Shaft Wall Solutions for Wood-Frame Structures

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Shaft Walls
Shaft Walls

Shaft Walls Form Shaft Enclosures

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

Source: IBC Commentary to Section 713.1
Types of Shaft Walls

Types of Shafts:
- Elevator
- Stair
- Mechanical
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 Ratings:

713.4 Fire-Resistance Rating:

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

SECTION 707
FIRE BARRIERS

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

- Wood-framed shaft walls permitted for any shaft walls in construction types III, IV and V
Shaft Wall Materials

**Type III Construction:**
Any material permitted by code for all interior elements
Fire-retardant treated wood for exterior walls

**Type IV Construction:**
Heavy/mass timber members (or any wood wall min. 1 hr) for all interior elements
Fire retardant treated wood or CLT for exterior walls

**Type V Construction:**
Any material permitted by code for all interior and exterior elements
# Shaft Wall Materials

<table>
<thead>
<tr>
<th></th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
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</thead>
<tbody>
<tr>
<td><strong>Interior Shaft Walls</strong></td>
<td>Any code permitted wood framing</td>
<td>Heavy timber or any code permitted wood framing (min. 1 hr rated required)</td>
<td>Any code permitted wood framing</td>
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<tr>
<td><strong>Exterior Shaft Walls</strong></td>
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Shaft Wall Materials

Light Frame Wood Shaft Walls

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

Mass Timber Shaft Walls

• Cost
• Construction Schedule
• Can double as architectural feature
• Successful fire tests for 2 Hr mass timber shaft walls exist (exposed and protected)

Photo: Lendlease
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-resistance-rated floor/ceiling assembly
- Nonfire-resistance-rated floor/ceiling assembly
- Fire-resistance-rated floor/ceiling assembly
- Fire-resistance-rated floor/ceiling assembly or roof/ceiling assembly
- Floor or roof deck
Continuity Provisions
Continuity Provisions

How do we achieve these requirements?

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

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

We’ll cover some detailing options later...
Supporting Construction Provisions

IBC 707.5.1 Supporting Construction:
• The supporting construction for a fire barrier shall be protected to afford the required fire-resistance rating of the fire barrier supported.

i.e. shaft walls that are not continuous to lowest level
Joints in Shaft Walls

SECION 707
FIRE BARRIERS

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

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

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

SECTION 713
SHAFT ENCLOSURES

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

SECION 707
FIRE BARRIERS

707.7 Penetrations.
Penetrations of fire barriers shall comply with Section 714.
Penetrations in Shaft Walls

Where are structural penetrations in shaft walls common?
• Main Floor Joists to Shaft Wall Connection
• Stair framing to Shaft Wall Connection
Penetrations in Shaft Walls

SECTION 714
PENETRATIONS

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

OR

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

To some, a new way of thinking:
Many are familiar with firestopping for MEP, but not structure, especially wood structure
Penetrations in Shaft Walls

Stair landing beam shaft wall structural penetration prior to firestop system installation
Shaft Walls that are also Exterior Walls

Structural Considerations
Shaft Walls that are also Exterior Walls

**Typical Exterior Wall Condition**
- Floor Diaphragm Braces Wall Joint
- Wind Loads on Exterior Wall

**Exterior Wall That is Shaft Wall**
- No Floor at Shaft to Brace Wall Joint
- Wind Loads on Exterior Wall
Shaft Walls that are also Exterior Walls

Intermediate Stair Landing Framing

Shaft wall

Consider “Hinge” at wall plates for out-of-plane wind & seismic loads due to lack of adjacent floor:
• Span plates horizontally
Shaft Walls that are also Exterior Walls

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

- Install additional member (rim) to span horizontally
Stairway Shaft Enclosures & Framing

Intermediate Stair Landing

Exterior Wall Plate Elevations Shifted Down to Intermediate Landing Elevation

- Eliminates Hinge Effect
- Avoids Interference with Landing Windows

Intermediate Stair Landing

When Stair Shaft Wall is Exterior Wall

2x10 LEDGER FASTED TO EACH WALL STUD WITH (3) 16d NAILS

LU210 FACE MOUNT HANGER
Shaft Wall Assemblies

Assembly selection considerations
• Fire resistance rating requirement (1 hr or 2 hr)
• Size and height of shaft
• Structural needs (gravity & lateral loads)
• Acoustics
• Space available for wall (allowed thickness)
Stair, Elevator & MEP Shafts

Main Differences & Unique Design Constraints
• Stair Shafts – Stair Framing
• Elevator Shafts – Rail supports
• MEP Shafts – Small Size
Shaft Wall Assemblies

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

1-Hour Double Wall
- UL U341

1-Hour Wall with Shaftliner
- UL V455
- UL V433
Shaft Wall Assemblies

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

2-Hour Double Wall
- UL U342
- UL U370
- GA WP 3820

2-Hour Wall with Shaftliner
- UL U336
- UL U373
- UL U375
- UL V455
- UL V433
- GA ASW 1000
Shaft Wall Assemblies W/Shaftliner

**2-Hour Fire Rating**
Design Reference: UL U373, ULC W312, WHI GP/WA 120-03, cUL U373

**59 STC Sound Trans.**
Test Reference: RAL TL 10-290

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

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

Source: Georgia Pacific

Source: UL U375
Shaft Wall Assemblies W/Shaftliner

Wood Framed Wall on 3 Sides of Shaft

CH Studs w/Shaftliner on 4th Side of Shaft
Shaft Wall Assemblies W/Shaftliner

Can also utilize wood framed shaft walls on 3 sides and CH studs with shaftliner on 4th side
Floor to Shaft Wall Detailing

Shaftliner in H-studs attached to wall with clips

Floor side wall provides typical floor support
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

- Fire-resistance rating still continues to the underside of the deck
- Assumes a tested assembly to the top of wall plate
- Above wall top plate, uses 703.3 allowance for fire-resistance calculations per 722
- 722 allows NDS Chapter 16 methods for fire resistance calculations for exposed wood
- The combustibility of the material is not an issue; must meet the fire rating requirement
AWC’s DCA3 provides floor to wall intersection detailing options

Addresses both continuity provisions and requirements for FRT elements in exterior wall plane
Floor to Shaft Wall Detailing

**FIGURE 11:**

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

- (2) 2x flat blocking between trusses
- Extend wall gypsum to underside of sheathing between trusses
- Floor sheathing
- Specify truss web holdback to allow gypsum installation
Floor to Shaft Wall Detailing

**FIGURE 12:**
Floor-to-Shaft Wall Intersection Detail with Supporting Beam Just Inboard of Wall

- Floor sheathing
- Ledger for ceiling attachment
- Floor joist
- Joist hanger
- Floor beam
Floor to Shaft Wall Detailing

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

- Can be a challenge structurally to make fasteners work
- Scheduling and sequencing considerations
- Allows use of standard face mount hangers
- A common situation at stair shaft intermediate framing
FIGURE 20: Mass Timber Floor Framing-to- Shaft Wall Attachment

- Gypsum wallboard (if required)
- Mass timber shaft wall
- Ledger for floor framing
- Floor framing
Stair Shafts

Attach ledger to each shaft wall stud with fasteners designed to account for gypsum.
Stair Shafts

- Wood blocking in wall used to achieve 1 hour of continuity
- Alternatively – interrupt both gypsum layers and use 2 layers of blocking in wall
- Key to attach ledger to studs, not blocking
Rationale for detail approval:
• Membranes on both side of wall provide fire resistance via their approved assembly; at floor cavity beam oversized to provide 2 hour char protection
Stair Shafts

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

- Beam bears directly on axially loaded post
- 2-hr protection provided all around beam via blocking
Elevator Shafts
Elevator Shafts

Rail bracket supported on (2) 2x12 laminated members supported and fastened between (2) 2x4 studs on to which gypsum boards are attached.

2x4 stud

Rail bracket

Typical stud and dry wall board construction
Elevator Shafts

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

• Size of MEP shaft may require a solution with one or more sides being shaftliner panels
• Ability to get inside shaft to finish gypsum panels often the controlling factor in wall assembly selection
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
This concludes The American Institute of Architects Continuing Education Systems Course

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WoodWorks