Light Wood-Frame Shaft Wall Detailing

for Code Compliance and Constructability

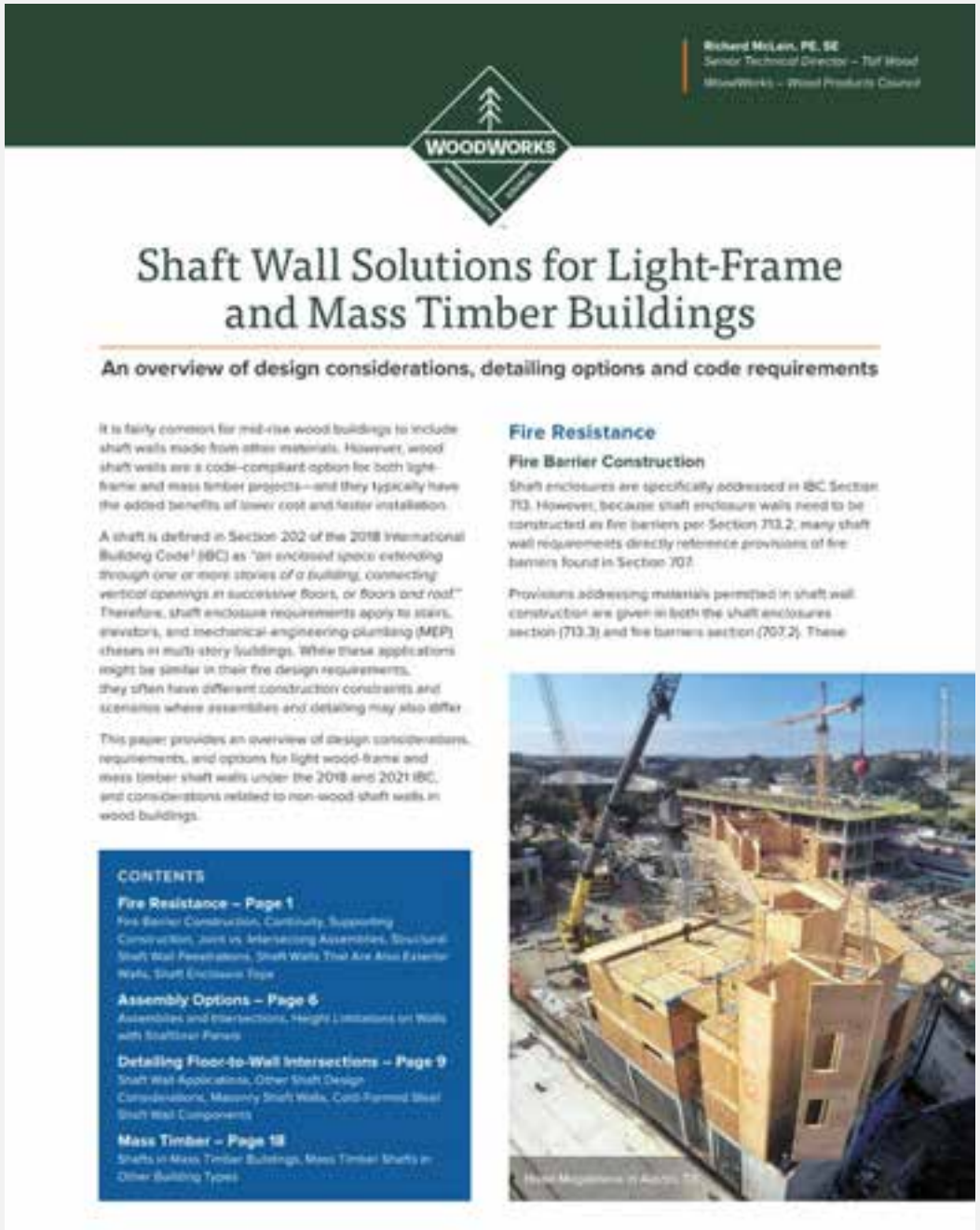
JASON BAHR, PE

DECEMBER 13, 2022

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

WOODWORKS

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 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 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.

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 Gypsum 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

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

https://www.woodworks.org/resources/shaft-wall-solutions-for-wood-frame-buildings/

Shaft Walls

Mass Timber

Photo: Quality Contractors

Steel Studs, Wood Studs

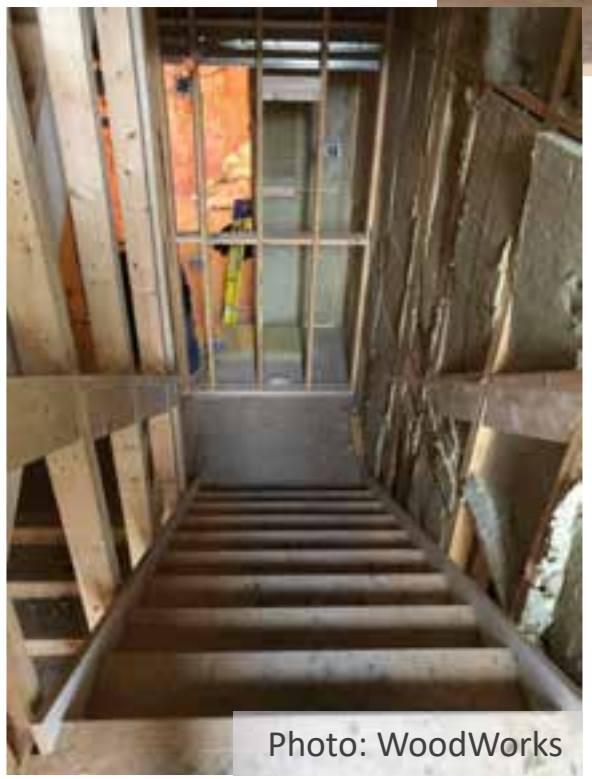


Photo: WoodWorks

Shaftliner Panels

Photo: Georgia Pacific

Masonry

Photo: WoodWorks

Types of Shaft Walls

Types of Shafts:

- Elevator
- Stair
- Mechanical


Photo: Jeff Morrow

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.

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.

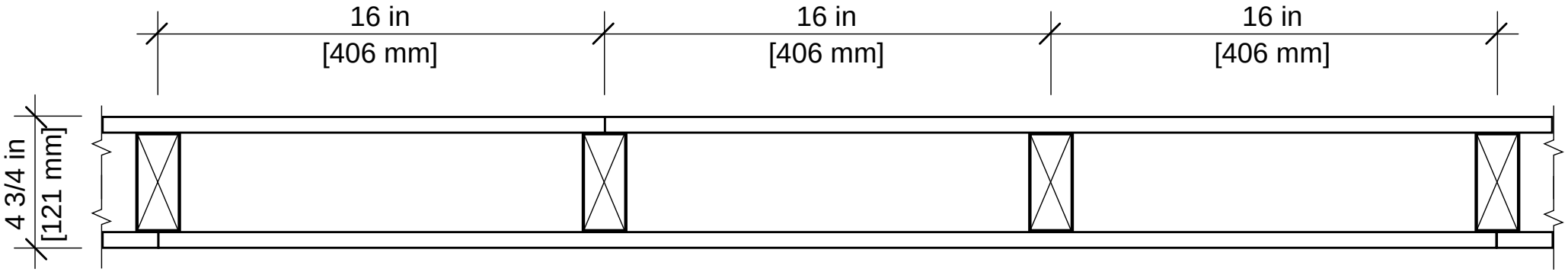
- IBC 713.2: Shaft Walls shall be constructed as **Fire Barriers**
- Many shaft wall provisions contained in *IBC Section 707: Fire Barriers*

Shaft Wall 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.

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

Continuity Provisions

Section 713: Shaft Enclosures

713.5 Continuity.

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

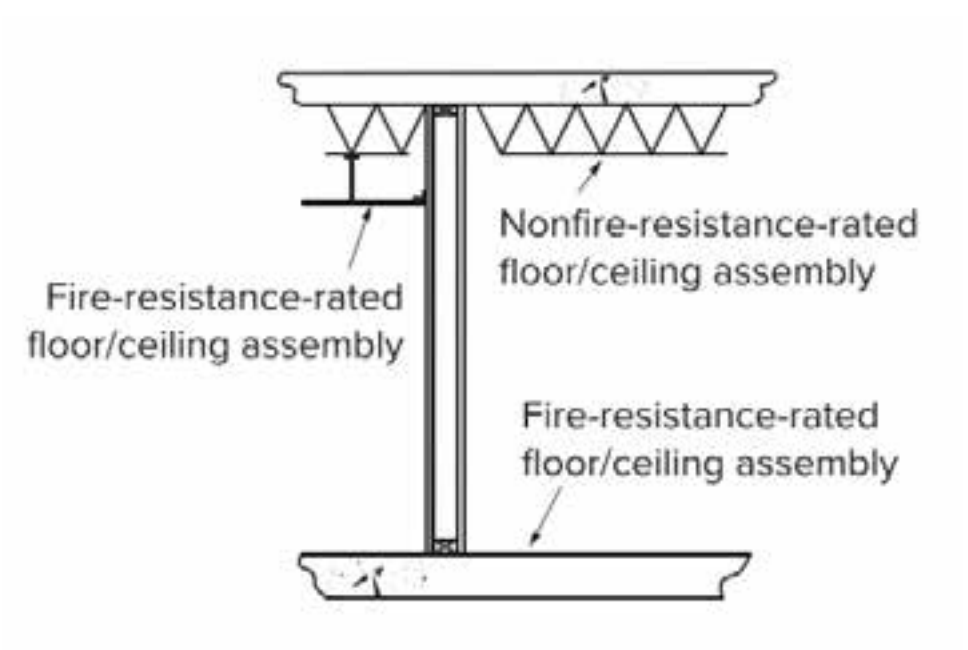
Section 707: Fire Barriers

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?



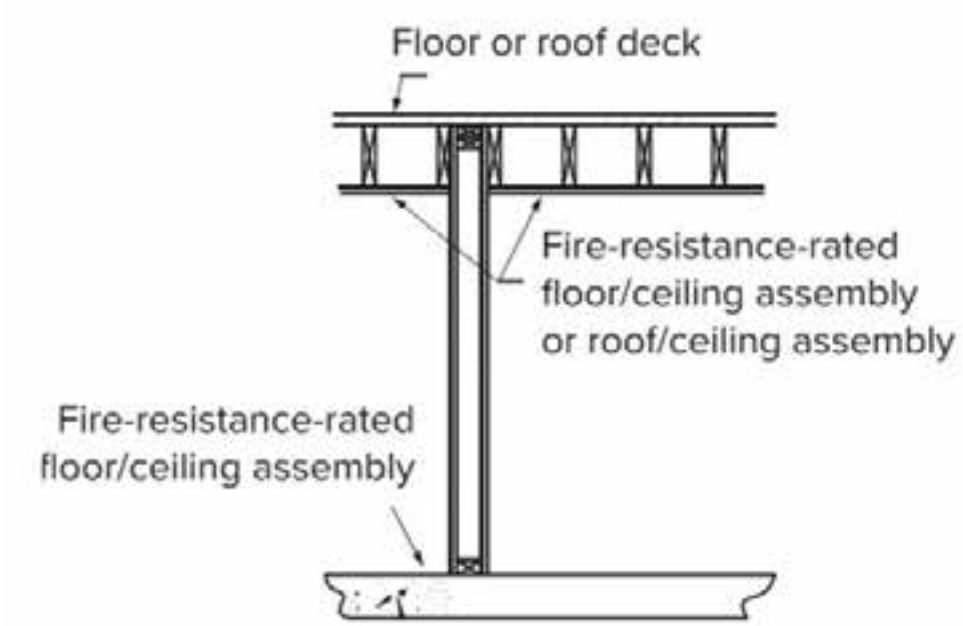


FIGURE 1: IBC Commentary Figure 707.5 – Continuity of fire barriers

Fire Barriers – IBC 707

Common Detailing Method: Fire Barrier & membrane extend to underside of floor deck above

Photo: WoodWorks

Fire Barriers – IBC 707

The 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

Photo: WoodWorks

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.

Section 707: Fire Barriers

707.7 Penetrations.

Penetrations of fire barriers shall comply with Section 714.

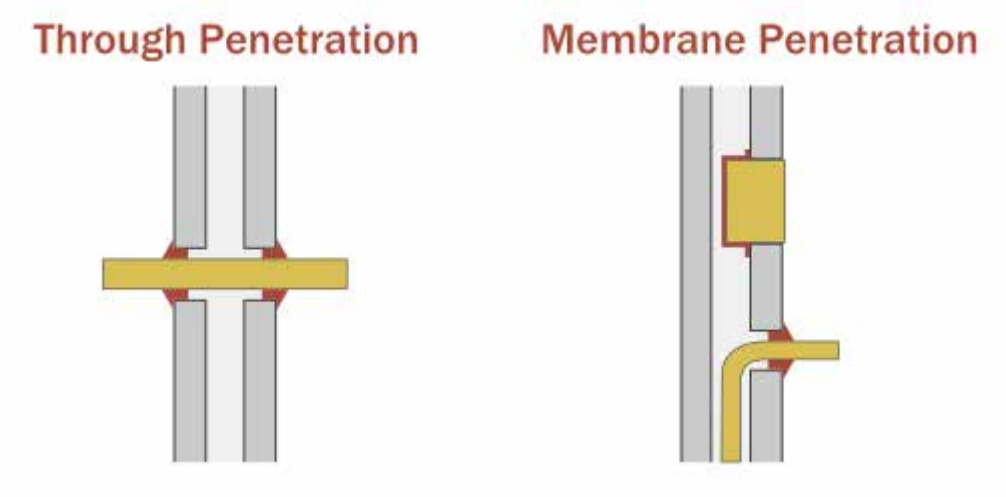
Penetrations in Shaft Walls

Where are structural penetrations in shaft walls common?

- Main floor joists to shaft wall connection
- Stair framing to shaft wall connection

Credit: WoodWorks

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

Credit: STI

Credit: WoodWorks

Penetrations in Shaft Walls

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

Credit: WoodWorks

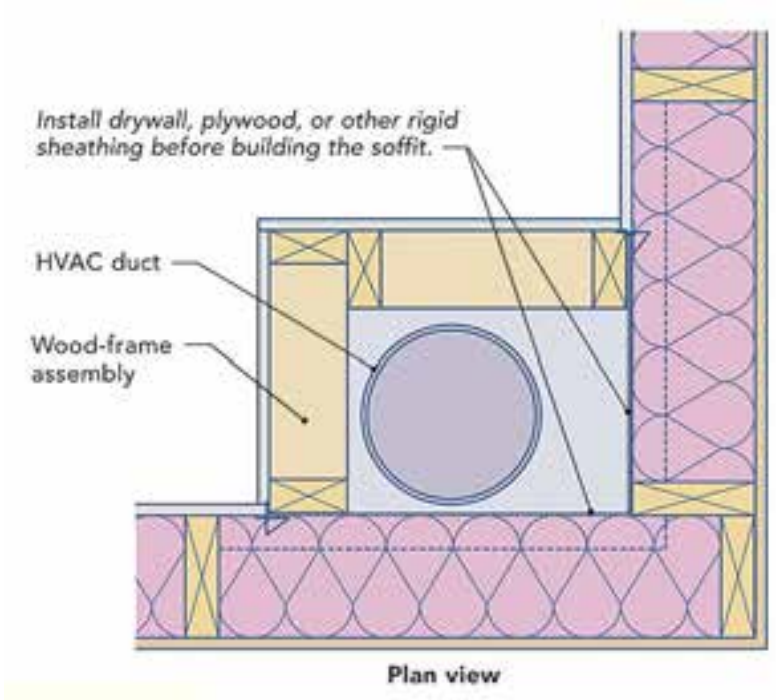
- Some firestopping systems available as tested configurations for wood conditions
- Most manufacturers can provide engineering judgement details, certification statements for this condition

Stair, Elevator & MEP Shafts

Main Differences & Unique Design Constraints:

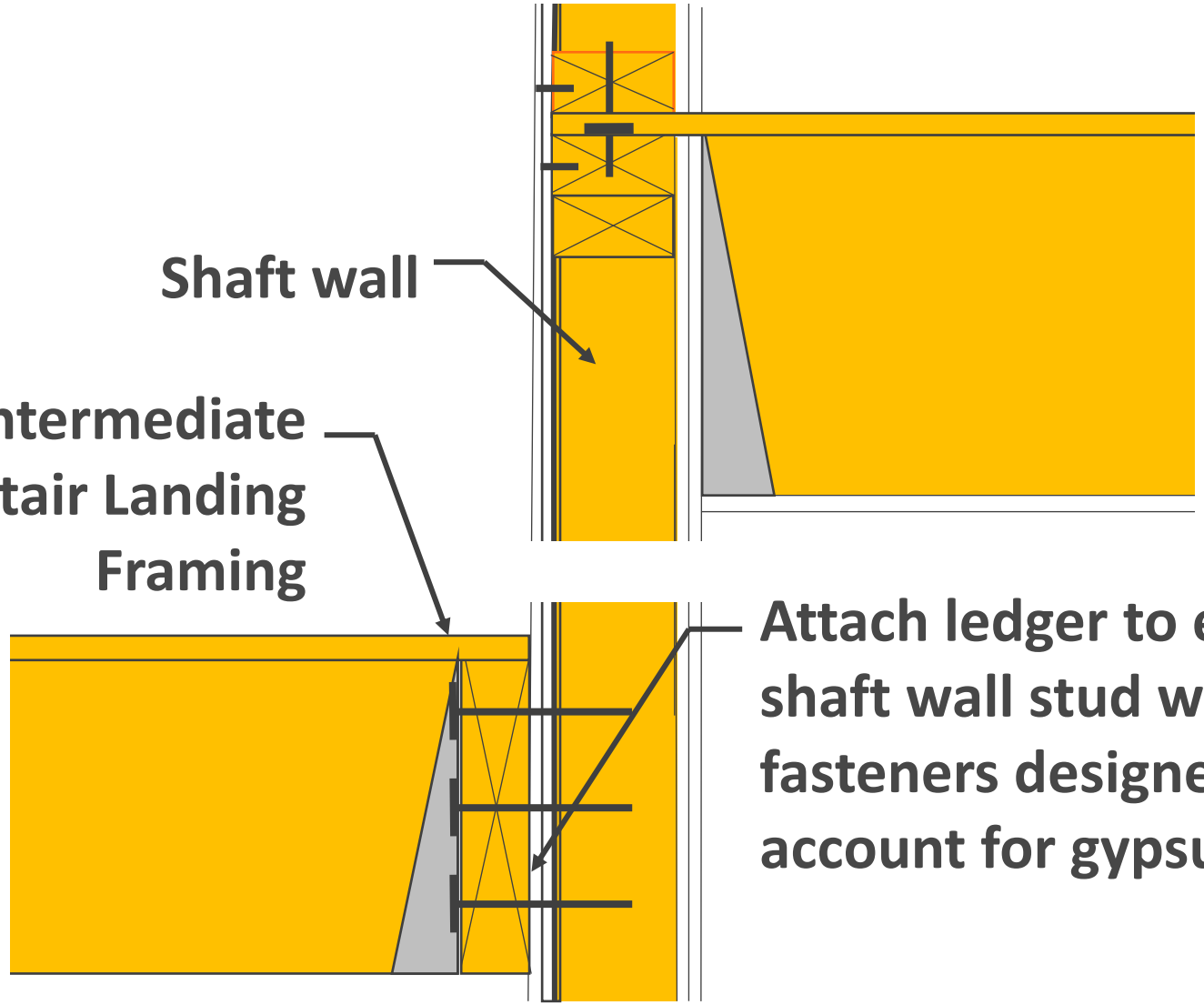
- Stair Shafts – Stair Framing
- Elevator Shafts – Rail supports
- MEP Shafts – Small Size


Credit: WoodWorks




Credit: WoodWorks

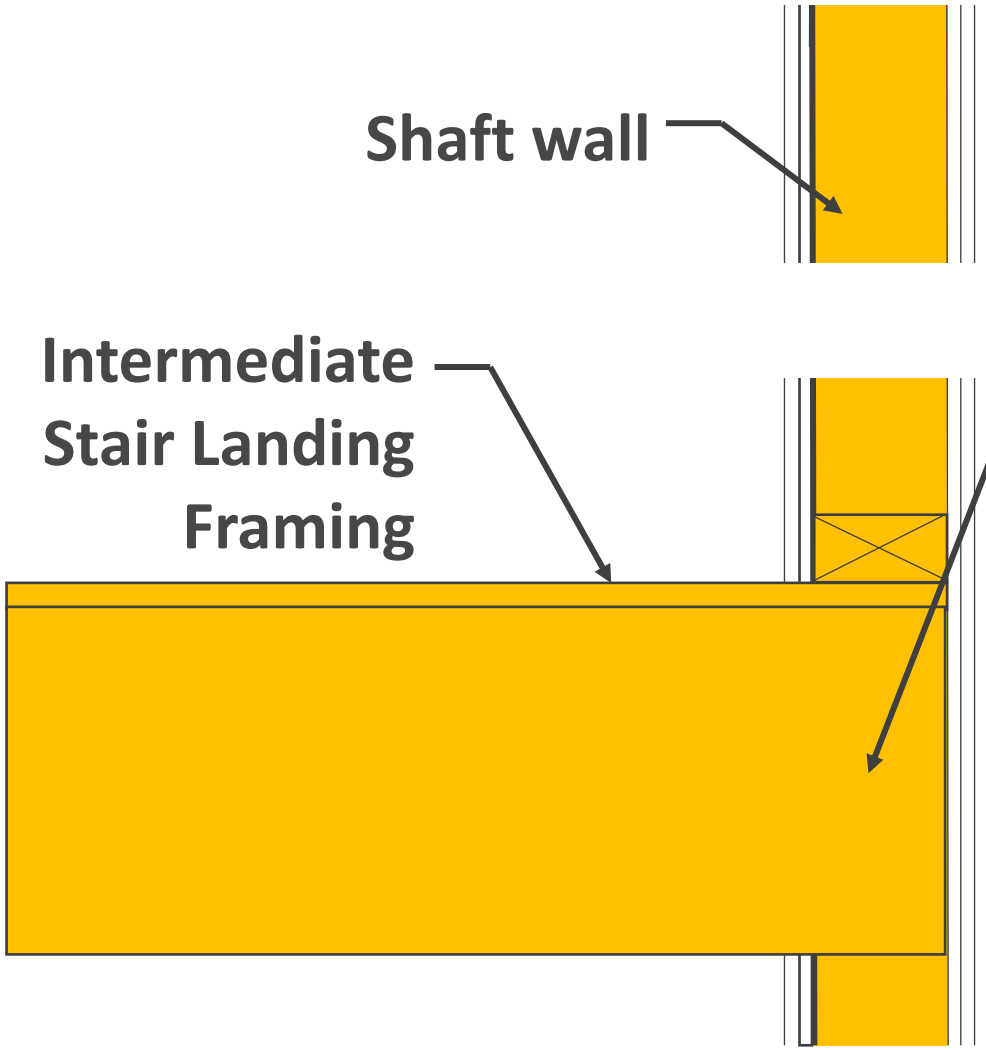
Stair Shafts




Credit: WoodWorks

Stairway Shaft Enclosures & Framing

Stair Shafts



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

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

Stair Shafts

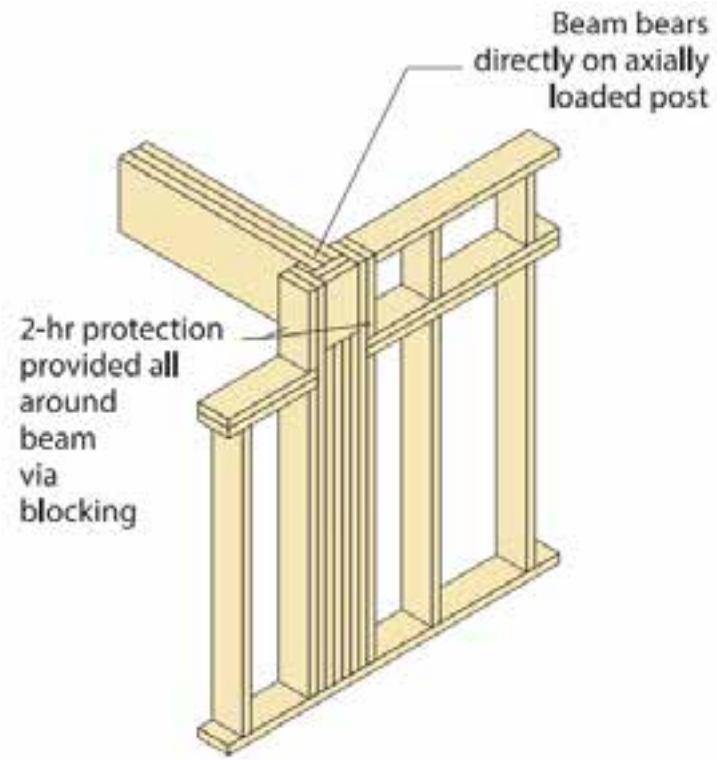
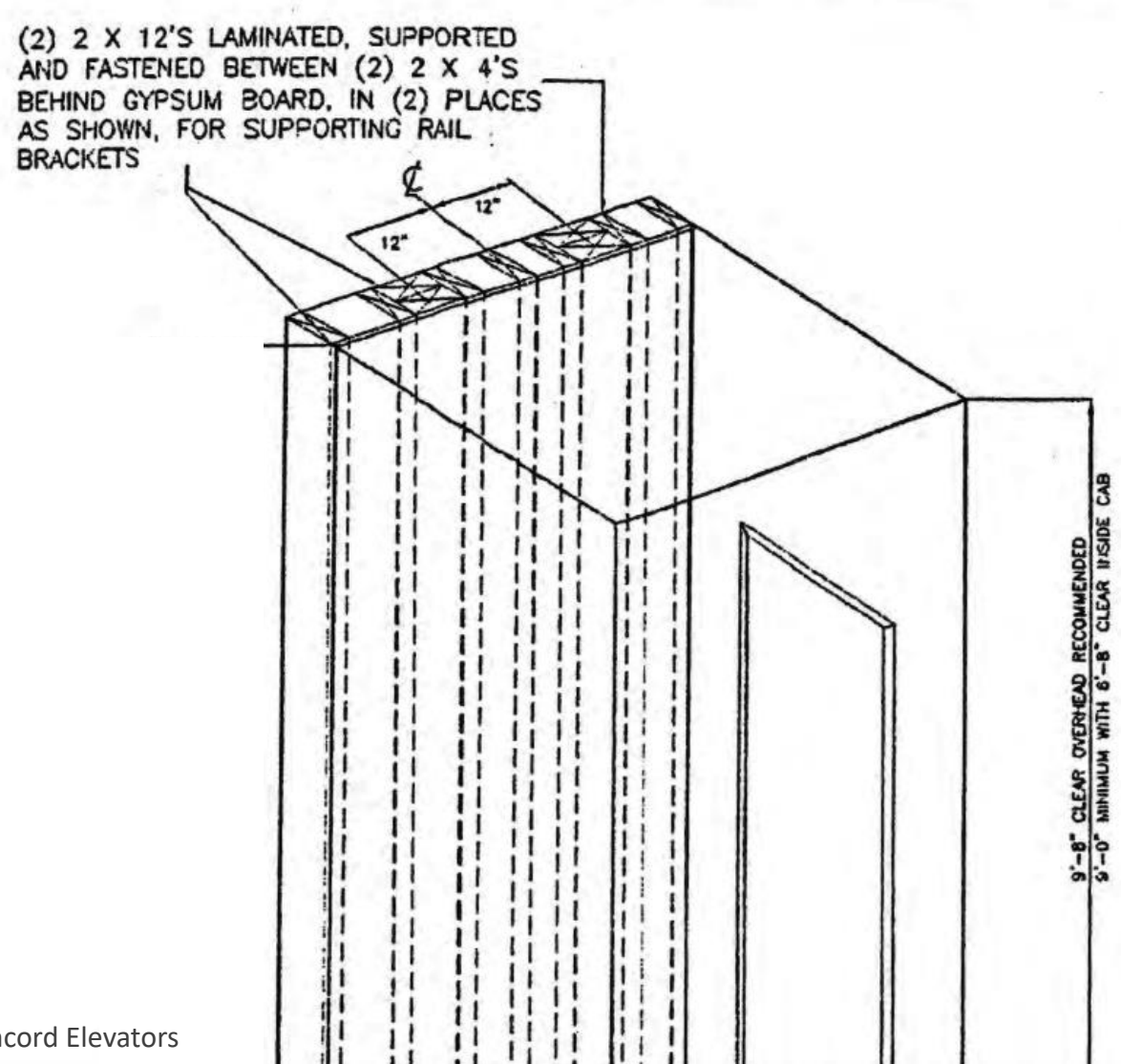


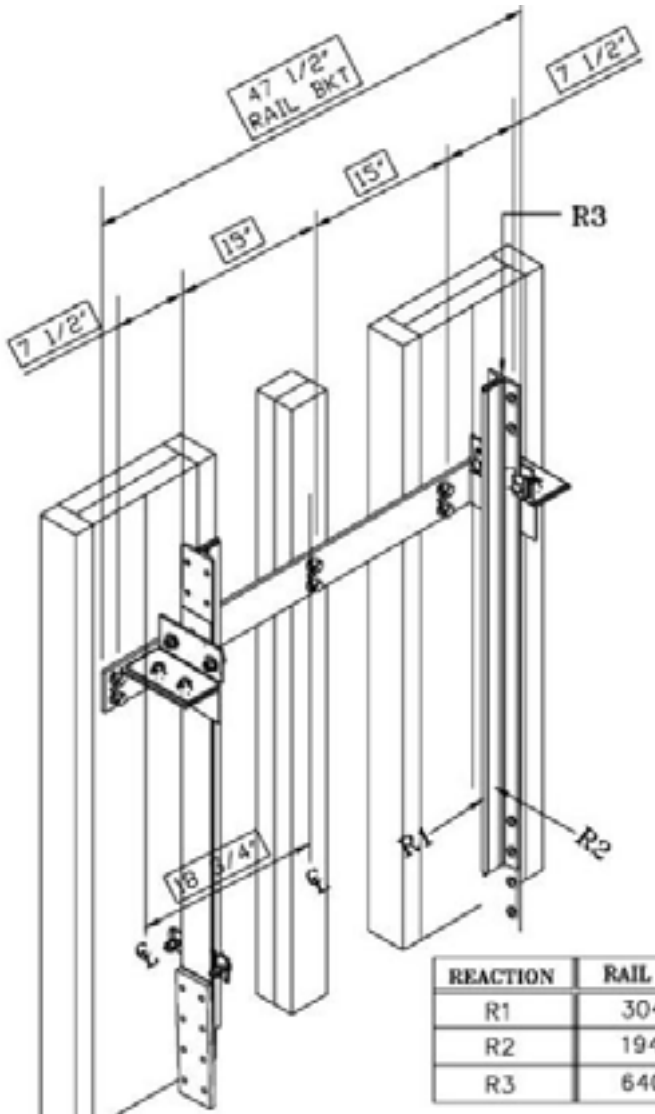
FIGURE 17: Stair framing beam in protected pocket in the shaft wall


Credit: WoodWorks

Elevator Shafts

Elevator Shafts

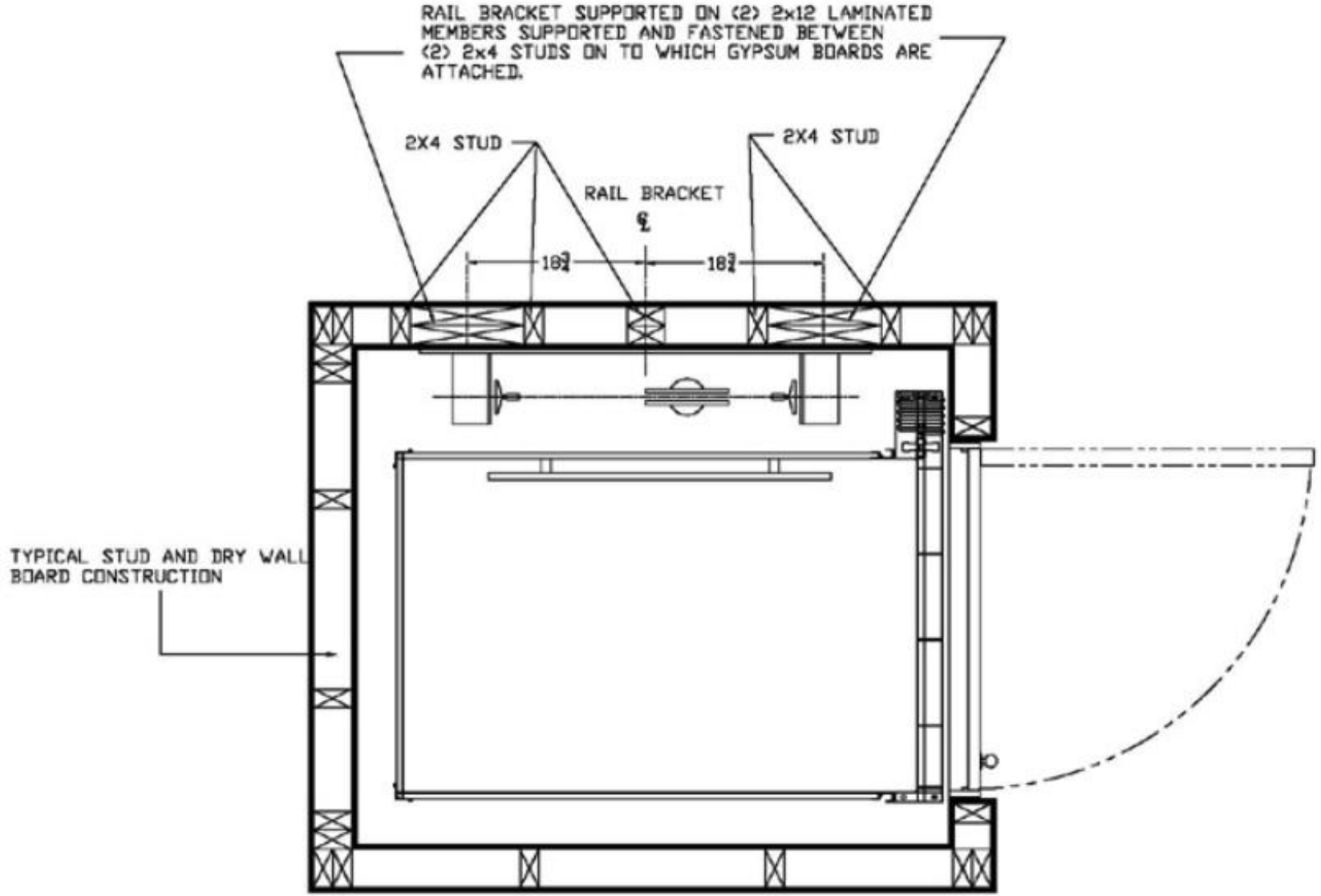




REACTION	RAIL FORCES
R1	304 LBS
R2	194 LBS
R3	6400 LBS

Credit: Concord Elevators

Elevator Shafts



Credit: Concord Elevators

MEP Shafts

Credit: WoodWorks

- 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

Floor to Shaft Wall Detailing

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

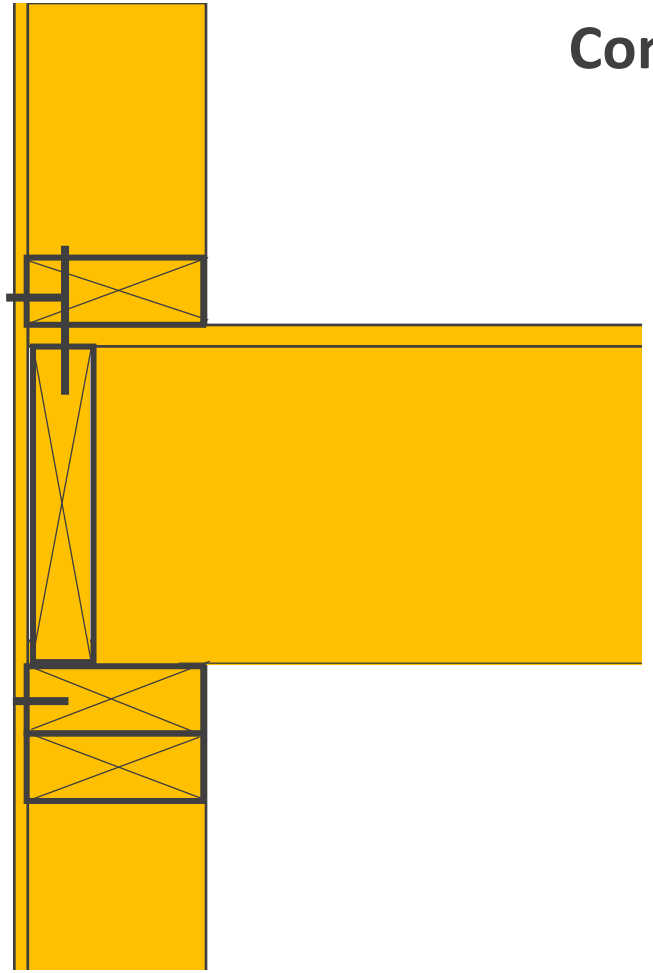
Some key considerations are:

- 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, rationale, insight

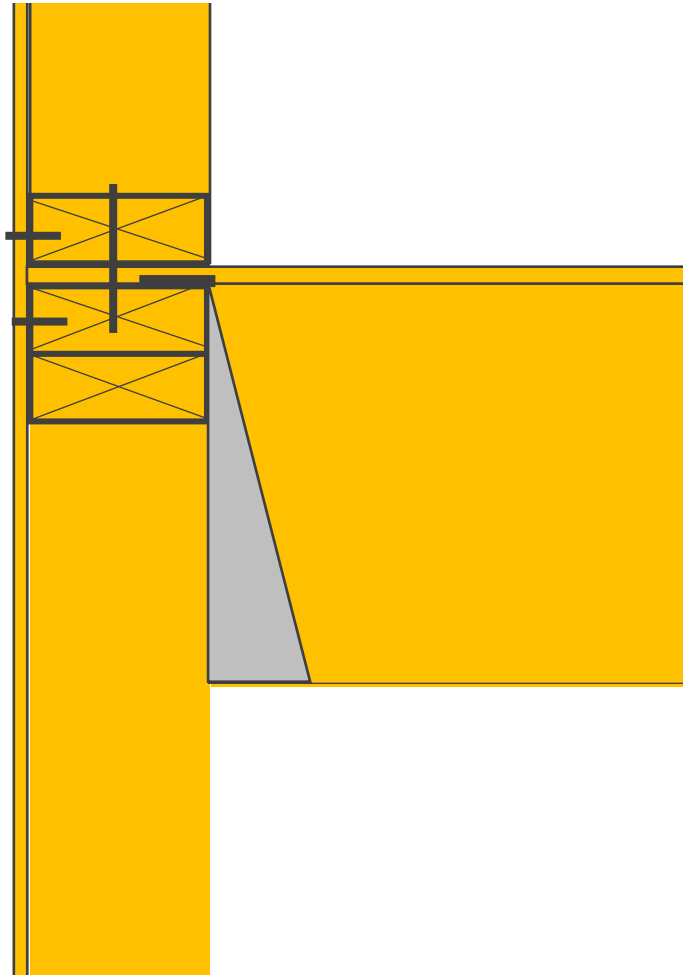
Light Wood-Frame Shaft Walls in Light Wood-Frame Buildings

Floor to Shaft Wall Detailing

Common Details



Platform Framing

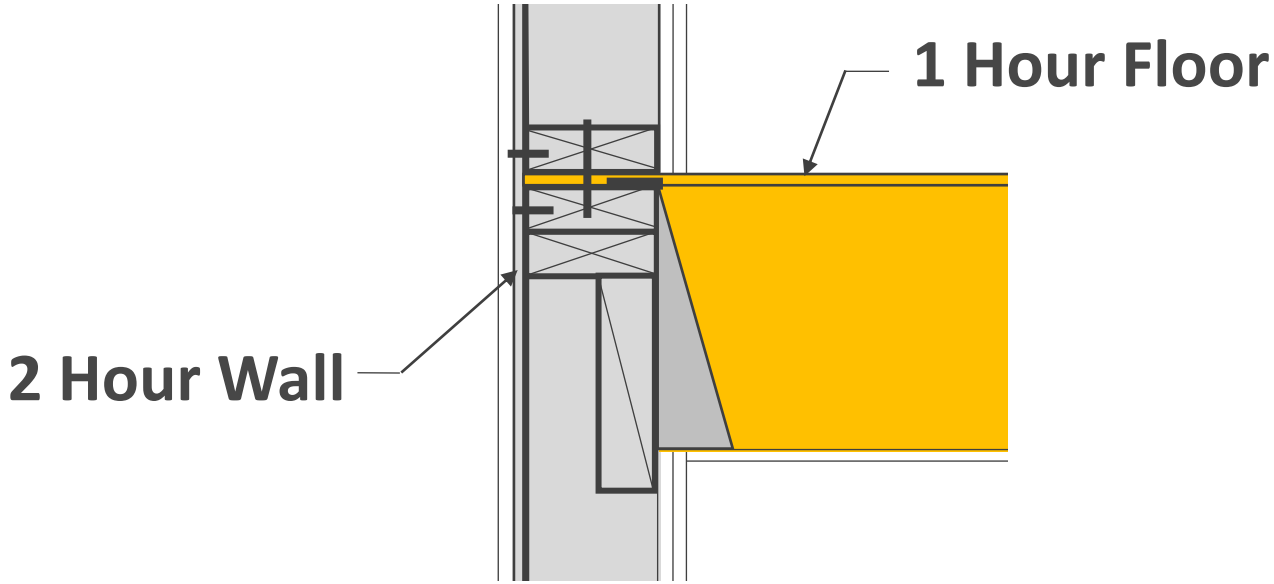


Semi-Balloon Framing

Floor to Shaft Wall Detailing

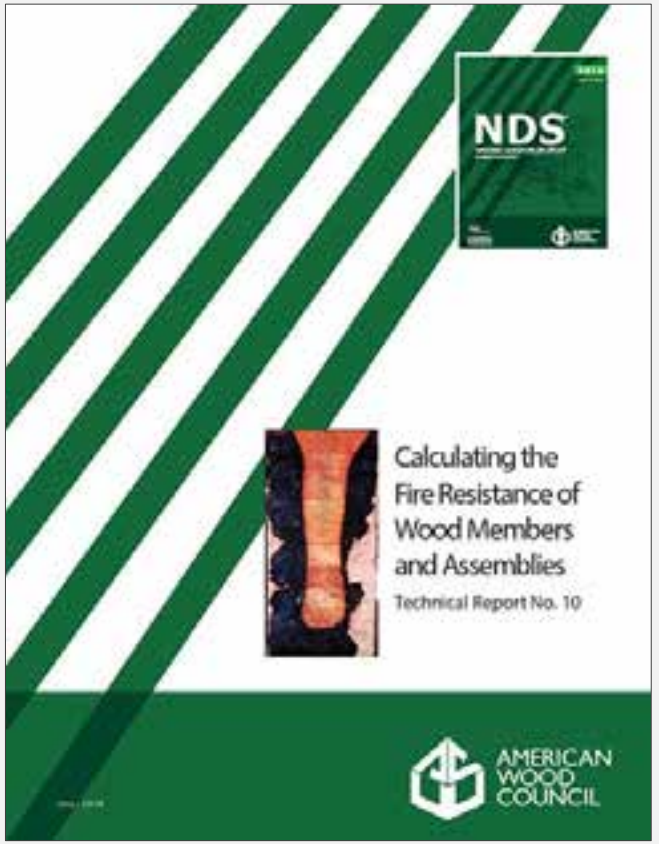
Supporting Construction: In platform and semi-balloon frame construction, if we have a 2-hour shaft wall and a 1-hour floor, how do we achieve this?

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"



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)



Floor to Shaft Wall Detailing

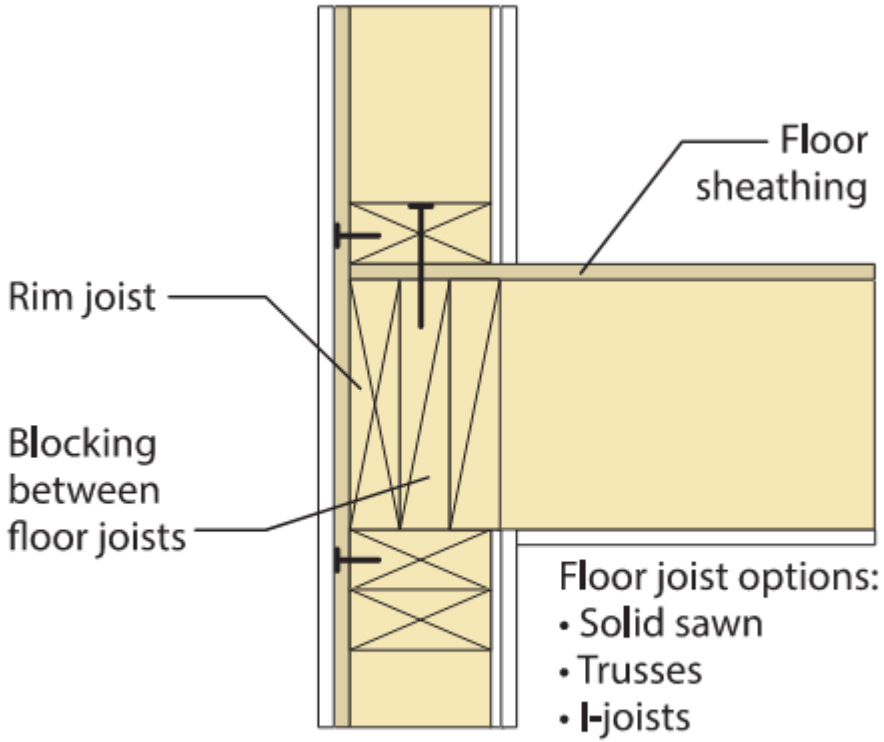


FIGURE 11: Floor-to-shaft wall intersection with blocking between floor joists

- Fire-resistance rating 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
- Combustibility of the material is not an issue; must meet the fire rating requirement

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

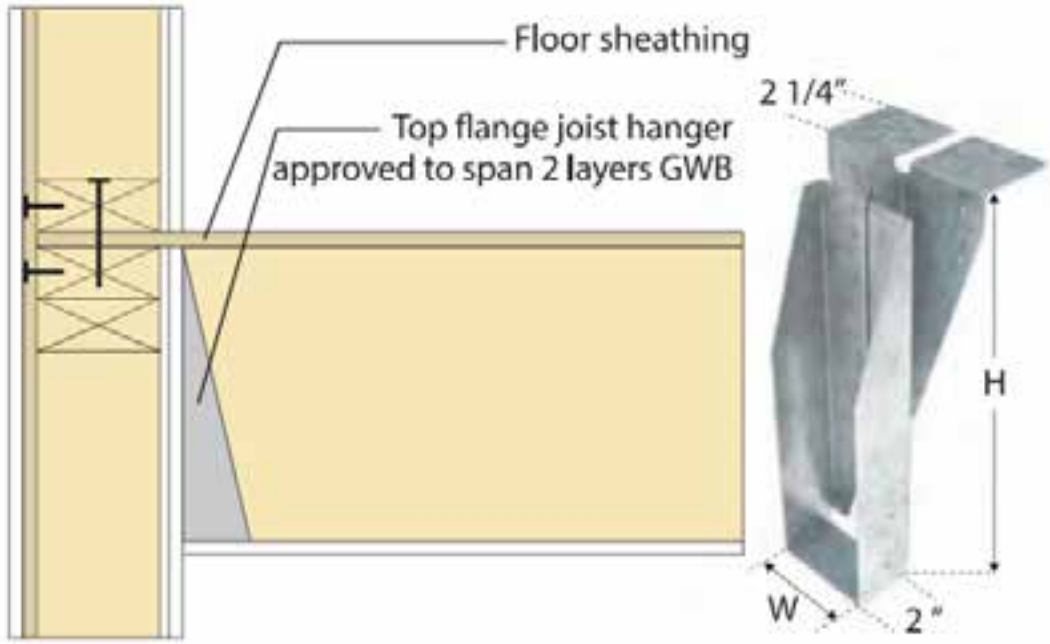
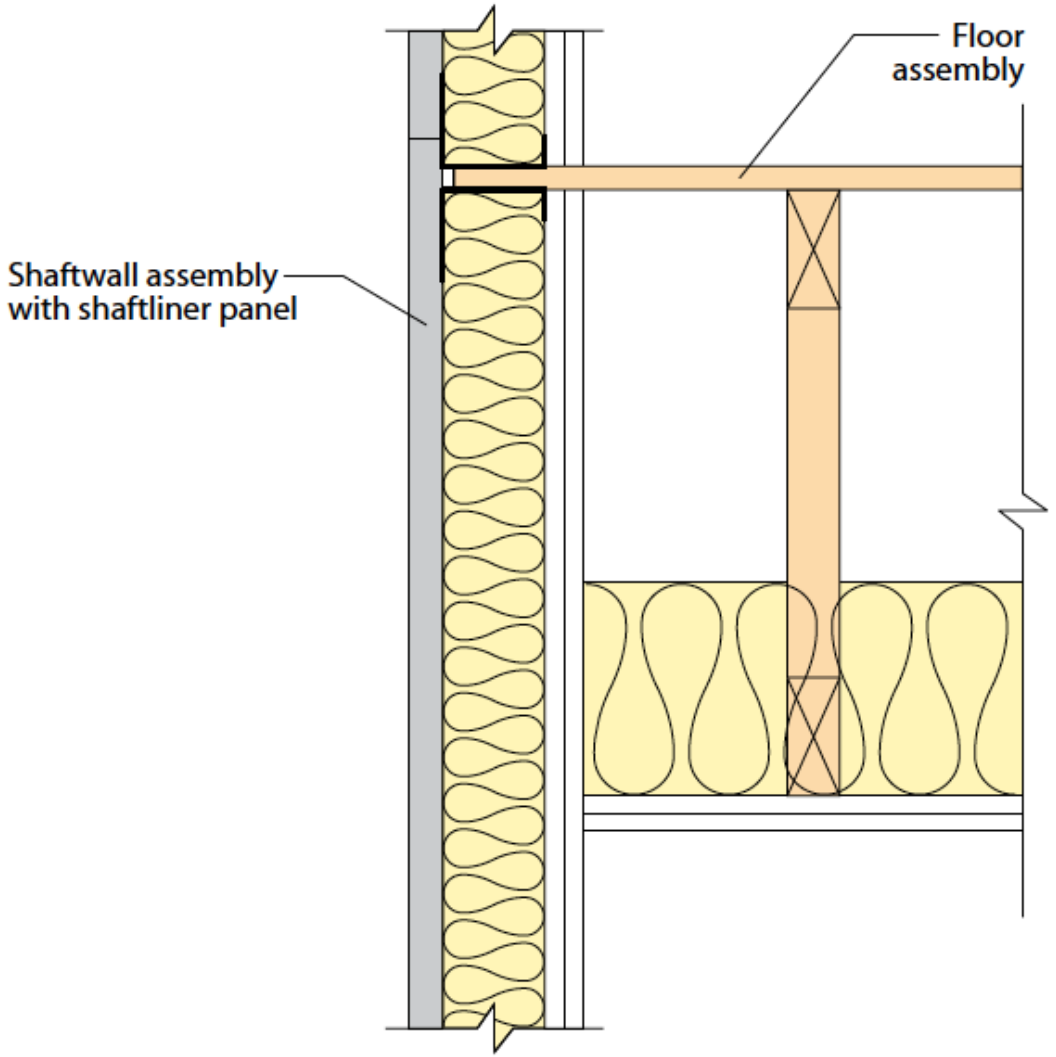


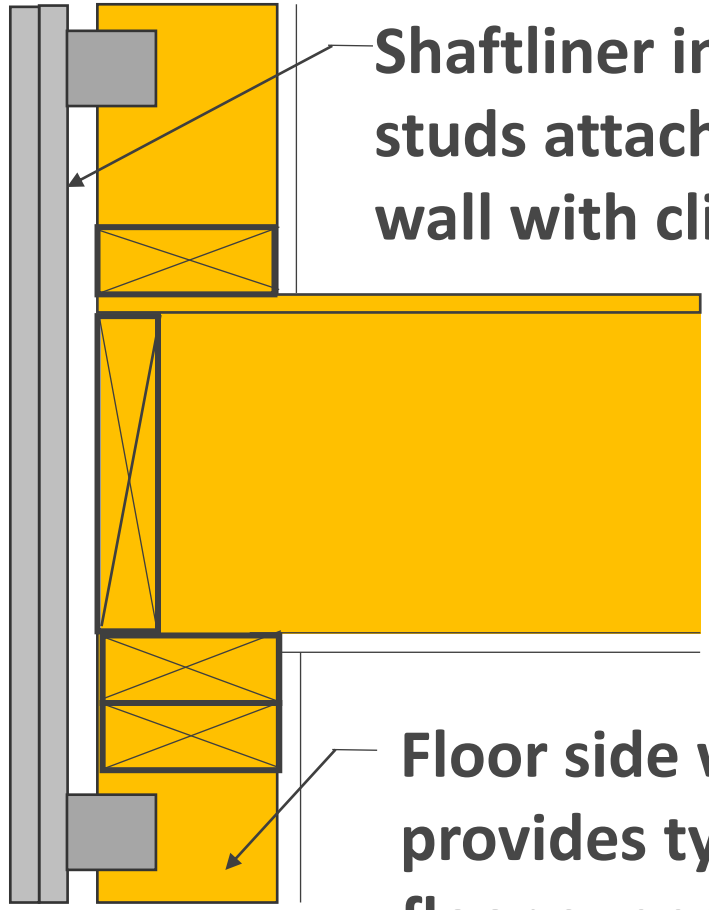
FIGURE 14: Floor-to-shaft wall intersection with hangers designed to span over gypsum

Credit (image on the right): MiTek Builder Products

Shaftliner Systems in Light Wood-Frame Buildings

Floor to Shaft Wall Detailing





Shaftliner in H-studs attached to wall with clips

Floor side wall provides typical floor support

Mass Timber Shafts in Light Wood-Frame Buildings

Floor to Shaft Wall Detailing

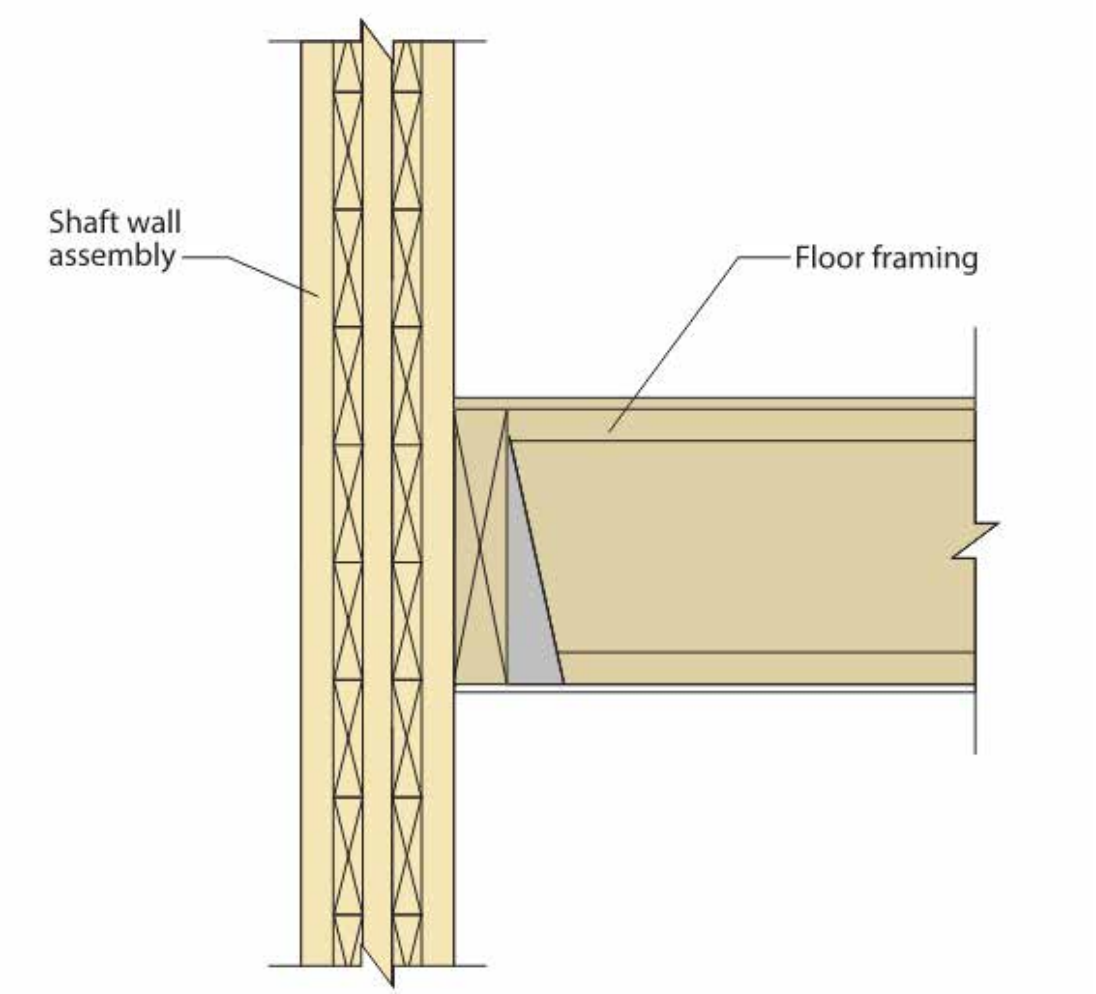
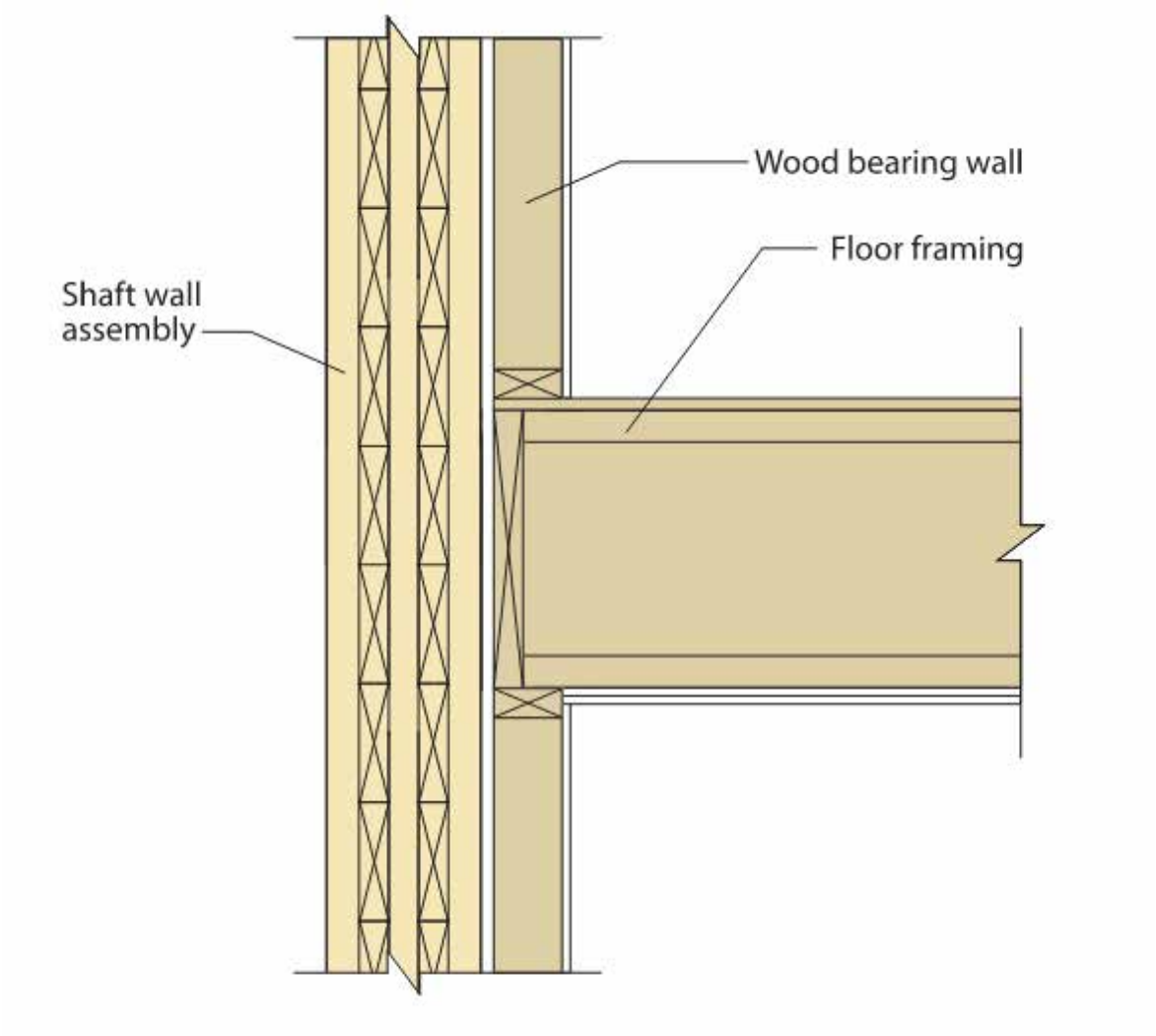
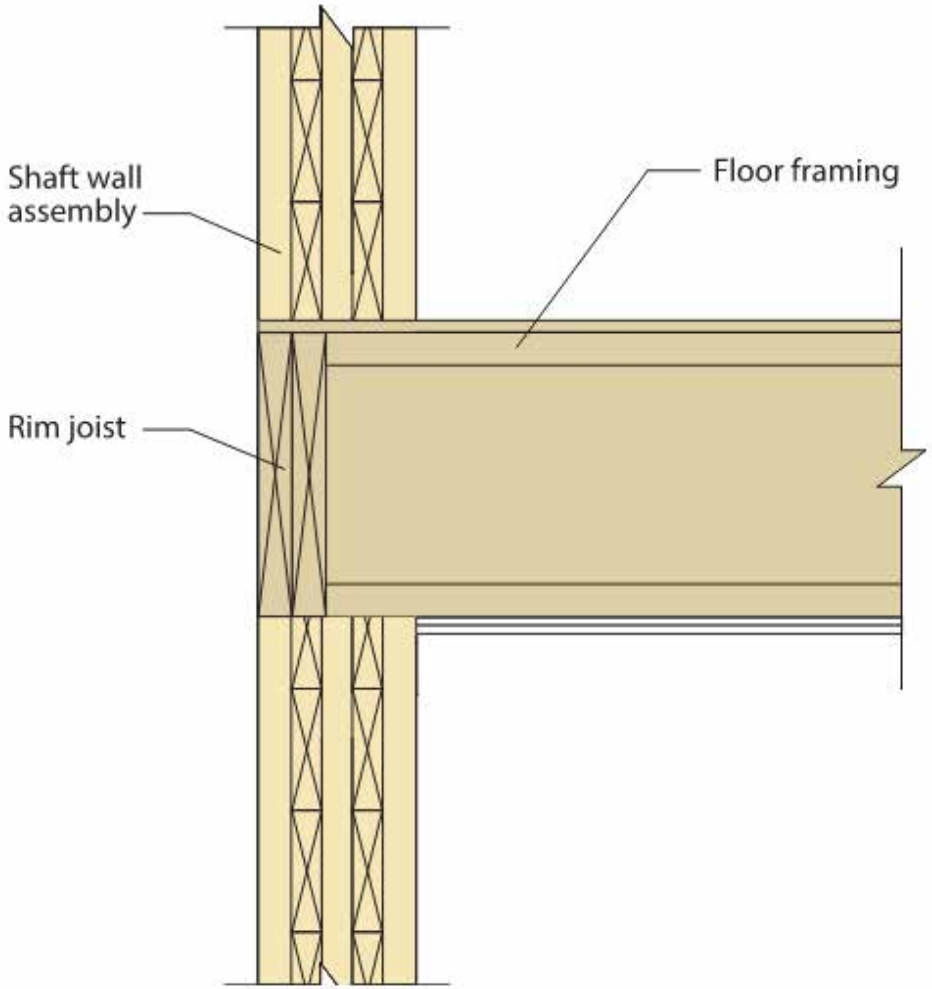



Photo: Alex Schreyer

Floor to Shaft Wall Detailing



Floor to Shaft Wall Detailing



Other Shaft Wall Materials in Light Wood-Frame Buildings

Masonry Shaft Walls

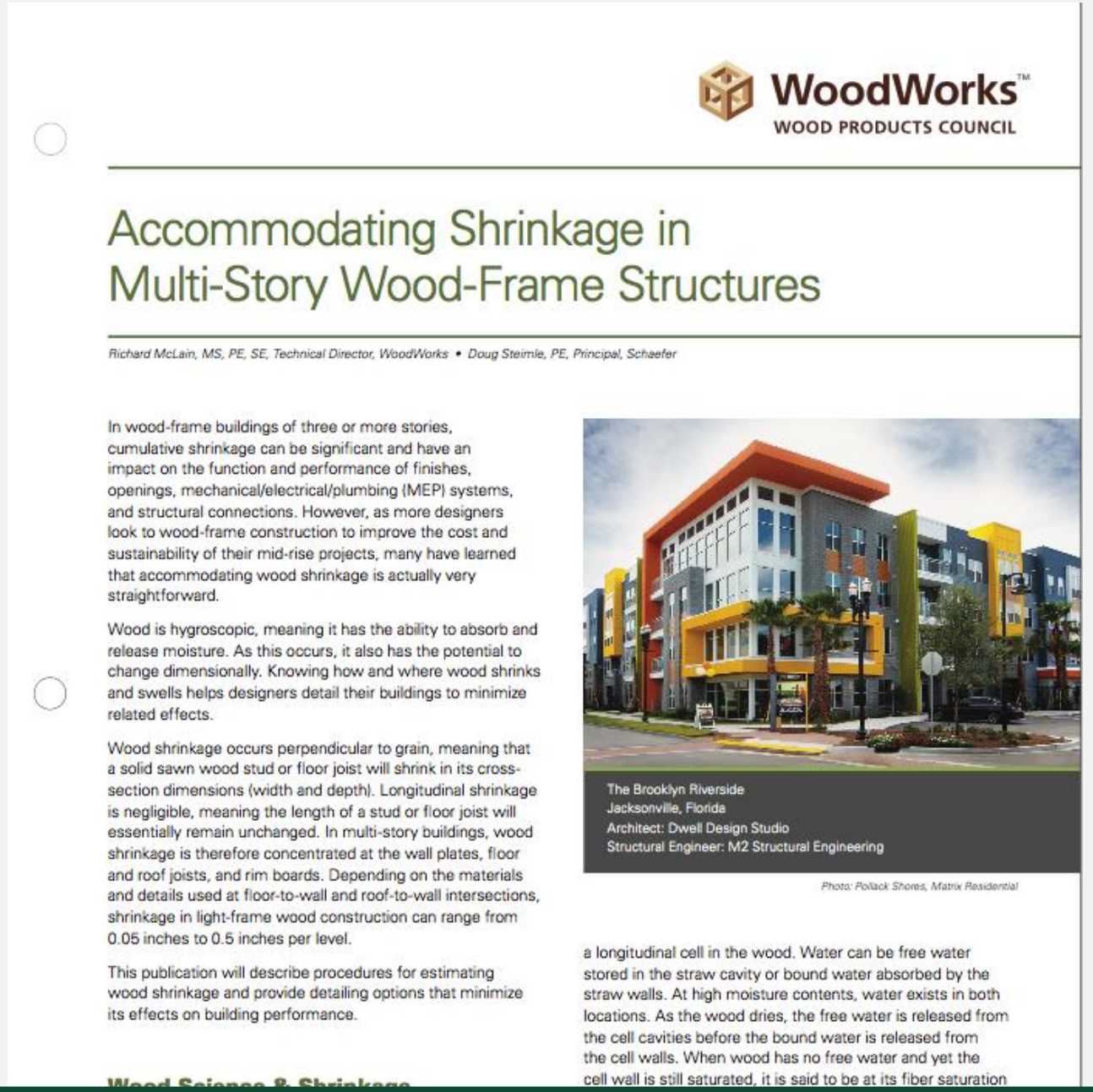
Mixing masonry shaft walls with wood floor framing can create several issues:

- 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 seismically isolating masonry shaft walls, only tie wood floor to masonry shaft if/where required (i.e., at door threshold)

Shrinkage & Movement Resource

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

Free resource at **woodworks.org**



WoodWorks™
WOOD PRODUCTS COUNCIL

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 cell wall is still saturated, it is said to be at its fiber saturation

https://www.woodworks.org/resources/accommodating-shrinkage-in-multi-story-wood-frame-structures/

Thank You!

Jason Bahr, PE

WoodWorks Regional Director | KS, AR, MO, OK, IA, MN

Jason.Bahr@woodworks.org

Copyright Materials

Funding provided in part by the Softwood Lumber Board