2021 IBC Significant Structural Changes

Part 5: Wood (Chapter 23)

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This five-part series discusses significant structural changes to the 2021 *International Building Code* (IBC) by the International Code Council (ICC). Part 5 includes an overview of changes to Chapter 23 on wood. Only a portion of the total number of code changes to this chapter is discussed in this article. More information on the code changes can be found in the 2021 *Significant Changes to the International Building Code*, available from ICC (*Figure 1*).

IBC Chapter 23 provides minimum accepted practices for the design and construction of buildings and structural components using wood. The following modifications were approved for the 2021 IBC. Changes are shown in strikethrough/underline format with a brief description of the change's significance.

Figure 1. 2021 Significant Changes to the IBC.

Wood Truss Bracing

Revised IBC Section 2303.4.1 now clarifies the installation of permanent truss member restraint and permanent diagonal bracing of individual wood truss members (*Figure 2*).

2303.4.1.2 Permanent individual truss member restraint (PITMR) and permanent individual truss member diagonal bracing (PITMDB). Where the truss design drawings designate the need for permanent individual truss member restraint, it shall be accomplished by one of the following methods:

1. PITMR and PITMDB installed using standard industry lateral restraint and diagonal bracing details in accordance with TPI 1 Section 2.3.3.1.1, accepted engineering practice, or Figures 2303.4.1.2 (1), (3), and (5).
2. Individual truss member reinforcement in place of the specified lateral restraints (i.e., buckling reinforcement such as T-reinforcement, L-reinforcement, proprietary reinforcement, etc.) such that the buckling of any individual truss member is resisted internally by the individual truss. The buckling reinforcement of individual truss members shall be installed as shown on the truss design drawing or on supplemental truss member buckling reinforcement details provided by the truss designer or in accordance with Figures 2303.4.1.2 (2) and (4).
3. A project-specific PITMR and PITMDB design provided by any registered design professional.

2303.4.1.2.1 Trusses installed without a diaphragm. Trusses installed without a diaphragm on the top or bottom chord shall require a project specific PITMR and PITMDB design prepared by a registered design professional.

Exception: Group U occupancies.

2303.4.1.3 Trusses spanning 60 feet or greater. The owner or the owner's authorized agent shall contract with any qualified registered design professional for the design of the temporary installation restraint and diagonal bracing and the PITMR and PITMDB for all trusses with clear spans 60 feet or greater.

(Deleted text not shown for clarity)

Permanent individual truss member restraint (PITMR) Restraint that is used to prevent local buckling of an individual truss chord or web member because of the axial forces in the individual truss member.

Permanent individual truss member diagonal bracing (PITMDB) Structural member or assembly intended to permanently stabilize the PITMR's.

Individual truss member A truss chord or truss web.

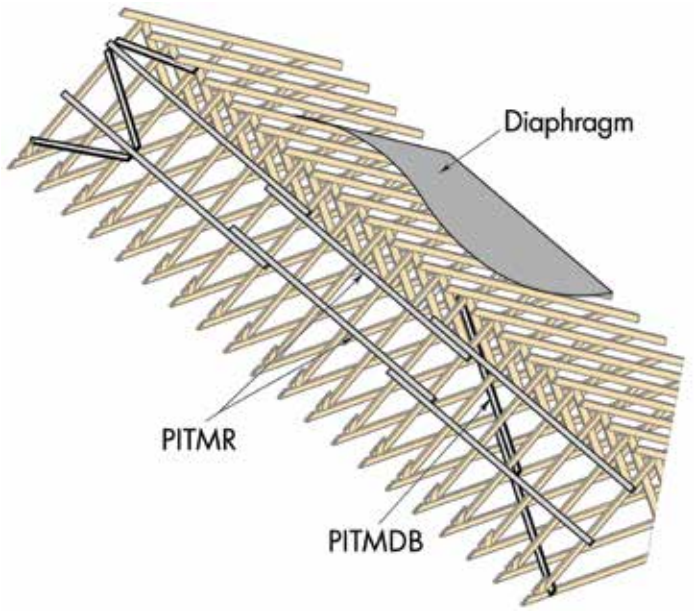

Figure 2. Permanent lateral and diagonal truss web bracing. (Only IBC Figure 2303.4.1.23 is shown for brevity).

Change Significance: The current industry standard of care for installing permanent truss member restraint and diagonal bracing requires that a truss installer (framer) rely on standard industry details. Such details are found in the document B*uilding Component Safety Information (BCSI) – B3: Permanent Restraint/*

Bracing of Chords & Web Members as referenced in ANSI/TPI 1 *National Design Standard for Metal Plate Connected Wood Truss Construction* Section 2.3.3.1.1. However, the reality in the field is that those framers are often not familiar with BCSI-B3 and not provided a copy of that document with the trusses. Owners, building designers, truss designers, truss manufacturers, and building officials typically rely on framers to accurately and completely interpret when, where, and how to install required restraint and diagonal bracing for pre-engineered wood trusses.

The new IBC Section 2303.4.1.2 requirements are intended to clarify truss bracing needs. Definitions for an Individual Truss Member, a Permanent Individual Truss Member Restraint (PITMR), and Permanent Individual Truss Member Diagonal Bracing (PITMDB) have been added to IBC Section 202. These definitions should eliminate some confusion in the design community and on the job site regarding what specific bracing members are required and their intended purpose. Terms such as bracing, bridging, continuous lateral brace, and x-bracing are often used but do not necessarily mean the same thing to everyone.

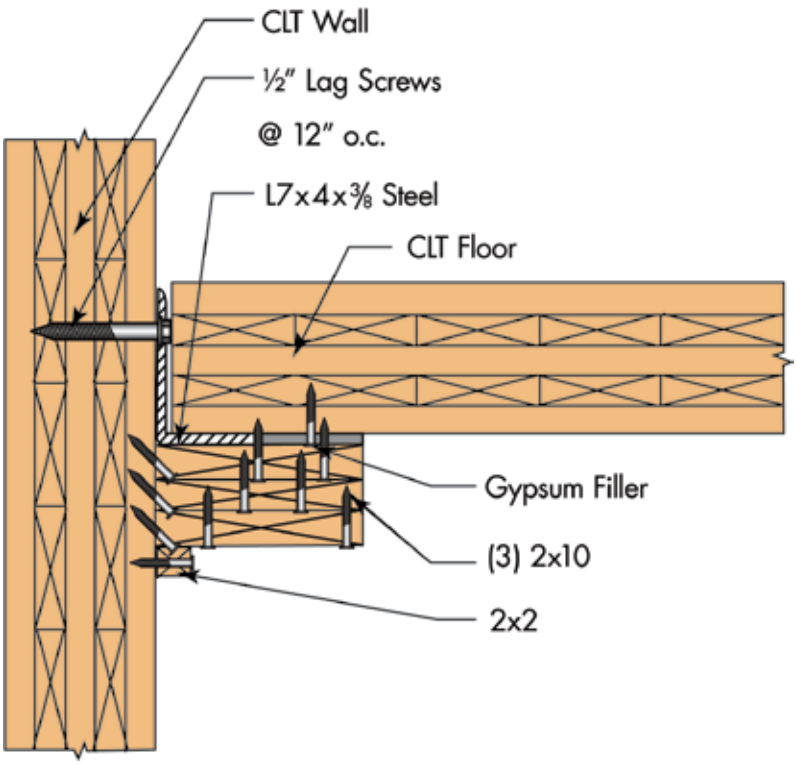

Figure 3. CLT floor-to-wall example from AWC TR10. Courtesy of the American Wood Council.

Type IV-A, IV-B, and IV-C Connection Protection

In new Type IV-A, IV-B, and IV-C construction, a testing option for connections that are part of a fire-resistance-rated assembly is provided. As a second option, a calculation approach for connections required to be protected for the fire-resistance rating of the connected elements is also available.

2304.10.1 Connection fire resistance rating. Fire resistance ratings for connections in Type IV-A, IV-B, or IV-C construction shall be determined by one of the following:

1. Testing in accordance with Section 703.2 where the connection is part of the fire resistance test.
2. Engineering analysis that demonstrates that the temperature rise at any portion of the connection is limited to an average temperature rise of 250°F (139°C), and a maximum temperature rise of 325°F (181°C), for a time corresponding to the required fire resistance rating of the structural element being connected. For the purposes of this analysis, the connection includes connectors, fasteners, and portions of wood members included in the structural design of the connection.

Change Significance: IBC Sections 704.2 and 704.3 require connections of columns and other primary structural members to be protected with materials that have the required fire-resistance rating. The new Section 2304.10.1 provides two options for demonstrating such compliance for connections in Types IV-A, IV-B, and IV-C construction: a testing option and a calculation option. The provisions do not apply to heavy timber (IV-HT) construction connections because heavy timber structural members do not have a prescribed fire-resistance rating.

IBC Sections 704.2 and 704.3 do not require connections that join elements of the structural frame to be tested in accordance with ASTM E119. The sections require the connections to be protected with a material having a fire-resistance rating greater or equal to the rating of the structural members to which they connect. It is neither practical nor possible to test connections in a standard fire test furnace since there is no capability to test the large connections used to transfer gravity loads. In addition, ASTM E119 does not include any provisions on how to test connections and assess their performance.

Option 1, described in Section 2304.10.1, Item 1, is consistent with ASTM E119 because the connection is included as part of the overall assembly being tested. In other words, the connection itself is not being tested; instead, the assembly is being tested with the connection included within it and is, therefore, subject to the ASTM E119 pass/fail criteria applicable to that assembly.

Some connections used in Types IV-A, IV-B, and IV-C construction are not part of the mass timber element or assembly testing. Option #2, an engineering analysis, is required for those connections by Section 2304.10.1 Item 2. IBC Section 722 permits structural fire-resistance ratings of wood members

to be determined using Chapter 16 of the American Wood Council's (AWC) *National Design Specification® (NDS®) for Wood Construction*.

Where a wood connection is required to be fire-resistance-rated, NDS Section 16.3 requires all components of the wood connection, including the steel connector, the connection fasteners, and the wood needed in the connection's structural design, to be protected for the minimum required fire-resistance time. The connection is permitted to be protected by wood, gypsum board, or other approved materials.

Analysis procedures have been developed that allow protection of these connections to be designed based on test results of ASTM E119 fire tests from protection configurations using the exterior thickness of the wood structural member, additional wood cover, and/or gypsum board. The AWC's *Technical Report 10* (TR10): *Calculating the Fire Resistance of Wood Members and Assemblies*, referenced in the NDS Chapter 16 Commentary, provides examples of connection designs meeting the requirements of IBC Section 704 and NDS Section 16.3 (*Figure 3, page 13*).

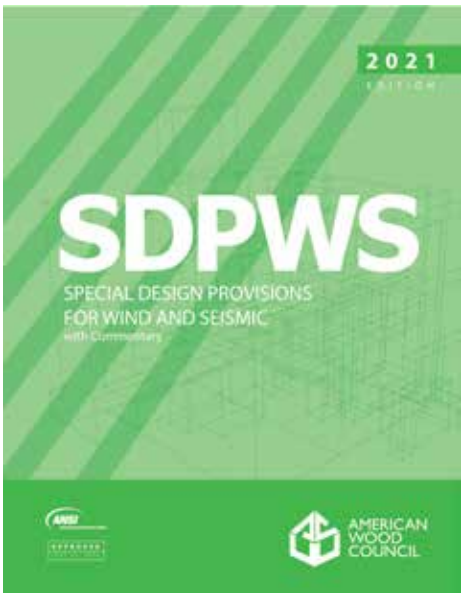

Figure 4. 2021 SDPWS is referenced in the 2021 IBC.

General Design Requirements for Lateral Force-Resisting Systems

The 2021 edition of AWC's *Special Design Provisions for Wind and Seismic* (SDPWS) is referenced in the 2021 IBC (*Figure 4*).

2305.1 General. Structures using wood-frame shear walls or wood-frame diaphragms to resist wind, seismic or other lateral loads shall be designed and constructed in accordance with AWC SDPWS and the applicable provisions of Sections 2305, 2306 and 2307.

Chapter 35

ANSI/AWC SDPWS – 2021~~2015~~: *Special Design Provisions for Wind and Seismic*

Change Significance: SDPWS provides criteria for proportioning, designing, and detailing engineered wood systems, members, and connections in lateral force resisting systems. Engineered design of wood structures to resist wind or seismic forces is either by allowable stress design (ASD) or load and resistance factor design (LRFD). Nominal shear capacities of diaphragms and shear walls are provided for reference assemblies. See the article (STRUCTURE, *July 2021*) outlining changes to the 2021 SDPWS.

Cripple Walls

Cripple wall requirements have been clarified to emphasize that if only interior wood-framed cripple walls exist in a design, no sheathing or solid blocking is required.

2308.5.6 Cripple walls. Foundation cripple walls shall be framed of studs that are not less than the size of the studding above. Exterior cripple wall studs shall be not less than 14 inches (356 mm) in length; or shall be framed of solid blocking. Where exceeding 4 feet (1,219 mm) in height, such walls shall be framed of studs having the size required for an additional story. See Section 2308.6.6 for cripple wall bracing.

2308.6.6.2 Cripple wall bracing in Seismic Design Categories D and E. For the purposes of this section, cripple walls in Seismic Design Categories D and E ~~having~~ shall not have a stud height exceeding 14 inches (356 mm) ~~shall be considered to be a story and~~, and studs shall be ~~braced~~ solid blocked in accordance with Section 2308.5.6 for the full dwelling perimeter and for the full length of interior braced wall lines supported on foundations, excepting ventilation and access openings. ~~Table 2308.6.1. Where interior braced wall lines occur without a continuous foundation below, the length of parallel exterior cripple wall bracing shall be one and one-half times the lengths required by Table 2308.6.1. Where the cripple wall sheathing type used is Method WSP or DWB and this additional length of bracing cannot be provided, the capacity of WSP or DWB sheathing shall be increased by reducing~~


Figure 5. Interior cripple walls.

~~the spacing of fasteners along the perimeter of each piece of sheathing to 4 inches (102 mm) on center.~~

Change Significance: Section 2308.5.6 has been clarified by adding the term *exterior* to the requirements. Also, contradictory text has been deleted from Section 2308.6.6.2. Where cripple walls are exterior walls supporting one or more stories, the wall must now be braced with either solid blocking or sheathing based on wall bracing requirements. These walls have been found to rack sideways and fail in moderate and large earthquakes. Adding sheathing or blocking stiffens the wall.

For buildings where exterior walls are supported by concrete or CMU foundation walls, and a cripple wall is part of an interior wall line, whether below an interior braced wall line or simply supporting the floor above, there is no requirement for bracing the wall line by blocking or sheathing. These walls are inside a much stiffer exterior foundation wall of concrete or CMU block and will not move independently of the floor and exterior walls during an earthquake (*Figure 5*).

Cripple wall bracing in Seismic Design Categories (SDC) D and E is now limited to 14 inches in height and must be solidly blocked along both interior and exterior braced wall lines. Therefore, buildings may only be one-story with a slab on grade foundation, concrete foundation walls, or a crawlspace consisting of studs 14 inches or less in height with solid-blocked cripple walls per Table 2308.2.1. Because cripple walls over 14 inches in height are considered an additional story, a one-story building over taller cripple walls is considered a two-story building and prohibited in SDC D and E. The extent of solid blocking of cripple wall studs to allow for ventilation and access openings has also been clarified.

Conclusion

Structural engineers responsible for wood design should be aware of significant structural changes in the 2021 IBC. New provisions include clarity on the installation of permanent truss web member lateral and diagonal bracing, both a testing and a calculation option for connections that are required to have a fire-resistance rating for new Type IV-A, IV-B, and IV-C construction, reference to the 2021 SDPWS, and cripple wall requirements emphasizing that, if only interior wood-framed cripple walls exist in a design, no sheathing or solid blocking is required.▪

Parts 1 through 4 of this series ran in STRUCTURE November and December 2021, and January and February 2022, respectively.

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