# Designing with Wood Under the IBC

## Construction Type, Building Size, and Fire Resistance

### Fire and Life Safety: Assessing Risk

The International Building Code (IBC) is guided by the principle of designing for fire and life safety based on the theory of equivalent risk. In other words, the code assesses the potential risk of each building and prescribes an appropriate minimum level of protection. Occupancy classifications (Chapter 3) help identify the risks associated with the building's use while construction types (Chapter 6) and their associated fire-resistance ratings (FRRs) establish, in part, different levels of fire safety. Allowable building sizes (Chapter 5) aim to balance these levels of risk and safety by limiting building heights and floor areas.

Occupancies with a higher risk generally have smaller allowable building sizes, while larger buildings are allowed for lower-risk occupancies. For example, in an office occupancy (Group B), most people in the building are expected to be alert and mobile, allowing them to evacuate more quickly than those in a residential occupancy (e.g., R-2), who may be asleep. The allowable building sizes in Chapter 5 balance the difference in risk between these occupancies by allowing larger buildings for business occupancies than residential within each construction type. As another example, consider assembly occupancies (A), which are associated with a higher density of people and longer egress times, versus low-hazard industrial facilities (F-1) that are sparsely populated; assembly occupancies often have smaller allowable building sizes while factories can be much larger.

Similarly, construction types with more stringent limitations on the types of materials that can be used and higher FRR requirements (i.e., higher levels of fire safety) are generally allowed to be taller and larger. On the other hand, construction types that are more lenient in terms of materials and FRRs generally have smaller allowable building sizes.


**The Village at Mines Park** / Golden, Colorado
SAR+ Architects / Fortis Structural / Millender White Construction

*Hybrid mass timber/light-frame wood student housing includes Types III-B, V-A, and I-A construction across four and five-story buildings*

Additional fire and life safety provisions are included throughout the IBC, such as egress requirements, fire protection and life safety systems (e.g., sprinklers, fire alarms, etc.), and additional FRR requirements. While not addressed explicitly in this paper, they follow a similar pattern; more stringent requirements often apply to higher-risk occupancies and/or fewer fire-resistance requirements.

This paper explores the interconnection between allowable building size, construction type, occupancy, FRRs, and other fire and life safety requirements, with an emphasis on where wood structural materials are permitted by code. Unless otherwise noted, references are to the 2024 IBC.

## Construction Types and Wood Use

IBC Section 602 defines five main construction types (Types I through V); Types I, II, III, and V have subcategories A and B, while Type IV has subcategories A, B, C, and HT. The five construction types are summarized as follows:

- ***Types I & II*** (IBC Section 602.2) – These construction types are generally required to have noncombustible building elements, but the IBC provides specific allowances for wood in Section 603 and Table 601, footnotes b and c. Most notably, these provisions allow the use of fire-retardant-treated wood (FRTW) or heavy timber in the roofs of Type I and II buildings, when certain conditions are met.

  For more information, see the WoodWorks article, *Using Wood in Types I and II Construction*.

  Construction Type I is the most restrictive in terms of fire and life safety requirements, so it is often the most expensive but allows the largest building size.

  Type II has less restrictive fire and life safety requirements, generally resulting in lower costs and smaller building sizes compared to Type I.

- ***Type III*** (IBC Section 602.3) – In Type III construction, wood elements can be used in floors, roofs, and interior walls. There is a general requirement that exterior walls must be constructed of noncombustible materials; however, FRTW framing and sheathing is permitted in exterior walls required to have an FRR of 2 hours or less. Where FRTW is permitted by the code, it must comply with the requirements of Section 2303.2.

  Type III-A generally requires a 1-hour FRR for interior structural elements, while these elements can usually be unrated in Type III-B. Exterior bearing walls must have a 2-hour rating in both of these types.

  For a detailed discussion of exterior walls in Type III construction, see the WoodWorks article, *Detailing Floor-to-Exterior Wall Conditions in Type III Projects*.

  In many cases, the allowable building sizes (height and area) for Type III construction are similar to those for Type II. Type II-A construction provides moderate allowable area increases over Type III-A; Types II-B and III-B are often equal. However, for certain occupancy groups, Type II construction will allow a larger building size.

- ***Type IV*** (IBC Section 602.4) – Often referred to as 'heavy timber' construction, this construction type has been in the building code for over a hundred years in one form or another, but its use has increased with the renewed interest in exposed wood buildings. In the 2021 IBC, the historic heavy timber construction type was renamed IV-HT and three new construction types were created for larger timber buildings: IV-A, IV-B, and IV-C. Type IV construction types are unique in that fire-resistive behavior is based in part on the inherent and long-demonstrated fire resistance of large solid wood framing.

  In Type IV-HT construction, structural wood components are permitted in floors, roofs, and interior walls when they meet the minimum cross-section sizes of Section 2304.11. Typically, these components can be exposed to the interior of the building. Per IBC Sections 602.4.4.1 and 602.4.4.2, exterior walls required to have an FRR of 2 hours or less are also permitted to use FRTW framing or cross-laminated timber (CLT) when the exterior surface is covered with FRTW sheathing or noncombustible materials.

  In Type IV-A, IV-B, and IV-C buildings, timber components are permitted when they meet the minimum cross-section sizes required for Type IV-HT, plus additional FRR requirements and exposure limits in IBC Sections 602.4.1, 602.4.2, and 602.4.3. These construction types also have unique requirements related to concealed spaces and shafts, which are addressed in two WoodWorks papers: *Concealed Spaces in Mass Timber and Heavy Timber Structures* and *Shaft Wall Requirements in Tall Mass Timber Buildings*.

  For more information on the design of Type IV structures, see the WoodWorks Tall Mass Timber webpage.

- ***Type V*** (IBC Section 602.5) – In Type V buildings, structural elements can be built from any material permitted by the code. Therefore, wood can be used throughout the structure, including floors, roofs, and both interior and exterior walls.

  Type V-A requires fire-resistance protection (typically 1 hour), while Type V-B allows unprotected wood construction, except where exterior walls must be protected because of proximity to a property line or adjacent building.

  Because Type V has the fewest fire-resistance requirements, it is often the most cost-effective option. However, it also offers the smallest allowable building size.

### Fire Walls

Fire walls serve to divide an area into separate buildings that are analyzed individually for the purposes of allowable area, height, and construction types. They can therefore be an effective way to achieve larger project areas using less stringent construction types (e.g., Type III or V); allowable building sizes are discussed later in this paper.

IBC Section 706.3 requires fire walls to be noncombustible, with the exception that combustible materials, including wood, can be used when separating Type V buildings. When noncombustible fire walls are used to separate wood buildings, it is common to use wood bearing walls on either side of a noncombustible assembly, particularly in light-frame applications. The wood bearing walls are not considered to be part of the fire wall assembly and do not contribute to the rating of the fire wall.

**TABLE 1:** Allowable wood materials for Types III, IV, and V construction

| Construction type | Type III | | Type IV | | | | Type V | |
|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | C | HT | A | B |
| **Exterior wall materials** | FRTW | | CLT (protected on exterior; interior protection varies by subtype) | | | FRTW, CLT (protected on exterior) | Any wood (LF, MT) | |
| **Roof elements** | Any wood (LF, MT) | | Heavy timber including MT (interior protection varies by subtype) | | | Heavy timber including MT | Any wood (LF, MT) | |
| **Interior elements** | Any wood (LF, MT) | | Heavy timber including MT (protection varies by subtype) | | | Heavy timber including MT; LF for interior partitions with a 1-hr FRR | Any wood (LF, MT) | |
| **Fire wall materials** | Noncombustible fire wall; opportunity for wood bearing wall on each side to meet structural stability requirements | | | | | | Any wood (LF, MT) | |

*CLT = Cross-laminated timber; FRTW = fire-retardant-treated wood, LF= light frame; MT = mass timber*
*Source: IBC Sections 601 and 706*

For more information on how to use fire walls to increase building sizes, see the WoodWorks paper, *Taking the Guesswork out of Mixed-Use Building Requirements*.

### Wood in Types III, IV, and V

Of the five construction types, Types III, IV, and V may be framed exclusively with wood, with specific material requirements described in the previous sections and summarized in Table 1.

## Fire-Resistance Rating Requirements

A building's construction type determines many of the minimum FRRs required for its structural elements, as shown in IBC Table 601 and partially reproduced in Table 2 below. Bearing and nonbearing exterior walls must also comply with the FRR requirements in IBC Section 705.5 and Table 705.5 (not shown), based on the fire separation distance from the property line or adjacent building.

FRR requirements can also come from other code provisions, as illustrated by the following examples.

Walls and floors between dwelling or sleeping units of multi-unit residential buildings are typically required to have an FRR of 1 hour; however, a 1/2-hour FRR is allowed in Types II-B, III-B, and V-B construction when sprinklered throughout with an NFPA 13 system (Sections 420, 708, and 711). For more information on the requirements for mass timber projects, see the WoodWorks paper, *Mass Timber in Affordable Multi-Family Housing*.

Multiple separated occupancies (Section 508.4), incidental uses (Section 509), and special provisions (Section 510) also require FRRs of select components and assemblies. For more information on mixed-use buildings, see WoodWorks' *Taking the Guesswork out of Mixed-Use Building Requirements*.

Shaft walls are required to have a minimum 2-hour FRR when connecting four or more stories, and a minimum 1-hour FRR for less than four stories. For more information, see WoodWorks' *Shaft Wall Solutions for Light-Frame and Mass Timber Buildings*.

## Allowable Building Size

Chapter 5 of the IBC details allowable heights and areas; height (in feet and number of stories) is addressed in Section 504 and area is addressed in Sections 506 and 507. In particular, the IBC includes three tables that are often used in determining a building's allowable size:

- Table 504.3 lists allowable building height in feet (measured as distance from grade plane to the average height of the highest roof surface). Values are given for non-sprinklered buildings (NS) as well as those equipped throughout with an NFPA 13 sprinkler system (S). For residential occupancies, additional values are given for buildings equipped with an NFPA 13R system (S13R) and an NFPA 13D system (S13D).
- Table 504.4 lists allowable building height in number of stories above grade plane. Values are provided for non-sprinklered (NS) or sprinklered (S) conditions, as well as the unique residential sprinkler options of NFPA 13R or 13D (S13R and S13D, respectively).
- Table 506.2 lists an allowable area factor. Values are given for non-sprinklered buildings (NS). When the building has an NFPA 13 sprinkler system, separate values are provided for single-story buildings (S1) and multi-story buildings (SM). For residential occupancies, values are listed for NPFA 13R and 13D sprinklers (S13R and S13D); however, these values are the same as the non-sprinklered (NS) tabulated values.

For single-occupancy buildings, the allowable area of each story is determined by adjusting the allowable area factor by any frontage increases, according to the following formula:

$$A_a = [A_t + (NS \times I_f)] \qquad \text{(IBC Equation 5-1)}$$

Where:

$A_a$ = Allowable area (sqft)

$A_t$ = Tabular allowable area factor based on actual sprinkler conditions (NFPA 13, NFPA 13R, etc.) and single or multi-story building configurations (S1 or SM) per Table 506.2

$NS$ = Tabular allowable area factor per Table 506.2 for a non-sprinklered building, regardless of whether the building is sprinklered

$I_f$ = Area increase factor due to frontage (percent) as calculated in Section 506.3

The total allowable building area is calculated as the allowable floor area times the number of floors, not to exceed three (or not to exceed four if the building has an NFPA 13R sprinkler system), per Equation 5-2. Note that buildings more than three stories tall are still limited to a 3x floor area multiplier for total building area. For example, a multi-story Group R-2 building designed as Type V-A with an NFPA 13 sprinkler system could have up to 36,000 sqft on any given story. A four-story building with these conditions would be permitted to have a total building area of 36,000 x 3 = 108,000 sqft (not accounting for potential frontage increases).

Table 3 summarizes the allowable building sizes for multi-family residential, Group R-2 occupancy. With a few exceptions, allowable building sizes generally decrease from left to right across the table (Type I-A to V-B); however, the sizes permitted in Types II-A, IV-HT, and III-A are similar. Likewise, similar allowable building sizes can be achieved with Types II-B and III-B. Tables can be developed for other occupancy groups and, while the values will change, these general patterns will remain for most occupancies.

## Unlimited Area Buildings

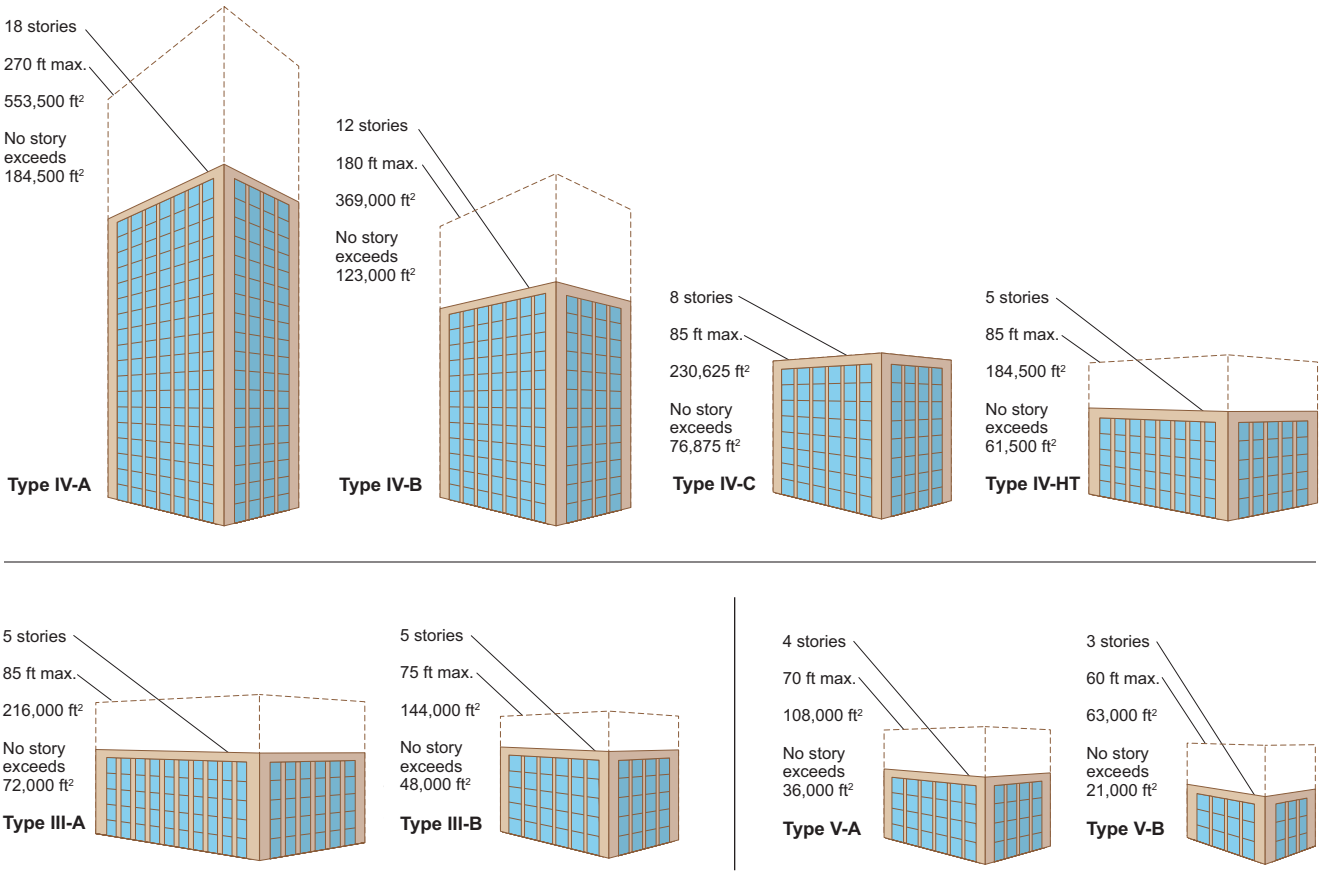
IBC Section 507 includes provisions for unlimited area buildings, which most commonly apply to one- or two-story buildings with at least 60 feet of open space around the perimeter (frontage) and low- or moderate-hazard occupancies. For projects that may qualify, it is advantageous to check the provisions of Section 507 before analyzing the allowable area according to Section 506, as the unlimited area provisions may permit the least restrictive construction type (V-B) while also allowing a large footprint. For more on this topic, see the WoodWorks paper, *Wood in Industrial Buildings: Systems, Codes, and Design Opportunities*.

**TABLE 2:** FRR requirements for building elements (hours)

| Building Element | Type I | | Type II | | Type III | | Type IV | | | | Type V | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B | C | HT | A | B |
| Primary structural frame[f] (see Section 202) | 3[a,b] | 2[a,b] | 1[b] | 0 | 1[b] | 0 | 3 | 2 | 2 | HT | 1[b] | 0 |
| Bearing walls – exterior[e,f] | 3 | 2 | 1 | 0 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 0 |
| Bearing walls – interior | 3[a] | 2[a] | 1 | 0 | 1 | 0 | 3 | 2 | 2 | 1/HT[g] | 1 | 0 |
| Nonbearing walls and partitions – exterior | See Table 705.5 | | | | | | | | | | | |
| Nonbearing walls and partitions – interior[d] | 0 | 0 | 0 | 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 | 2 | 2 | 2 | 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 | 1-1/2 | 1 | 1 | HT | 1[b,c] | 0 |

*Source: IBC Table 601 / See IBC for footnotes*

**FIGURE 1:** Allowable building sizes for residential (R-1 and R-2) occupancies




*Notes: Based on IBC Tables 504.3, 504.4, and 506.2 / Assumes building is fully sprinklered with an NFPA 13 system / No frontage increases shown Areas shown are for multi-story buildings / Equal floor heights shown for all buildings and levels; actuals may vary*

**TABLE 3:** Allowable heights and areas for Group R-2 occupancy

| I-A | I-B | II-A | II-B | III-A | III-B | IV-A | IV-B | IV-C | IV-HT | V-A | V-B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Allowable Height (IBC Table 504.3) (ft)** | | | | | | | | | | | |
| Unlimited | 180 | 85 | 75 | 85 | 75 | 270 | 180 | 85 | 85 | 70 | 60 |
| **Allowable Stories (IBC Table 505.4)** | | | | | | | | | | | |
| Unlimited | 12 | 5 | 5 | 5 | 5 | 18 | 12 | 8 | 5 | 4 | 3 |
| **Allowable Area per Story (IBC Table 505.2) (ft²)** | | | | | | | | | | | |
| Unlimited | Unlimited | 72,000 | 48,000 | 72,000 | 48,000 | 184,500 | 123,000 | 76,875 | 61,500 | 36,000 | 21,000 |

*Note: Assumes the building is fully sprinklered with an NFPA 13 system and no frontage increase*

## Selecting a Construction Type

While it is common to choose a construction type based on structural material—i.e., to assume that steel and concrete structures should be Type II, light-frame wood should be Type V, and exposed heavy timber should be Type IV—this approach can lead to design inefficiencies. Although these generalizations do fit within the IBC requirements, it is beneficial to have a full understanding of the allowable use of materials in all five construction types, and the unique allowances and limitations associated with each. The IBC states:

> ***602.1.1 Minimum requirements.*** *A building or portion thereof shall not be required to conform to the details of a type of construction higher than that type which meets the minimum requirements based on occupancy even though certain features of such a building actually conform to a higher type of construction.*

## Heights and Areas with Sprinklers

The allowable heights and areas tables in IBC Chapter 5 show tabular values for non-sprinklered (NS) buildings and those equipped with an NFPA 13 sprinkler system (S). For residential construction, the tables also include tabular values for NFPA 13R and NPFA 13D sprinklers (S13R and S13D). Although NS values are provided for all occupancies as a baseline reference, some occupancies require the use of sprinklers. These tables illustrate the benefits of providing NFPA 13 sprinkler systems even when they are not required. For most occupancies and construction types, Tables 504.3 and 504.4 show that buildings sprinklered with an NFPA 13 system (S) are permitted an extra 20 feet and one story in allowable height above the non-sprinklered (NS) values; notable exceptions are Type IV-A and IV-B construction and some H and I occupancy groups. Additionally, Table 506.2 shows that a floor area increase of 300% is allowed for single-story buildings (S1) while an increase of 200% is allowed for multi-story buildings (SM). Buildings equipped with an NFPA 13R sprinkler system (S13R) may still achieve height increases but are capped at four stories and 60 feet. As previously noted, no area increase is permitted with the use of an NFPA 13R sprinkler system. Additional area increases are also possible for buildings with adequate frontage.

This section permits the use of elements commonly used in a higher construction type without requiring that the entire building meet all the provisions of that construction type. For example, if a building's size permitted the use of Type V-B construction, it could still be completely framed with noncombustible materials while being classified as V-B. Similarly, a Type III or V building could be framed with a combination of combustible and noncombustible materials.

For cost-efficiency, it is usually best to start a construction type analysis with Type V-B, which offers the least restrictive fire-resistance requirements and the most material flexibility. However, it is also the most restrictive in terms of allowable building size. Type V-A allows larger buildings than V-B, while requiring a 1-hour FRR for many building elements.

If Type V construction doesn't allow the desired building size, the next most cost-effective option is often III-B, followed by III-A. However, there are times when it could be advantageous to consider construction types in a different order. For example:

- When a non-residential building fits within the limitations of either Type V-A or III-B construction, III-B may be advantageous as Table 601 does not require an FRR for interior elements, while Type V-A requires a 1-hour FRR. However, Type III-B has additional limitations and requirements for exterior walls; therefore, Type III-B may be particularly appealing if the exterior walls will be noncombustible and non-load-bearing.
- If an industrial building with mass timber walls does not qualify for Type V construction, Type IV-HT may have advantages over Type III. Type III requires wood exterior wall elements to be FRTW, for which there are limited mass timber options.
- For mid-rise mass timber buildings that meet the requirements for Type III or IV-HT and have noncombustible exterior enclosures, Type III-A or III-B may be preferable in order to avoid the Type IV-HT requirements related to concealed spaces and the need for a 1-hour FRR on non-mass timber interior walls.

In summary, it is often beneficial to compare multiple construction types in the early code analysis of a project.

## Additional Resources

WoodWorks offers numerous resources tailored to specific building sizes, uses/occupancies, and wood materials (i.e., light-frame or mass timber). These resources highlight the unique requirements for, and differences between, each construction type, which is helpful in selecting the optimal construction type for a particular design. They also illuminate the wide variety of project types in which wood can be used successfully. Examples include:

- *Mass Timber in Affordable Multi-Family Housing* includes insights on the differences between **Types III, IV, and V** construction when using mass timber in multi-family applications.
- *Fire Requirements for Mass Timber Elements: Code Applications, Construction Types, and Fire Ratings* includes insights into the differences between **Types III, IV, and V** construction in mass timber applications.
- *Concealed Spaces in Mass Timber and Heavy Timber Structures* outlines specific differences in the treatment of concealed spaces in **Types IV-A, IV-B, IV-C, and IV-HT** construction.
- *Wood in Industrial Buildings: Systems, Codes, and Design Opportunities* includes insights on the use of light-frame, mass timber, and hybrid framing in **Types I, II, III, IV, and V** construction, primarily for warehouse applications.
- *Hybrid Design: Mass Timber Floor and Roof Panels Over Light-Frame Wood Walls* includes insights on the use of light-frame/mass-timber hybrid designs in **Types III, IV-HT, and V** construction.
- *The Modular Design Process – Design of the Units* includes insights into the use of light-frame modular design in **Types III and V** construction, with an emphasis on multi-family applications.
- *Taking the Guesswork out of Mixed-Use Building Requirements* provides guidance on determining allowable heights and areas for **Types III and V** construction when multiple occupancies exist in one building, with an emphasis on light-frame wood applications.
- *Mixed Use Code Strategies Part 1* and *Part 2* provide similar guidance to the paper above, with additional discussion of tall mass timber structures.
- *How to Create a Vertical Addition with Mass Timber* includes insights on construction types and allowable building sizes when using mass timber for a vertical expansion of an existing building.
- *Exterior Walls in Mass Timber Buildings – Part 1: Code Requirements and Commonly Used Materials* outlines the material options available for exterior walls in **Types III, IV, and V** construction.
- *Interior Walls in Mass Timber Buildings* outlines the material options available for interior walls in **Types III, IV, and V** construction.

## Conclusion

Understanding the interdependence of construction types, allowable building sizes, and FRRs is key to optimizing the design of a building. Construction types dictate the materials that are permitted and provide many of the FRR requirements that apply to different building elements. Construction types, in combination with building occupancy and the presence and type of sprinklers, also dictate the allowable building size in terms of height, number of stories, and floor area. This paper introduces these concepts, giving designers a foundation for making informed decisions about where wood can be used.

Photo Jeremy Bittermann

**First Tech Federal Credit Union** / Hillsboro, Oregon / Hacker / Kramer Gehlen & Associates / Swinerton

*Five-story, Type III-B office building with a hybrid mass timber and steel structural system*

Photo Ron Blunt

**80 M Street** / Washington, DC / Hickok Cole / Arup / Davis Construction

*High-rise vertical addition with three new stories of Type IV-C mass timber over an existing seven-story, Type II-B concrete building*

## About WoodWorks – Wood Products Council

WoodWorks provides education and free project support related to the design, engineering, and construction of commercial and multi-family wood buildings in the U.S. For assistance with a project, visit www.woodworks.org/project-assistance or email help@woodworks.org.



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