Frequently Asked Questions Regarding Continuity of Fire Resistance in Cold-Formed Steel Structures

By Robert Grupe, SFIA General Manager, Architectural Services

Executive Summary

Current editions of the IBC model building code mandate various levels of continuity of fire-resistant rated walls and partitions in a building. This continuity extends both vertically and horizontally throughout the structure. This paper will address the following points:

1. At issue is the interface between the specific wall or partition and a floor or roof/ceiling assembly. The primary question is whether the wall should be continuous through the horizontal assembly and, if so, what the structural implications are.

   There are seven wall types defined for continuity in the IBC code. They are:

   - Exterior walls
   - Fire walls
   - Fire barriers
   - Fire partitions
   - Shaft enclosures
   - Smoke barriers
   - Smoke partitions

2. In this discussion, mid-rise cold-formed steel (CFS) framed construction will be the focus with an emphasis on fire walls, fire barriers, and fire partitions. The following requirements on continuity found in the IBC relating to cold-formed steel (CFS) framing are offered:

   A fire wall must run continuously vertically from the foundation to, or through, the roof to divide one building into two independent buildings.

   A fire barrier must run vertically from floor assembly to floor (or roof) assembly. The barrier must be continuous from the foundation, or top of the floor, below to the underside of the floor or roof sheathing, slab or deck above, essentially penetrating the ceiling membrane of the upper floor assembly and extending through the upper floor framing cavity.

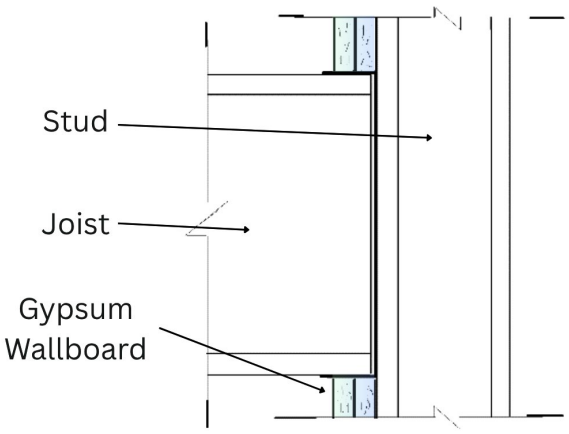
   A fire partition must be continuous from the foundation, or top of the floor, below to the underside of the floor or roof sheathing, deck or slab above, or to the underside of a floor/ceiling or roof/ceiling assembly having a fire-resistance rating that is not less than the fire-resistance rating of the fire partition.

3. Any proposed solution must be approved by the Authority Having Jurisdiction over the project in question. To further complicate the issue, the concept of continuity in this case typically cannot be validated through recognized test procedures.

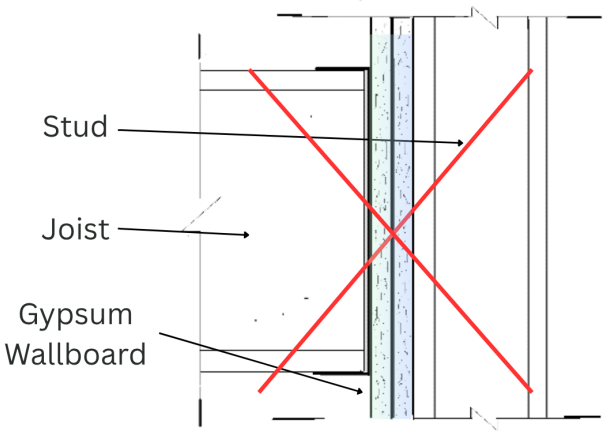
4. An important concept to understand is that structure takes precedence over fire resistance.

   An appropriate cold-formed steel (CFS)–framed structural connection requires two steel components in direct contact—for example, a stud and joist. A conflict arises when a literal interpretation of the building code—for fire resistance—places gypsum wallboard between the steel elements, a structurally untenable condition.

   This requirement, in conjunction with the inability to provide recognized test verification, positions potential solutions combining continuity and structure into an area prone to interpretation. The two illustrations below depict both a proper structural connection and an improper solution.



Detail A



Detail B

Detail A, a common balloon frame detail, is the **proper structural solution**.

The gypsum wallboard for fire resistance is broken at the floor line to accommodate the structural connection between the floor joist to the stud.

This is not meant to imply that the solution satisfies the fire-resistant requirement, but only the structural connection.

Detail B is the **improper** structural solution. The floor load from the floor joist will not be able to be adequately transferred to the structural stud.

5. The requirements on continuity for fire walls, fire barriers, and fire partitions found in the IBC are very different. Each is unique, while serving a specific function. Solutions are available for each, though any potential solution must be found acceptable to the Authority Having Jurisdiction over a given project.

1. What is continuity?

The definitions and requirements for continuity of the walls and partitions in question can be found in chapter seven of the 2024 edition of the IBC. The chapter is titled “Fire and Smoke Protection Features.”

The User Notes at the beginning say the chapter provides “detailed requirements for fire-resistive-construction, including structural members, walls, partitions and horizontal assemblies.” The chapter then goes on to define the code requirements on fire resistance for:

- Exterior walls: Section 705
- Fire walls: Section 706
- Fire barriers: Section 707
- Fire partitions: Section 708
- Shaft enclosures: Section 712
- Smoke barriers: Section 709
- Smoke partitions: Section 710

Each section defines the purpose and requirements for each wall type. Within the requirements is specific language on “continuity.” The common language used in each type is that the wall or partition shall “extend” from a designated lower elevation—such as the foundation or lower floor/ceiling assembly vertically up to a designated higher elevation, such as a point within the upper floor/ceiling or roof/ceiling assembly. Similar language is utilized for any horizontal continuity requirements.

2. What are the different options to achieve continuity?

Relating to fire walls, fire barriers, and fire partitions there are three very different definitions for continuity. All three types of assemblies require specific fire-resistance ratings, which can vary by application. Further, the IBC defines fire-resistance ratings as:

> *Fire-Resistance Rating: The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by tests, or the methods based on tests, prescribed in Section 703.*

A common solution is to select an assembly that meets the required hourly rating when tested according to ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.

For example, UL Design No. U419 is a common nonstructural wall with a fire-resistance rating of 1 to 4 hours. For the wall to be load-bearing, the appropriate UL Design must be modified to meet that structural requirement. To meet the continuity requirements at the head of the wall, it can follow one of three options:

Option 1 | Fire Wall: Fully penetrate the above floor/ceiling assembly. A fire wall.

Option 2 | Fire Barrier: Terminate at the underside of the floor or roof sheathing, slab or deck above, essentially penetrating the ceiling membrane of the upper floor assembly and extending through the upper floor framing cavity.

Option 3 | Fire Partition: Terminate underside of the floor or roof sheathing, deck or slab above, or to the underside of a floor/ceiling or roof/ceiling assembly having a fire-resistance rating that is not less than the fire-resistance rating of the fire partition.

The three details illustrate the concepts of continuity. In all three cases the wall framing and the floor/ceiling framing are made of cold-formed steel (CFS) components.

Options 1 and 2 illustrate balloon-type framing, whereas Option 3 may be either balloon or platform framing. The floor/ceiling assembly is a common fire-resistant assembly using cold-formed steel (CFS) joists with steel deck and poured gypsum concrete. Underneath the joist is a resiliently suspended layer of a proprietary Type X gypsum wallboard.

The area of interest is shown within the red rectangle. In each option, the rectangle takes a different position as it transitions to meet the varying code requirements. They are all at the interface of a cold-formed steel (CFS) wall assembly and floor/ceiling assembly.

3. What are the ramifications for cold-formed steel in Option 1 | Fire Wall?

Option 1 is a fire wall. In the figure, the red rectangle is continuous through the entire floor/ceiling assembly.

Requirements for the use of this wall are found in Section 706 of the IBC. The ceiling is breached, the joist framing is oriented parallel to the fire wall, and therefore is interrupted by the wall. The floor system in this case is a steel deck with poured gypsum concrete. The concept here is that the wall divides the building into two separate and structurally independent buildings.

Description

The IBC definition of a fire wall is as follows:

> *Fire Wall: A fire-resistance rated, smoke tight wall having protected openings, which restricts the spread of and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.*

Assuming this is a two-hour fire wall, the four layers of fire resistive gypsum wallboard run continuously through the floor joist cavity. As the definition requires, the primary fire-resistant membrane, gypsum wallboard, is continuous from the foundation through the roof. As stated earlier, the fire wall essentially structurally divides one building into two independent structures.

Applications

The IBC requires the use of a fire wall to establish separate buildings for the purpose of determining what is described as:

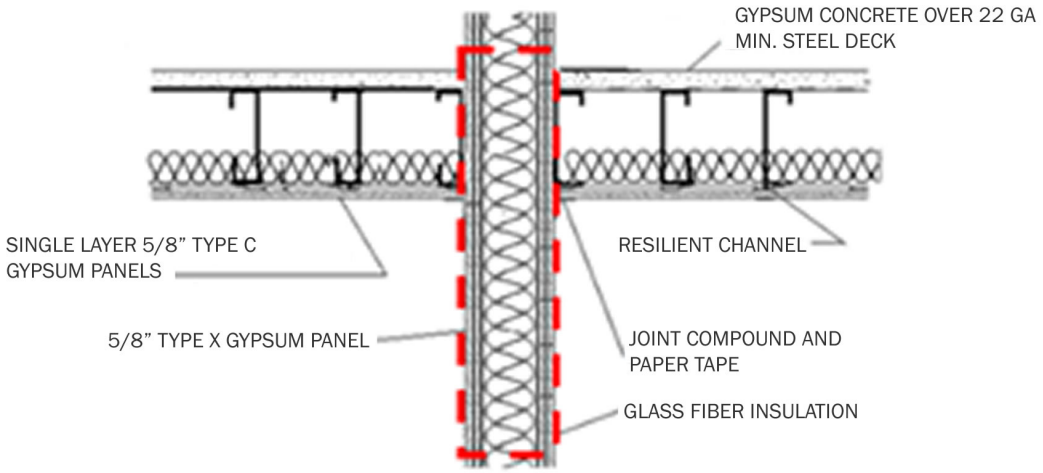
- Area limitations
- Height limitations
- Types of construction
- Allowable number of control areas

The IBC also considers the condition in which the fire wall separates a building of two different heights. An example would be a fire wall that separates a two-story structure from one that is three stories. There are certain requirements as to how high the wall must extend above the lower building roofline. The final concept to understand is that there is also a horizontal continuity component to fire walls.

Cold-Formed Steel Ramifications

The use of a fire wall generally precludes the wall's function as a structural (load-bearing) wall. The fire wall is typically nonstructural and flanked with structural walls, one on each side of the fire wall. In the event of a fire, the flanking wall assures the structural stability of the building that is not compromised in the fire.

The 2021 *GA 600 Fire Resistance and Sound Control Design Manual* has devoted a whole section, termed Area Separation Fire Walls, to the flanking wall concept. Of interest is ASW 0700, which is a fire wall embedded between two cold-formed steel (CFS) framed walls.



Option 1 | Fire Wall

4. What are the ramifications for cold-formed steel in Option 2 | Fire Barrier?

Option 2 is for a fire barrier. The requirements for the use of this wall are found in Section 707 of the 2024 IBC. The red rectangle top line, in this case, is just below the steel deck.

Description

The 2024 IBC describes a fire barrier as follows:

> *Fire Barrier: A fire-resistance rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained.*

The framing type shown in the example is a modified balloon. The floor truss framing is interrupted by the wall framing. Although the vertical wall framing runs continuously, the four layers of gypsum board terminate right below the steel deck.

Applications

Similar to fire walls, the IBC dictates where fire barriers are required. The following list is taken from the IBC:

- Atrium enclosures
- Incidental uses
- Control areas
- Separated occupancies
- Fire areas

Fire barriers, as determined by IBC, are also used for:

- Shaft enclosures
- Stairway and ramp enclosures
- Exit passageways
- Horizontal exits

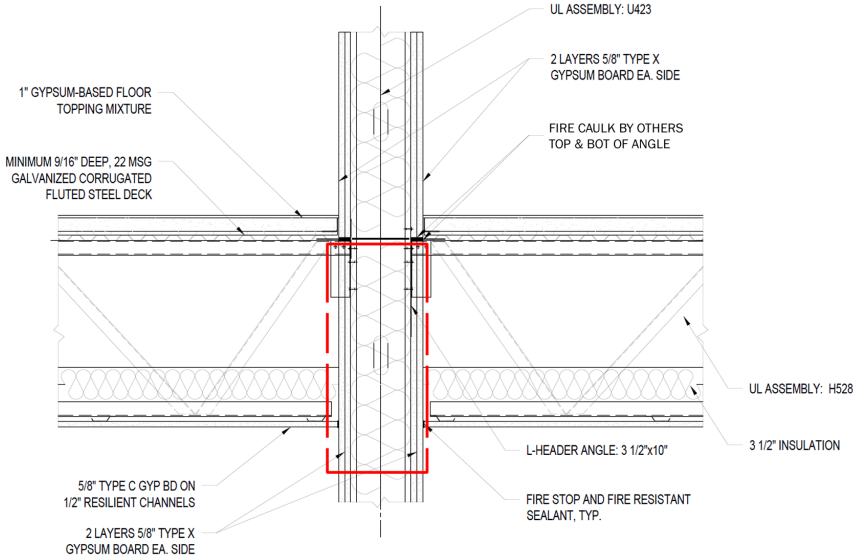
Cold-Formed Steel Ramifications

The challenge here is that the perpendicular orientation of the floor framing requires the fire barrier to also be structural. The interface then entails a dual requirement: to provide an adequate structural connection while ensuring continuity of fire resistance.

In this option, continuity of the structural frame is also important. Appropriate structural lateral connections must be incorporated to assure the continuity of the floor diaphragm. In this regard, a licensed specialty structural engineer should be consulted.

The Option 2 illustration shows the fire-resistive gypsum wallboard installed on the wall framing continuously through the plane of the gypsum wallboard ceiling—that is, through the cavity created by the floor framing system. Regardless of whether the framing is platform or balloon, the continuity of the gypsum wallboard must be maintained through the floor framing.

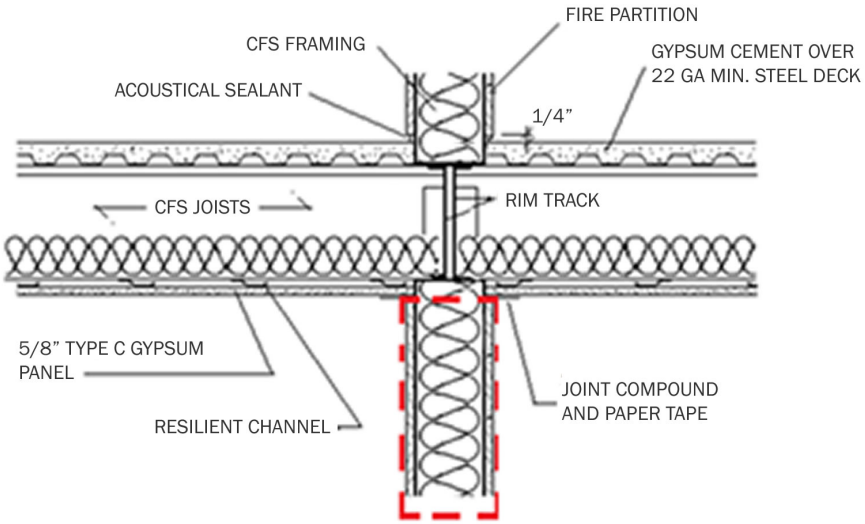
At this point, no industry-standard acceptable solutions exist. However, solutions may become available through specific proprietary building materials. For example, poured gypsum concrete floors on steel decks could potentially be detailed to provide fire protection. Proposed solutions must be found acceptable by the Authority Having Jurisdiction over a given project.



Option 2 | Fire Barrier

Detail provided by BYLD, Inc.

5. What are the ramifications for cold-formed steel in Option 3 | Fire Partition?



Option 3 | Fire Partition

Option 3 relates to a fire partition. Requirements for the use of this wall are found in Section 708 of the IBC.

Description

The IBC describes a fire partition as follows:

> *Fire Partition: A vertical assembly of materials designed to restrict the spread of fire in which openings are protected.*

If the intent is to carry the gypsum board membrane of the wall assembly to the underside of the floor or roof sheathing, slab or deck above, the requirements discussed for fire barriers also apply to fire partitions.

If the intent is to terminate the fire partition at the underside of a floor/ceiling or roof/ceiling assembly with a fire-resistance rating equal to or greater than that of the fire partition, then Option 3 applies. The vertical wall framing in this example terminates at the floor framing system. The top of the red rectangle is just below the ceiling of the floor system.

Applications

The following IBC examples show where fire partitions are required and where openings must be protected:

- Egress balconies
- Walls separating ambulatory care facilities
- Vestibules

Protected openings implies that all openings in the fire-resistive wall must be designed to restrict the possibility of the fire and in some cases, smoke breaching the wall.

Examples of openings include doors and penetrating items such as those common with mechanical, electrical, and plumbing services. This is not unique to fire partitions; protected openings are a requirement in all three types of walls.

Cold-Formed Steel Ramifications

The vertical gypsum wallboard that is attached to the wall terminates below the ceiling plane. To establish an adequate structural load path for the wall, the ceiling should be broken to allow the floor framing system to bear directly on the wall framing.

Since cold-formed steel (CFS) systems provide non-combustible construction, there is no requirement for draft stopping or fire blocking.

Conclusion

The concept of continuity has a very specific meaning relating to fire resistance in the IBC. At its core, the concern is to maintain fire integrity of an assembly as it transitions through adjacent building elements or through 'openings' in the assembly. The IBC defines three levels of continuity. Each is unique and separate from the other two forms of continuity, while serving a very specific function. Solutions are available for each form, and any potential solution must be found acceptable to the Authority Having Jurisdiction over a given project.

Notes

1. SFIA acknowledges the technical assistance provided by Rich Walke of Creative Technology, Inc., in preparing this paper

2. 2024 IBC, Chapter 7, "Fire and Smoke Protection Features," Sections 703, 705-710, and 712 on fire-resistance ratings for respective wall types

3. ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials

4. 2021 GA 600, Fire Resistance and Sound Control Design Manual, "Area Separation Fire Walls" section

ABOUT THE AUTHOR

Robert Grupe is General Manager, Architectural Services at the Steel Framing Industry Association (SFIA), managing the SFIA's Architectural Services Team nationwide. Grupe is a 40-year-plus industry veteran and popular seminar and webinar presenter. He spent over 38 years with United States Gypsum Company in various technical and management positions, including product and system design and technical consultation to the AEC community.