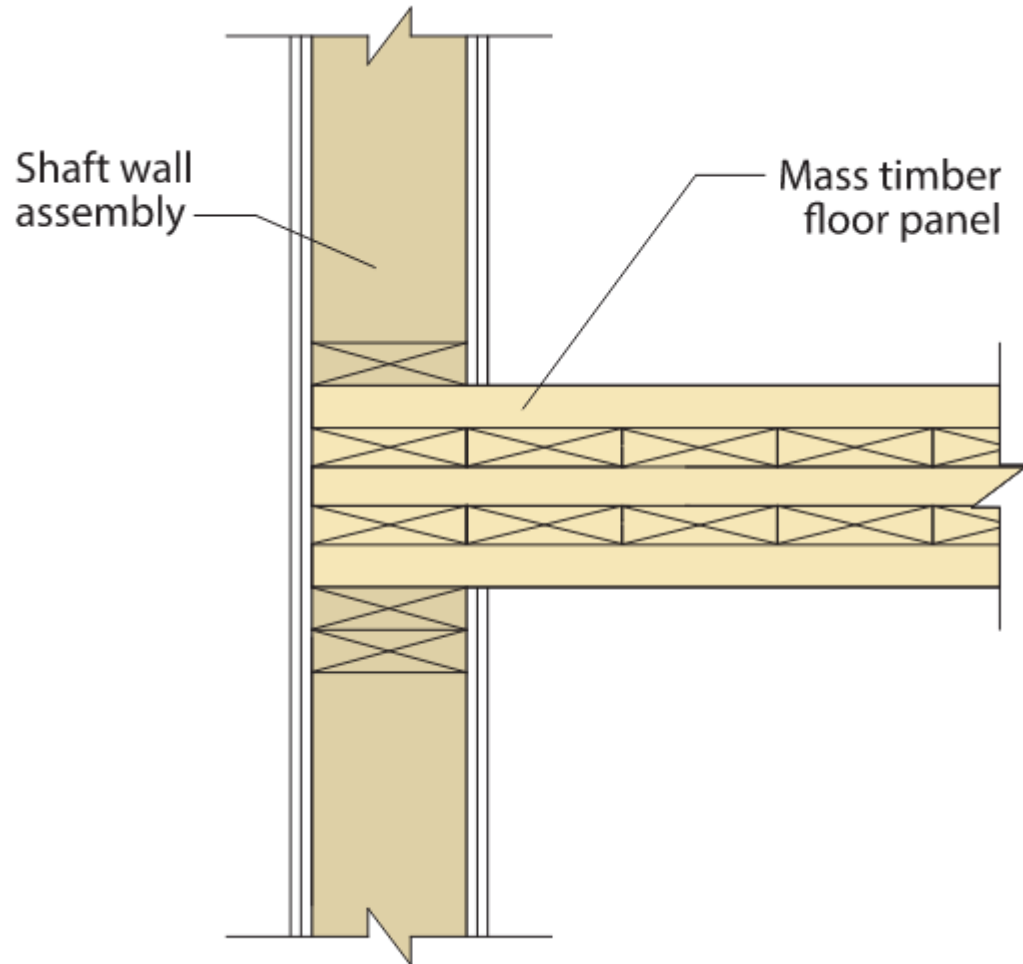
Shaft Walls – Intersecting Floors: **DISCLAIMER**

Please note that the following details are examples of what we have seen used on projects and do not necessarily represent details that will be accepted and applicable in all jurisdictions and to all projects.

These details are not intended as recommendations for universally accepted details. Local product availability and manufacturer specifications should also be considered for each project.

The Architect of Record and Engineer of Record should verify acceptance of the details used on their project with all provisions of the building code, including local amendments, with the local Authority Having Jurisdiction.

Floor to Shaft Wall Detailing



Additional
consideration:

- » Adequate CLT bearing area

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.

Continuity Provisions



Floor to Shaft Wall Detailing

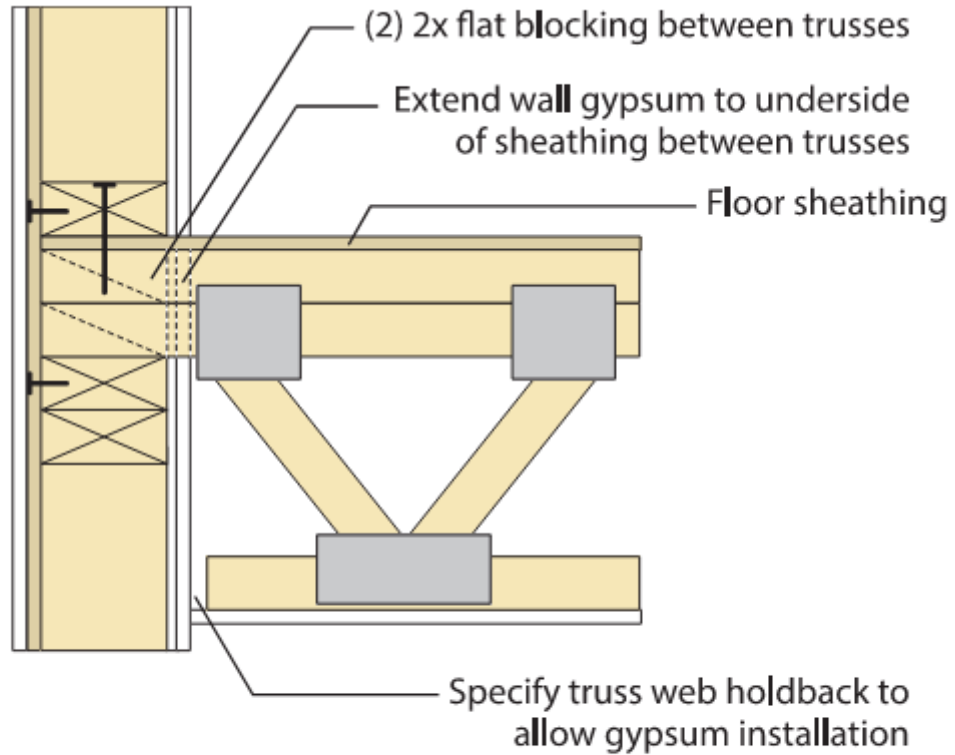
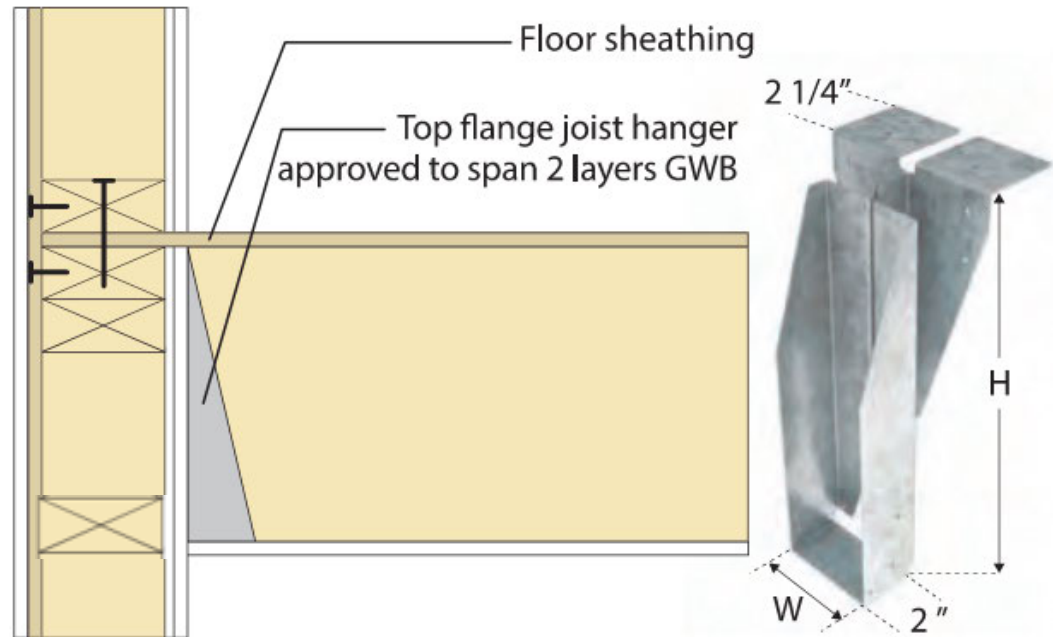


FIGURE 12: Floor-to-shaft wall intersection with gypsum extending to underside of sheathing between trusses



Floor to Shaft Wall Detailing



- » A conservative solution
- » High cost for special order hangers

FIGURE 14: Floor-to-shaft wall intersection with hangers designed to span over gypsum

Credit (image on the right): MiTek Builder Products

Floor to Shaft Wall Detailing

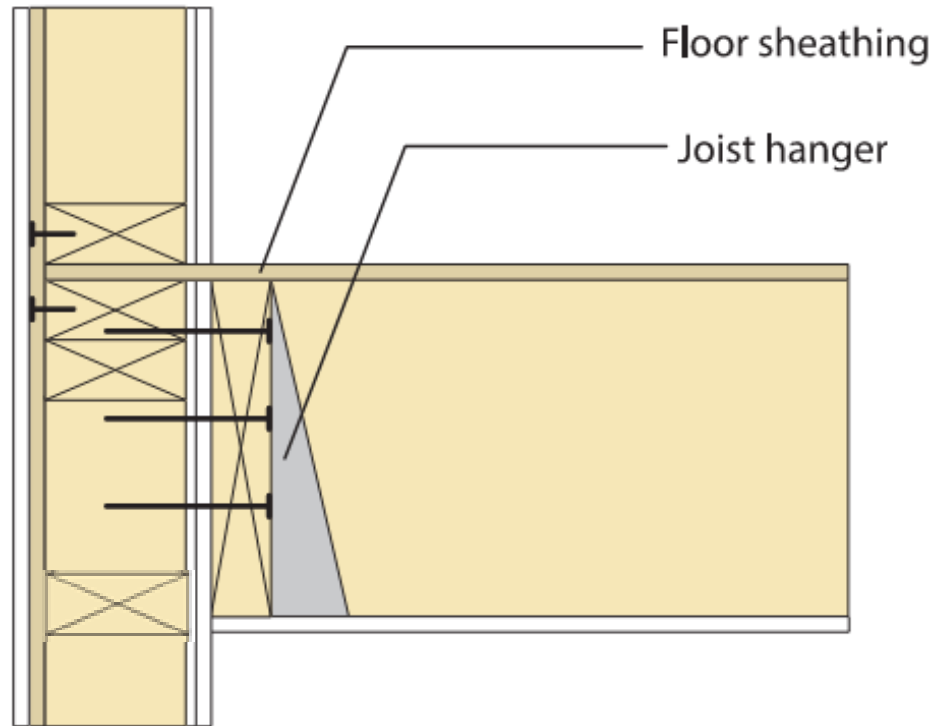


FIGURE 15: Floor framing ledger attached to shaft wall through two layers of gypsum

- » 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

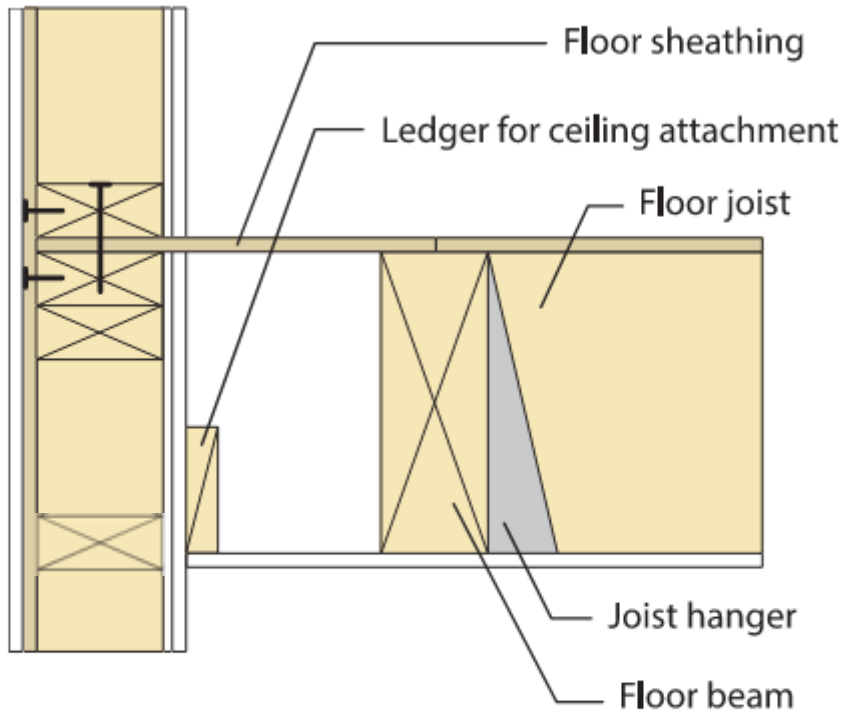


FIGURE 13: Floor-to-shaft wall intersection with supporting beam just inboard of wall



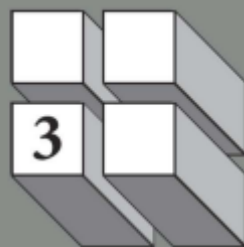
Credit: WoodWorks

Continuity Provisions

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**

Design for Code Acceptance



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 exposure where the wall has a fire separation distance of 10 feet or less. For exterior walls with a fire separation distance of greater than 10 feet, the required fire-resistance-rating applies only to exposure from the interior. The designer should note that some state and local building code amendments may require fire resistance rating for exposure from both sides of exterior walls, regardless of fire separation distance; however, the solutions and example details provided in this document are based on compliance with national model building codes.

Code recognition of one and two-hour wood-frame wall systems is also predicated on successful fire and hose stream testing in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction Materials*.

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-rated wall assemblies. Lumber shall be identified by the grade mark of a lumber grading or inspection agency that has been approved by an accreditation body that complies with the *American Softwood Lumber Standard (PS 20)*. The fire-resistance-rated assemblies described in this document, as well as those listed in other sources are not species- or grade-specific unless specifically noted as such.

Descriptions of successfully tested I-joist floor assemblies are provided in [Table 3](#) for one-hour fire-resistance-rated floor/ceiling assemblies and [Table 4](#) for two-hour fire-resistance-rated floor/ceiling assemblies. I-joists are required to comply with ASTM D5055, *Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists*. Where resilient channels are specified, single-leg (RC-1) resilient channels shall be used. Alternatively, two-leg

Code Acceptance



Component Additive Method (CAM) for Calculating and Demonstrating Assembly Fire Resistance

Wood-frame walls and floors offer designers a unique opportunity to provide structures with economy as well as proven energy performance. Where these assemblies are required by the building codes to achieve a minimum fire resistance rating, a wide range of options for design exists.

Building Code Requirements

For both new and existing construction, many building codes require structural elements such as exterior walls, load bearing partitions, floor/ceiling assemblies and roofs to achieve a minimum fire resistance rating. Historically, these assemblies have been tested in accordance with ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials or UL 263 Standard for Fire Tests of Building Construction and Materials, and assigned an hourly fire resistance rating based on assembly performance. Many sources are available for obtaining information on the fire resistance of assemblies: The 2012 International Building Code-Table 721; the American Wood Council's Fire Rated Wood Floor and Wall Assemblies (DCA3), Gypsum Association's GA 600 Fire Resistance Design Manual; and Underwriters' Laboratories Ultimate Fire Wizard, to name a few.

Building codes include both tested assemblies as well as methods for calculating fire resistance, de-

veloped from conducting a series of fire resistance tests. The Component Additive Method (CAM) provides for calculating the fire resistance of load bearing and non-load bearing floor, wall, ceiling and roof assemblies. The calculated fire resistance provisions within Section 722.6 of the *International Building Code® (IBC)* were developed using CAM.



Floor to Shaft Wall Detailing

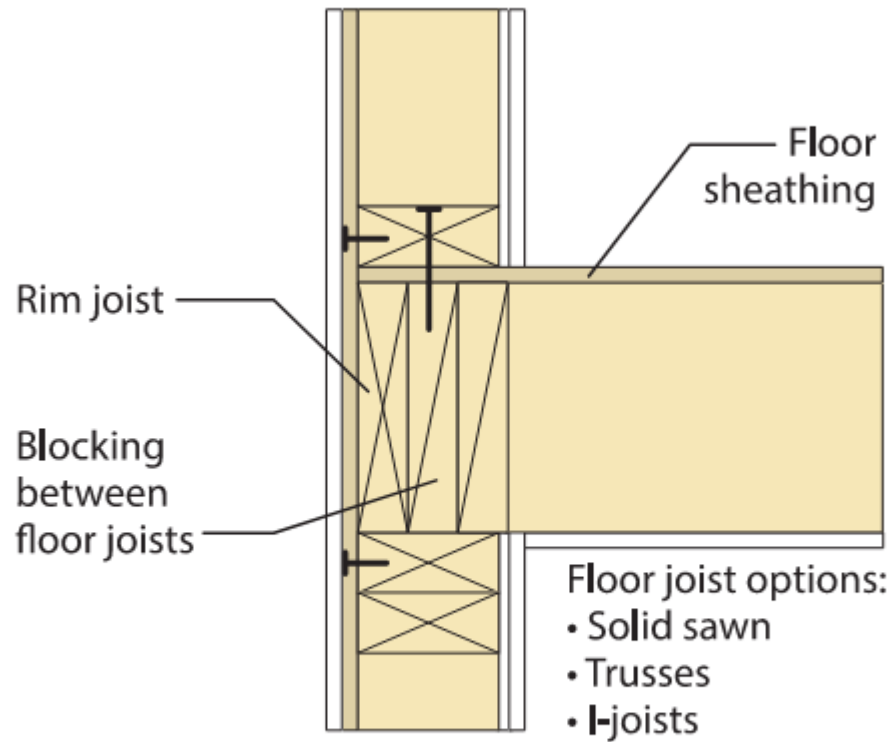


FIGURE 11: Floor-to-shaft wall intersection with blocking between floor joists

Part 2: Outline

- » Shaft Wall vs. Exterior Wall
 - » Shaft Wall Fire Rating Requirements and Materials
 - » Shaft wall to Floor Intersections
- Penetrations



Photo: Avesta Housing

Penetrations in Shaft Walls

Section 707: Fire Barriers

707.7 Penetrations.

Penetrations of fire barriers shall comply with Section 714.

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.

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

2021 IBC Change: 1023.5 Penetrations

1023.5 Penetrations.

Penetrations into or through interior exit *stairways* and *ramps* are prohibited except for the following:

1. Equipment and ductwork necessary for independent ventilation or pressurization.
2. *Fire protection systems*.
3. Security systems.
4. Two-way communication systems.
5. Electrical raceway for fire department communication systems.
6. Electrical raceway serving the *interior exit stairway* and *ramp* and terminating at a steel box not exceeding 16 square inches (0.010 m²).
7. Structural elements supporting the *interior exit stairway* or *ramp* or enclosure, such as beams or joists.

Such penetrations shall be protected in accordance with Section 714. There shall not be penetrations or communication openings, whether protected or not, between adjacent interior exit *stairways* and *ramps*.

Exception: *Membrane penetrations* shall be permitted on the outside of the *interior exit stairway* and *ramp*. Such penetrations shall be protected in accordance with Section 714.4.2.

Penetrations in Shaft Walls

Section 714: Penetrations

714.3.1.1 Fire-resistance-rated assemblies.

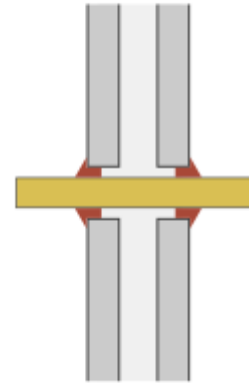
Penetrations shall be installed as tested in an approved fire resistance rated assembly.

or

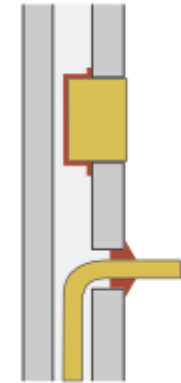
714.3.1.2 Through-penetration firestop system.

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.

Through Penetration



Membrane Penetration



Penetrations in Shaft Walls



To some, a new way of thinking:

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

Penetrations in Shaft Walls



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

Credit: WoodWorks

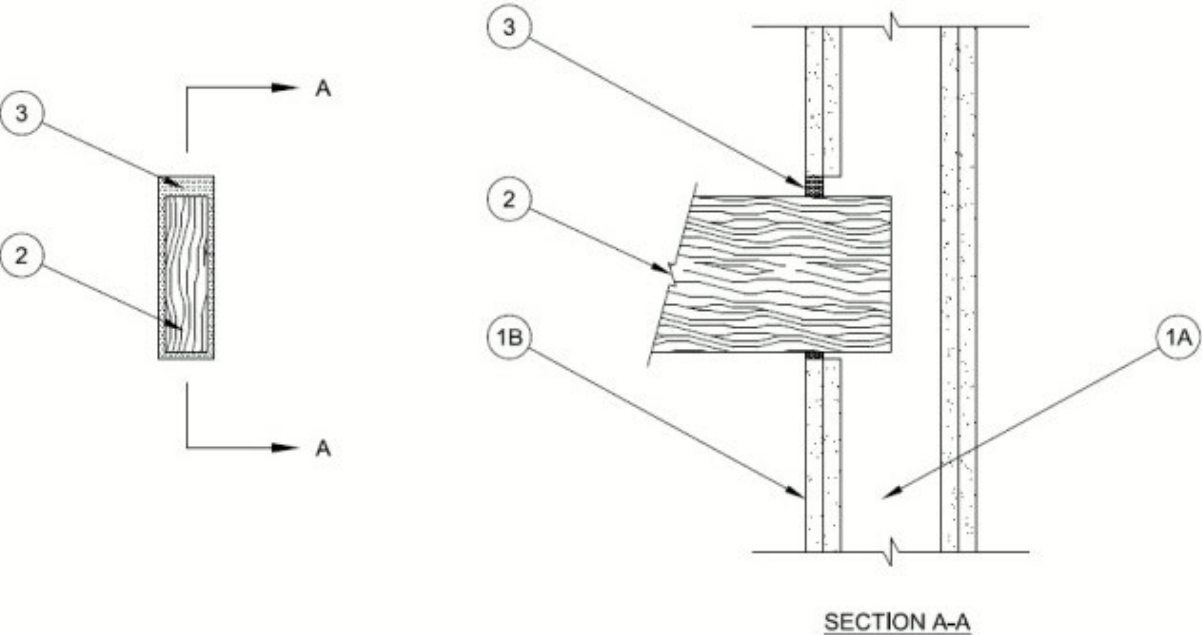
- » Some firestopping systems available as tested configurations for wood conditions
- » Most manufacturers can provide engineering judgement details, certification statements for this condition

Penetrations in Shaft Walls

System No. W-L-7244

August 24, 2016

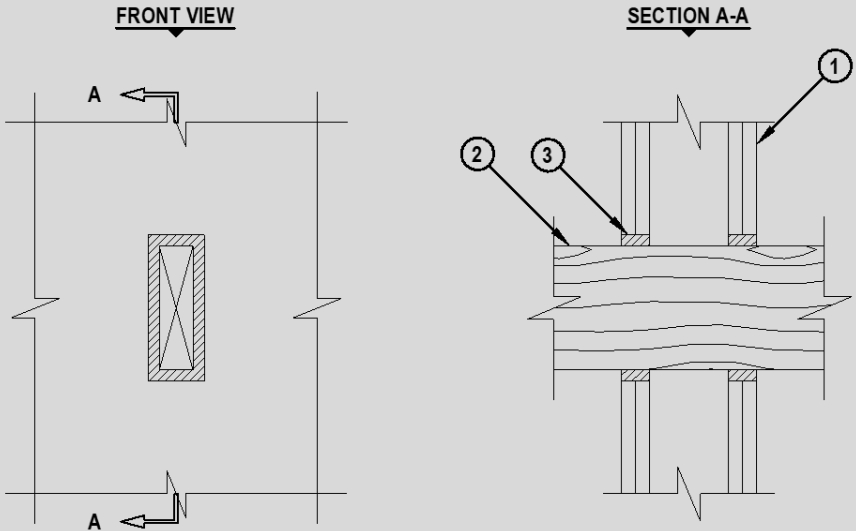
ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Ratings — 1 and 2 Hr (See Item 1)	F Ratings — 1 and 2 Hr (See Item 1)
T Ratings — 1 and 2 Hr (See Item 1)	FT Ratings — 1 and 2 Hr (See Item 1)
	FH Ratings — 1 and 2 Hr (See Item 1)
	FTH Ratings — 1 and 2 Hr (See Item 1)



DH

ENGINEERING JUDGMENT FIRESTOP DETAIL

F-RATING = 2-HR.



- 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)

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

Saving Lives through Innovation and Education

Part 2: Outline

- » Shaft Wall vs. Exterior Wall
- » Shaft Wall Fire Rating Requirements and Materials
- » Shaft wall to Floor Intersections
- » Penetrations
- Stair, Elevator, & Mechanical Shaft Considerations



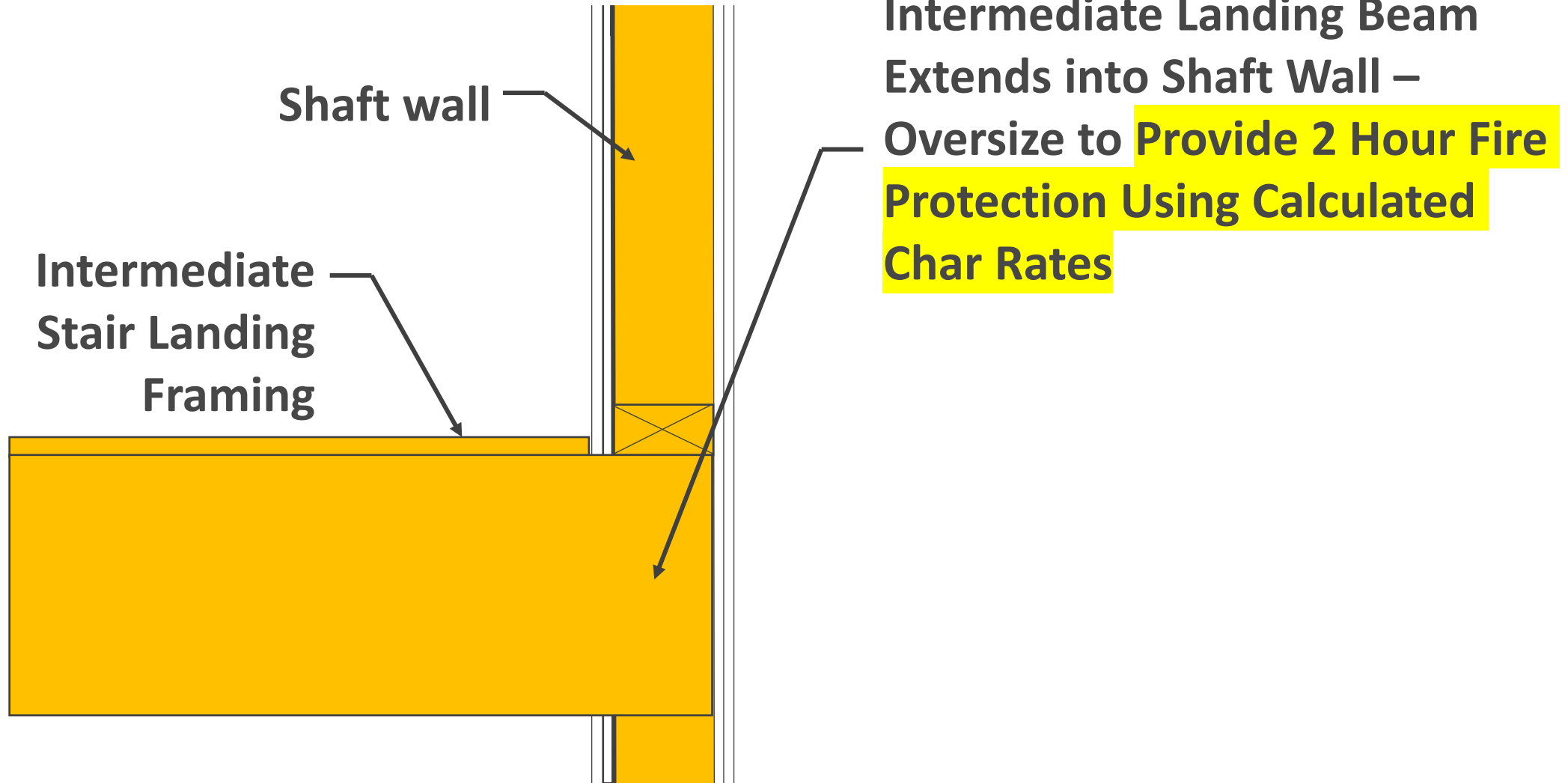
Photo: Avesta Housing

Stair, Elevator & MEP Shafts

Main Differences & Unique Design Constraints:

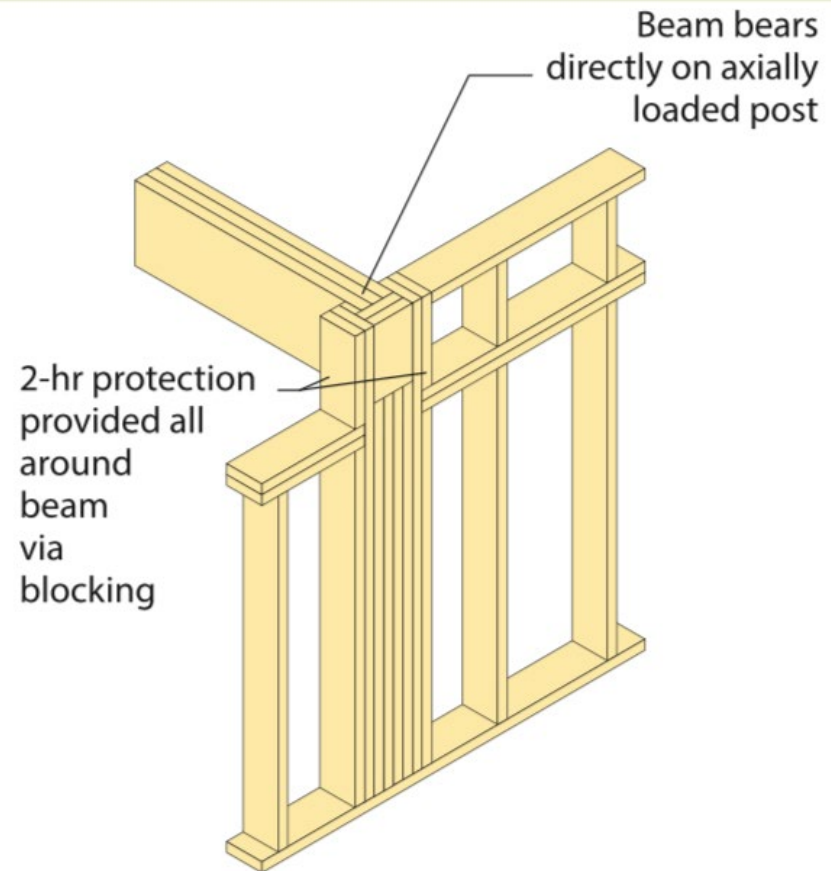
- » **Stair Shafts** – Stair Framing
- » **Elevator Shafts** – Rail supports
- » **MEPF Shafts** – Small Size

Stair Shafts



Stair Shafts

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



Credit: WoodWorks

Stairway Shaft Enclosures & Framing

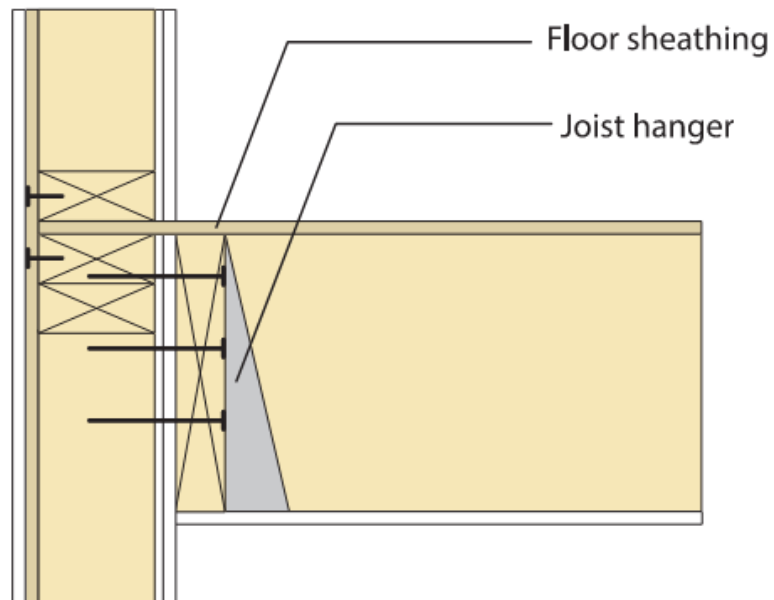


FIGURE 15: Floor framing ledger attached to shaft wall through two layers of gypsum

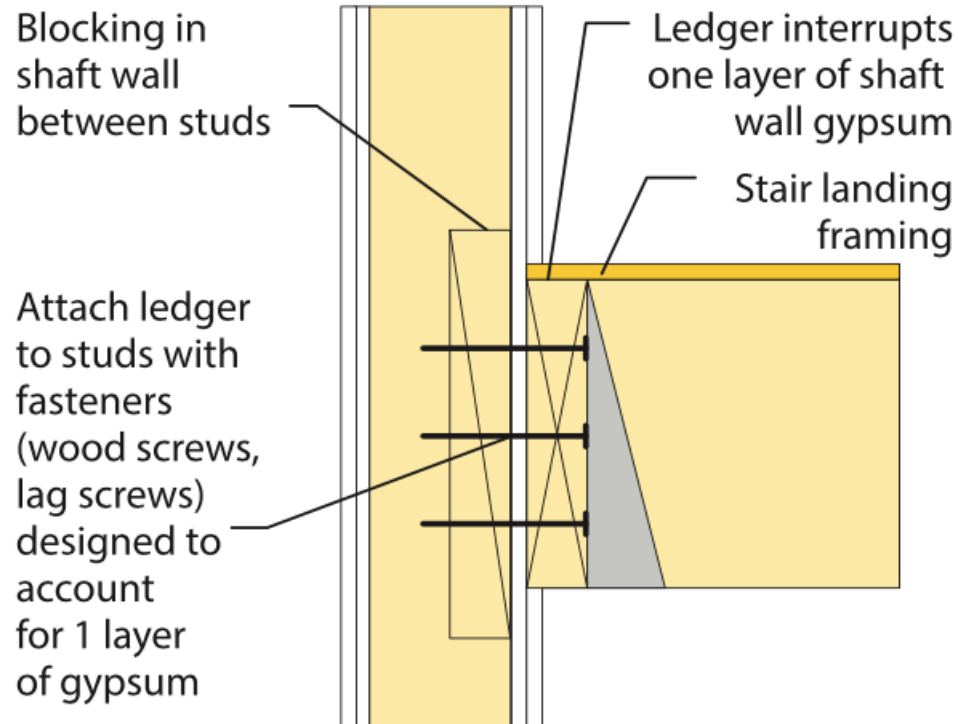


Credit: WoodWorks

Stair Shafts

FIGURE 15:

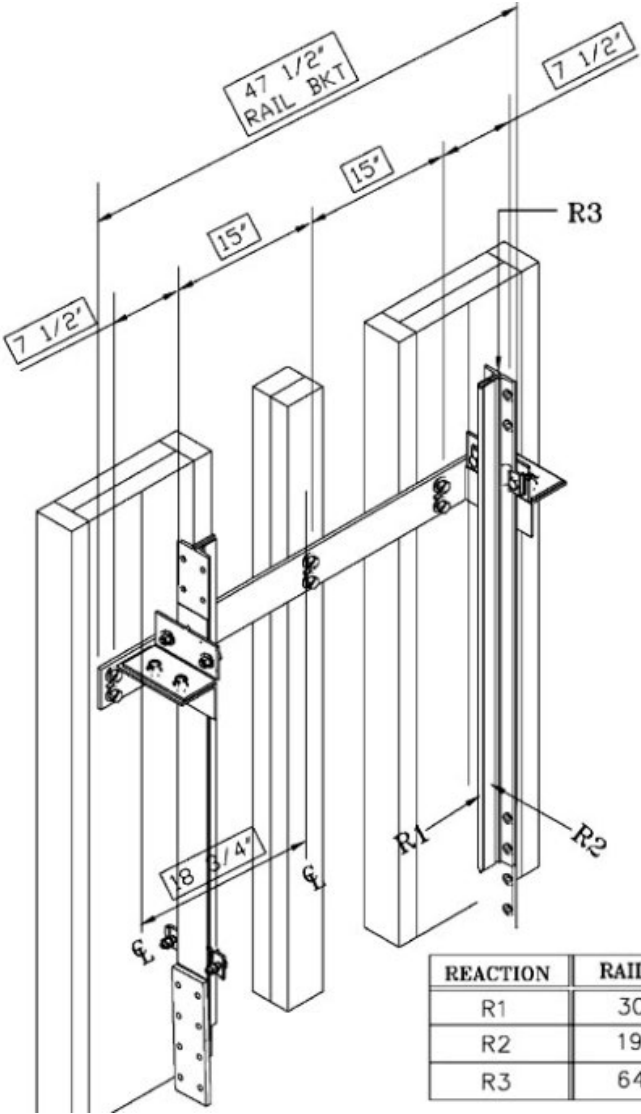
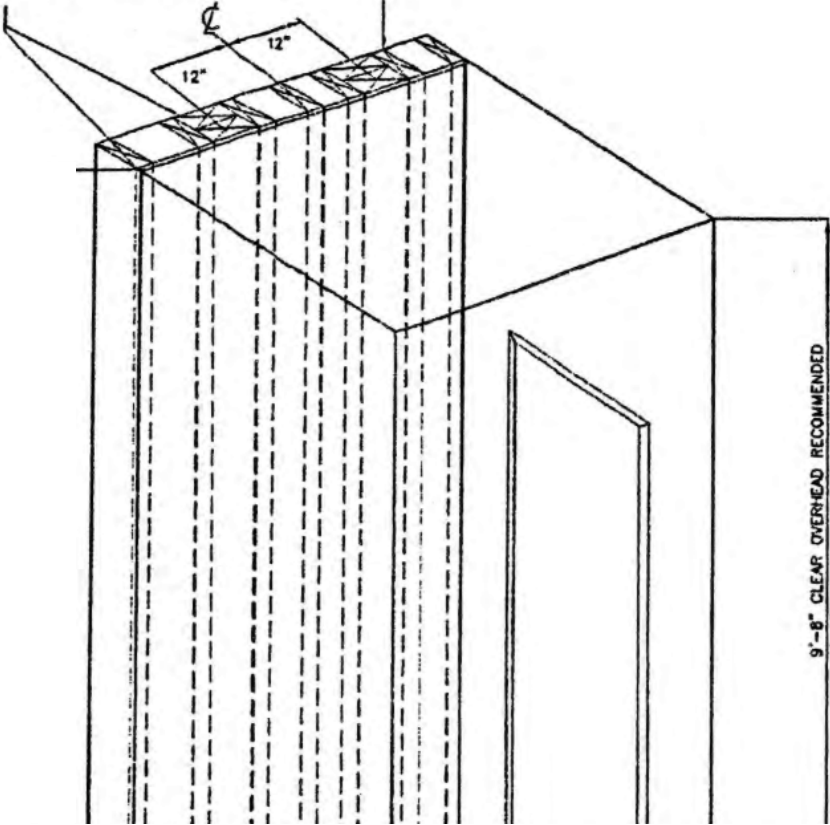
Stair Framing to Shaft Wall Attachment with Blocking in Lieu of One Continuous Gypsum Layer



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

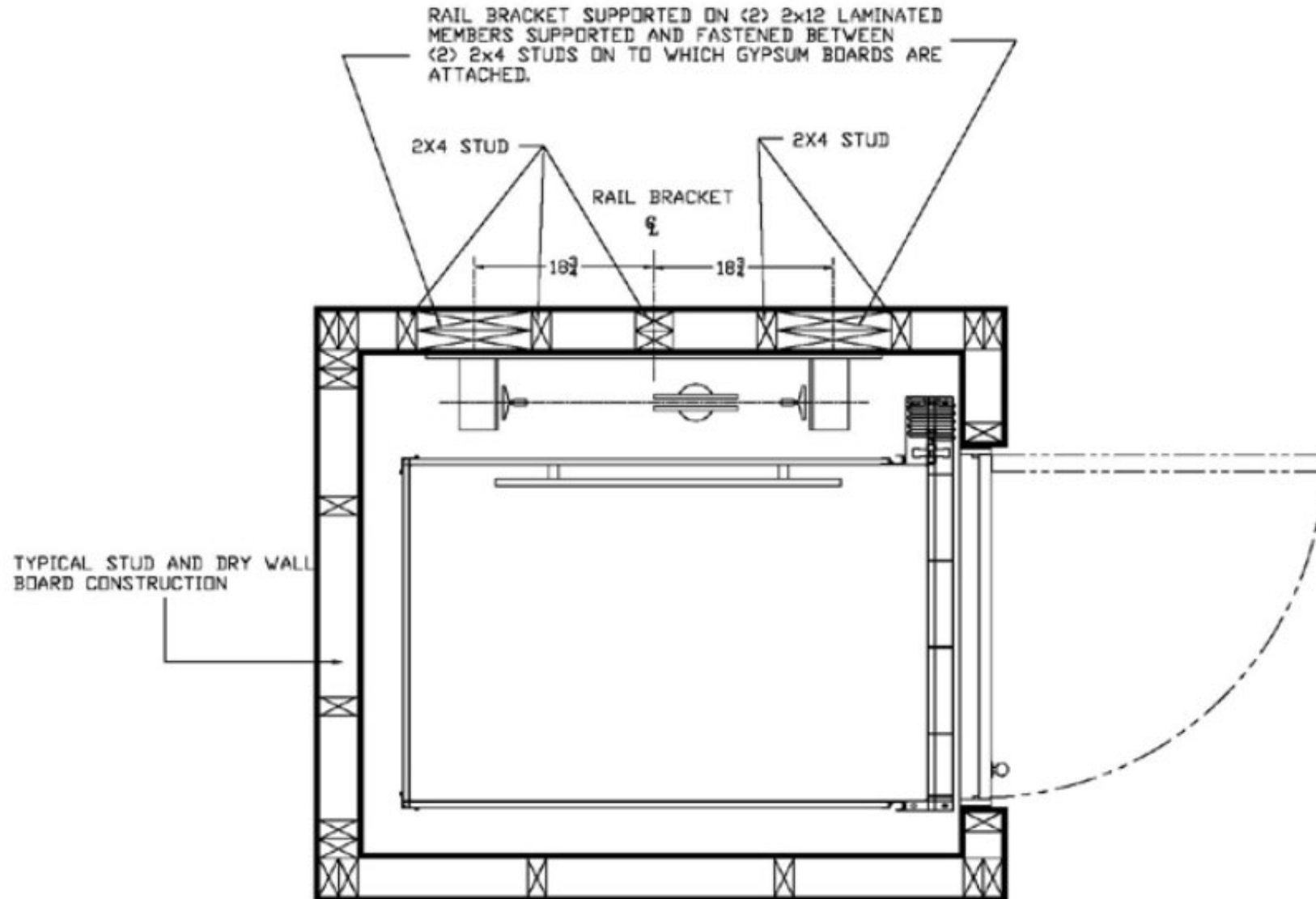
Elevator Shafts

(2) 2 X 12'S LAMINATED, SUPPORTED AND FASTENED BETWEEN (2) 2 X 4'S BEHIND GYPSUM BOARD, IN (2) PLACES AS SHOWN, FOR SUPPORTING RAIL BRACKETS



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

Elevator Shafts



Elevator Shafts



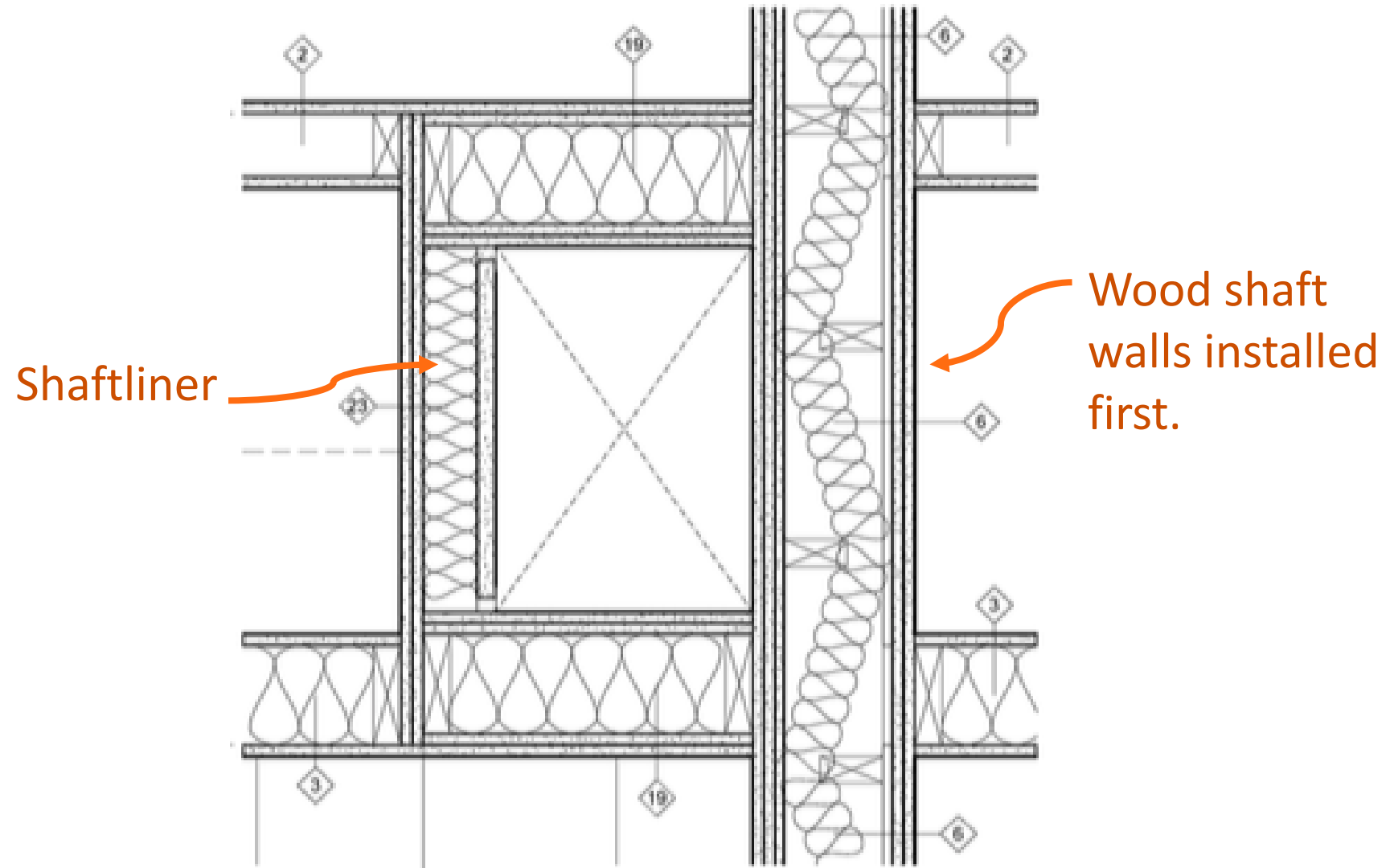
Credit: WoodWorks

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

Mechanical Shafts – Small Size

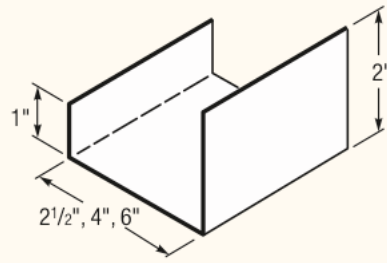
Limitations

- Some have height limitations, both per story and overall system
- Not structural, may require back-up wood wall



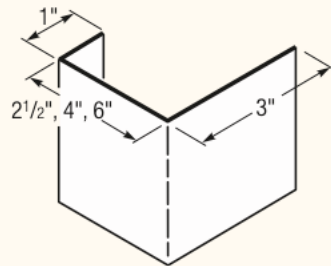
Shaftliner Systems – Configuration Options

USG Steel J-Runner (JR)



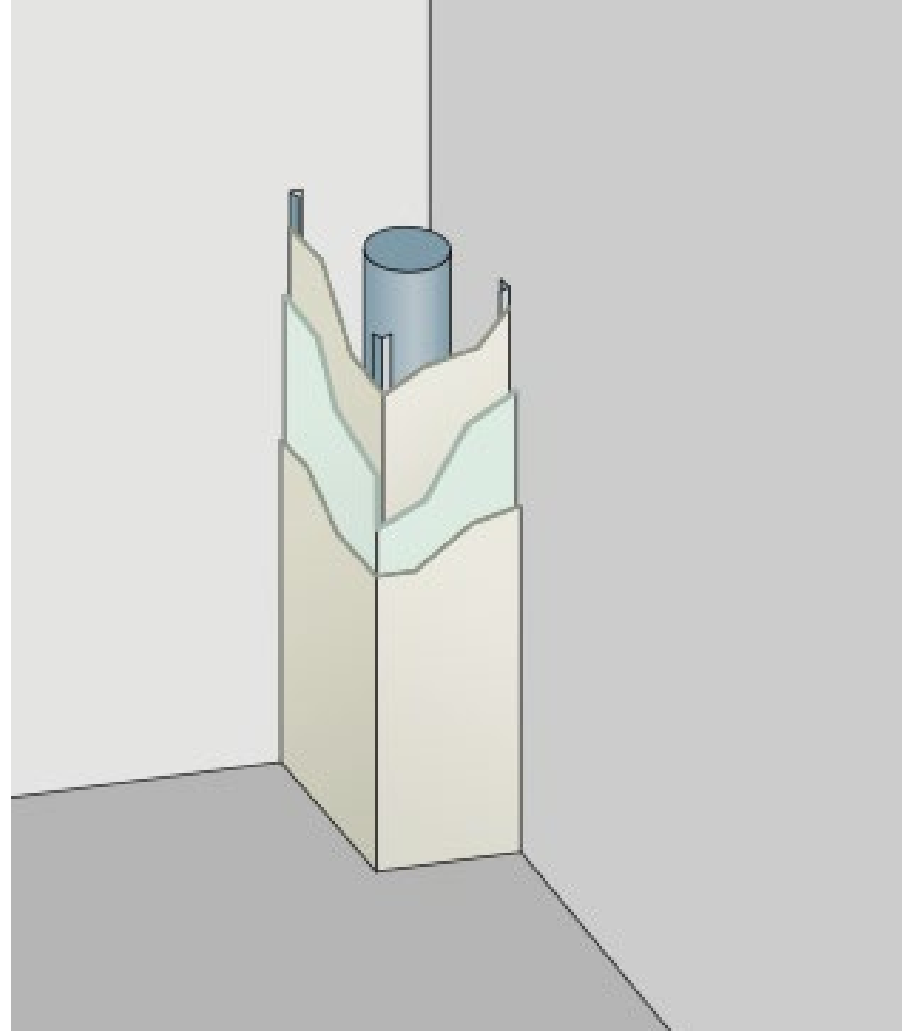
J-Runner (JR)

USG Steel Jamb-Strut (JS)



Source: USG

Jamb-Strut (JS)

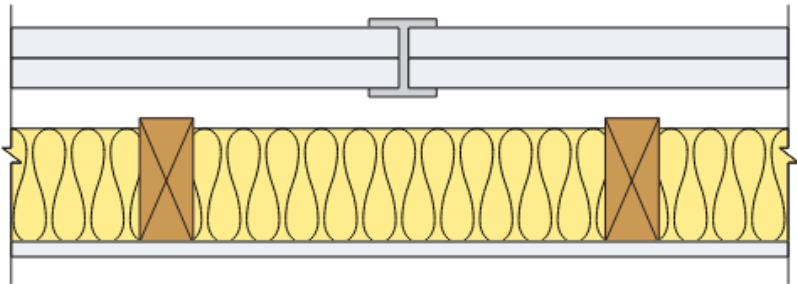
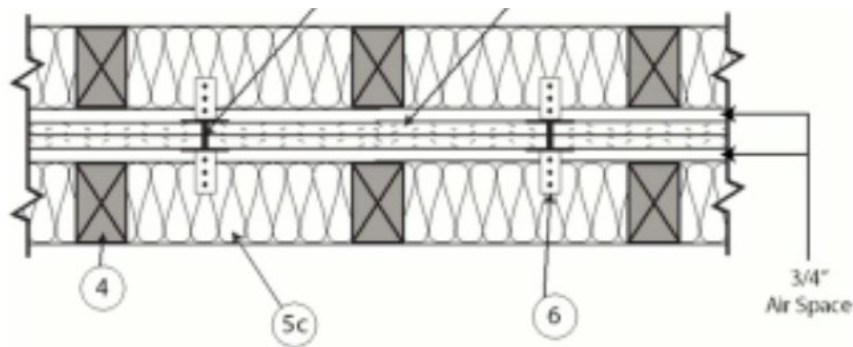


Shaftliner Systems – Configuration Options



Source: Clark Dietrich

H-Stud Option



59 STC Sound Transmission

Test Reference: RAL TL 10-290

Two layers 1" (25.4 mm) shaftliner inserted in H-studs 24" (610 mm) o.c., min. 3/4" (19 mm) air spacing between liner panels and adjacent or wood metal framing

Sound tested with 2"x4" stud wall with 1/2" (12.7 mm) wallboard or interior panels and 3-1/2" (89 mm) fiberglass insulation in stud space

FIGURE 8: UL U373

Credit: Georgia Pacific

Shaftliner Systems





Source: Clark Dietrich

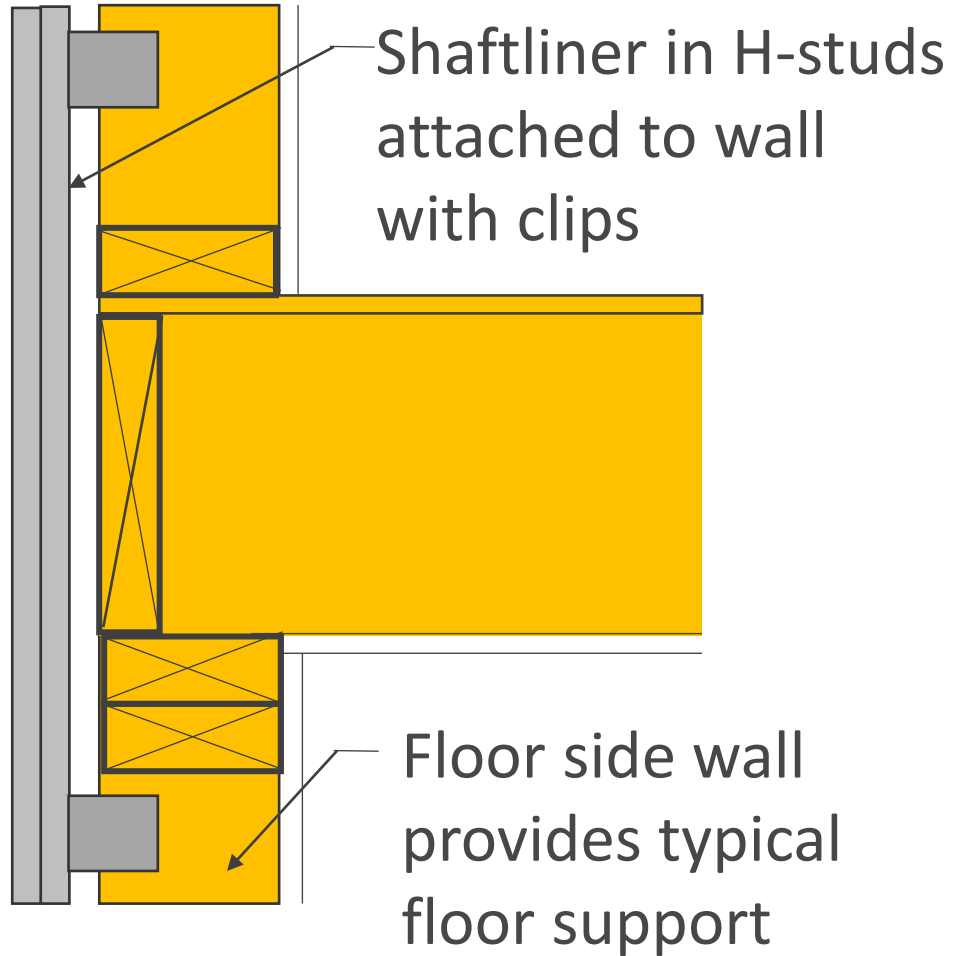
- » H-studs are non-structural
- » Can only resist nominal horizontal pressures and self weight (but limited on self weight capacity)

PERFORMANCE SELECTOR

WALL SYSTEMS—LIMITING HEIGHTS TABLE

			One-Hour Shaft Wall / Stairwell (U415 System A) ^b				Two-Hour Shaft Wall (U415 System C) ^b			
Stud Type and Size	Designation	Allowable Deflection	5	7.5	10	15	5	7.5	10	15
	212CH-18	L/120	11' 5"	10' 0"	9' 1" ^d	7' 11" ^d	—	—	—	—
		L/240	10' 7"	9' 3"	8' 4" ^d	7' 4" ^d	—	—	—	—
		L/360	9' 4"	8' 2"	7' 5"	6' 6"	—	—	—	—
	212CH-34	L/120	13' 5"	11' 8"	10' 8"	9' 3"	—	—	—	—
		L/240	12' 3"	10' 9"	9' 9"	8' 6"	—	—	—	—
		L/360	10' 10"	9' 6"	8' 7"	7' 6"	—	—	—	—
	400CH-18	L/120	15' 2"	12' 5"	10' 9" ^d	8' 9" ^d	15' 2"	12' 5"	10' 9" ^d	8' 9" ^d
		L/240	14' 5"	12' 5"	10' 9" ^d	8' 9" ^d	14' 5"	12' 5"	10' 9" ^d	8' 9" ^d
		L/360	12' 9"	11' 2"	10' 1" ^d	8' 9" ^d	12' 9"	11' 2"	10' 1" ^d	8' 9" ^d
	400CH-34	L/120	20' 5"	17' 10"	16' 2" ^d	13' 4" ^d	20' 5"	17' 10"	16' 2" ^d	13' 4" ^d
		L/240	17' 6"	15' 3"	13' 10"	12' 1" ^d	17' 6"	15' 3"	13' 10"	12' 1" ^d
		L/360	15' 3"	13' 4"	12' 1"	10' 7" ^d	15' 3"	13' 4"	12' 1"	10' 7" ^d

Floor to Shaft Wall Detailing



Floor to Shaft Wall Detailing

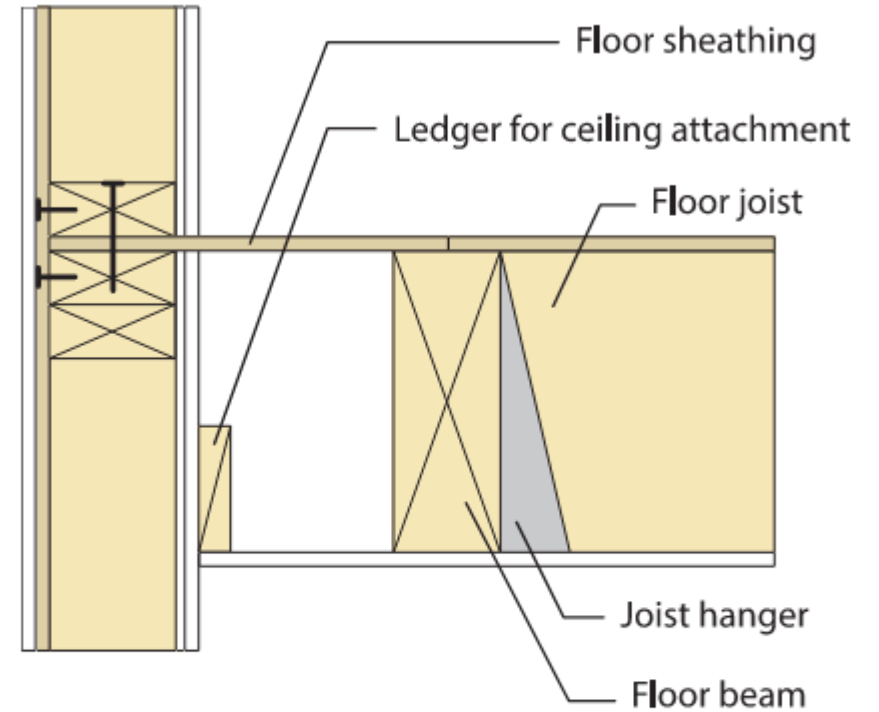
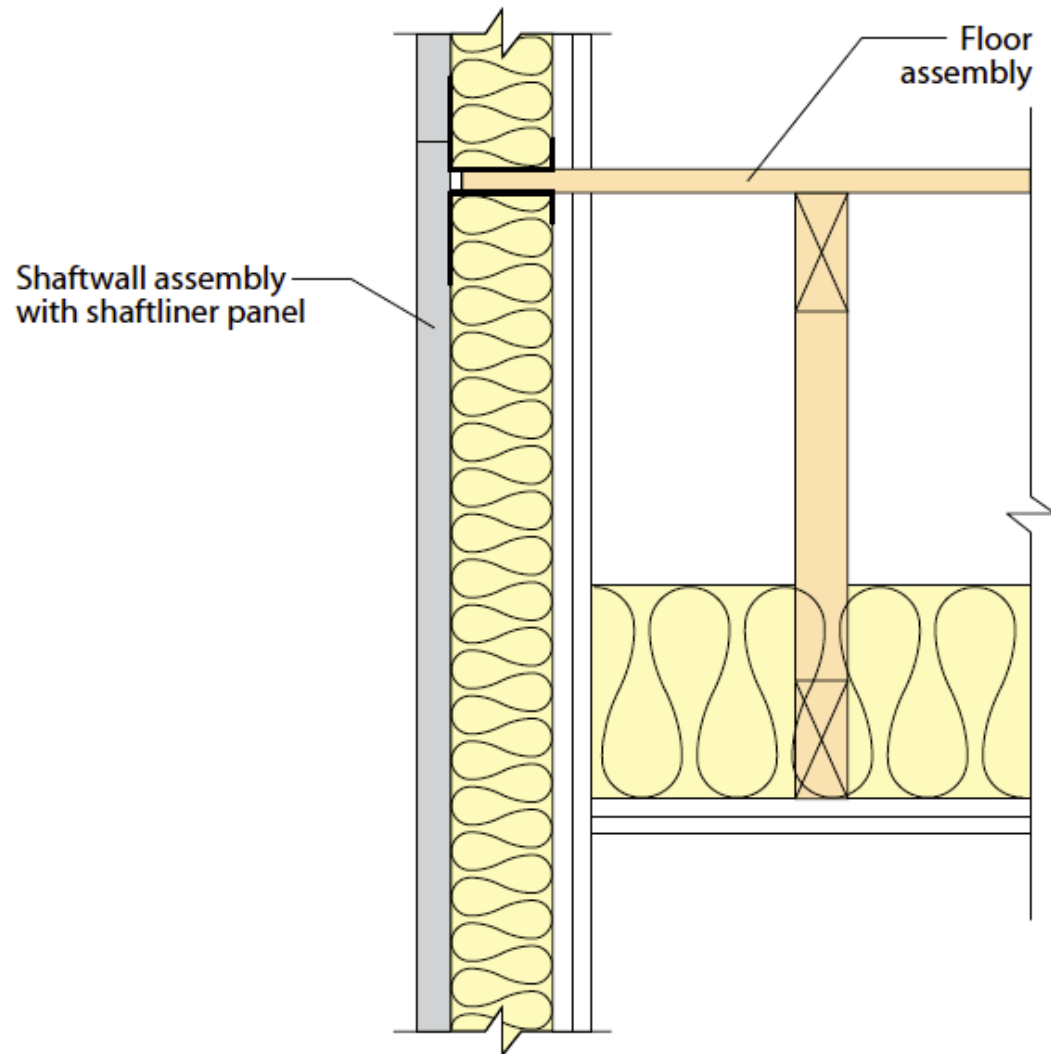
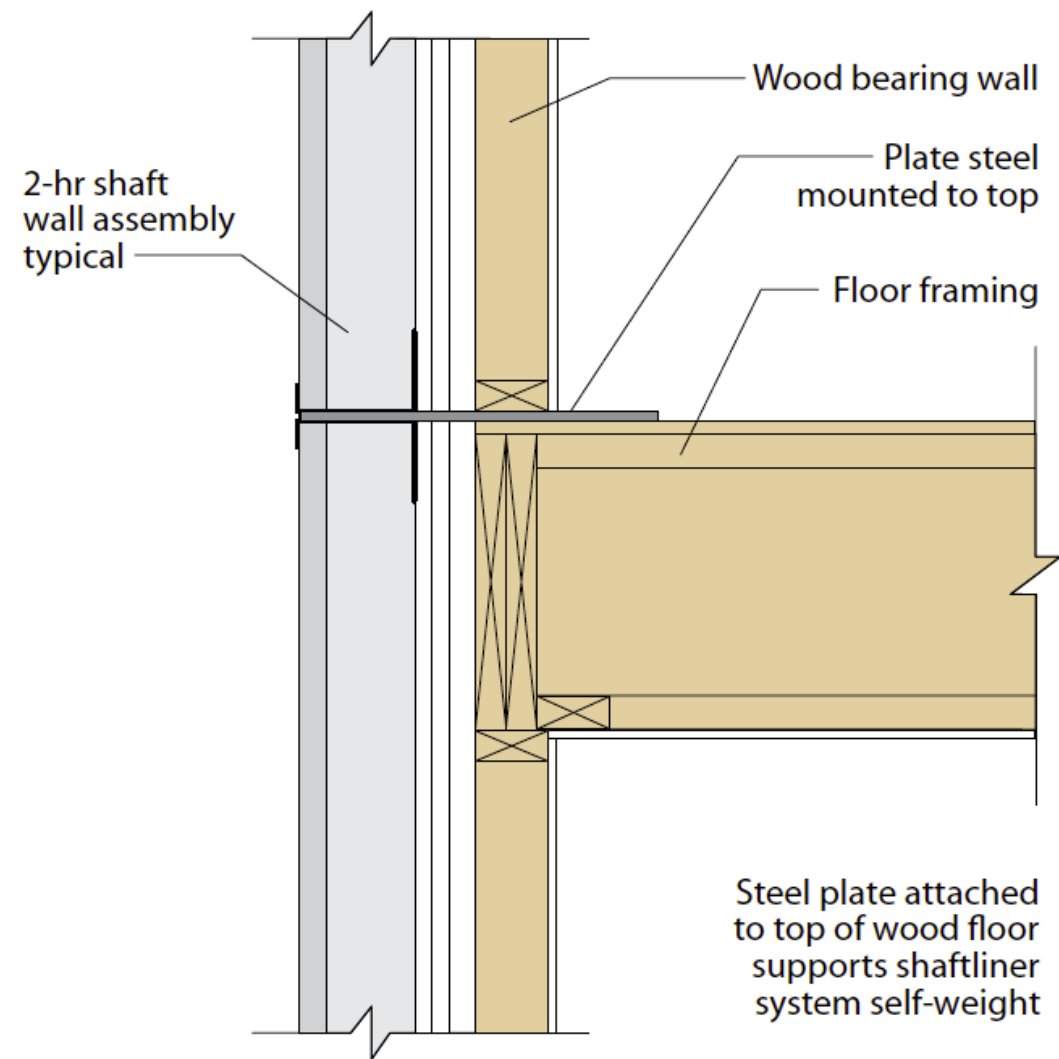
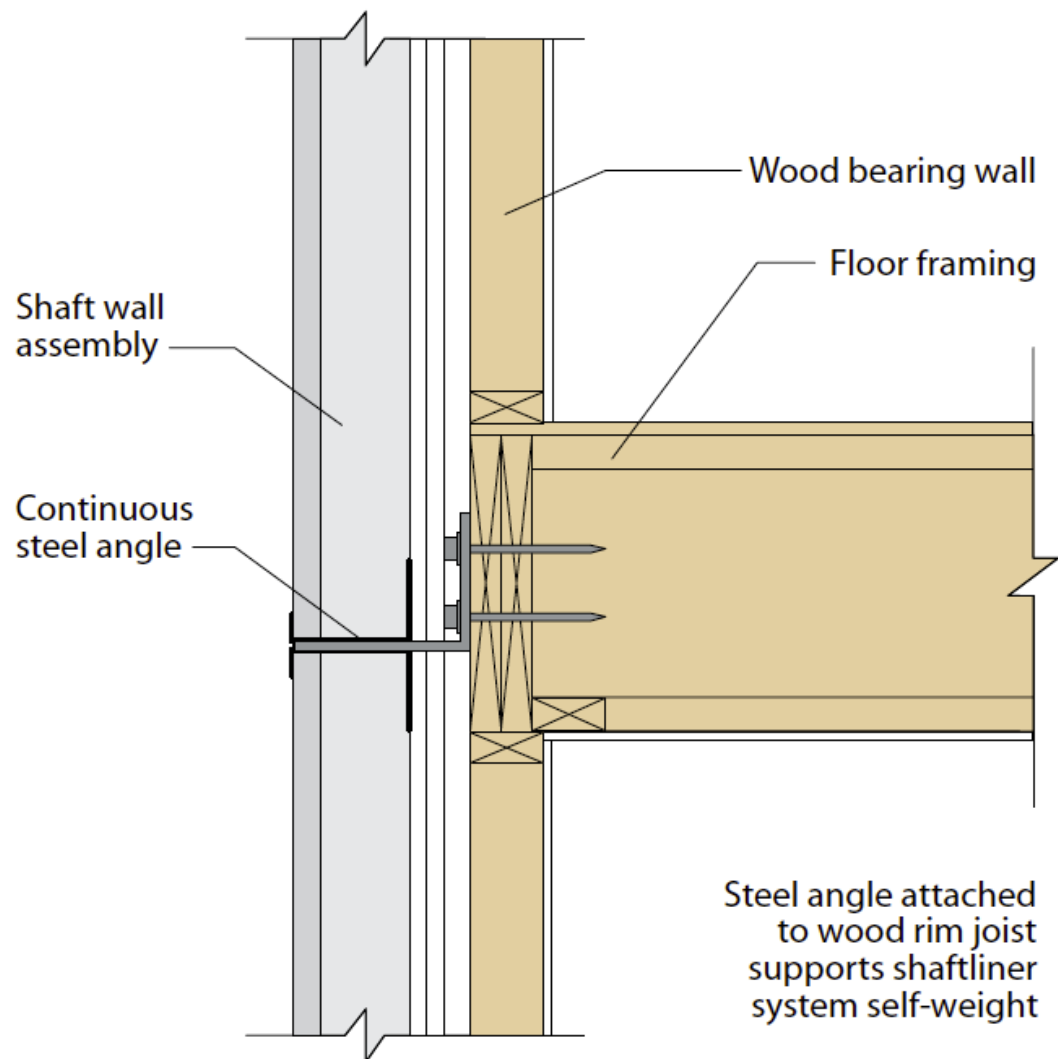


FIGURE 13: Floor-to-shaft wall intersection with supporting beam just inboard of wall

Shaftliner Systems – Support Details





What is being enforced in jurisdictions you are working in?

Questions? Ask us anything.



Laura Cullen, PE

Regional Director | GA, MS

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