

Concealed Spaces in Mass Timber and Heavy Timber Structures

Richard McLain, PE, SE • Senior Technical Director – Tall Wood, WoodWorks

Concealed spaces, such as those created by a dropped ceiling in a floor/ceiling assembly or by a stud wall assembly, have unique requirements in the International Building Code (IBC) to address the potential of fire spread in non-visible areas of a building. Section 718 of the 2018 IBC includes prescriptive requirements for protection and/or compartmentalization of concealed spaces through the use of draft stopping, fire blocking, sprinklers, and other means. For information on these requirements, see the WoodWorks Q&A, *Are sprinklers required in concealed spaces such as floor and roof cavities in multi-family wood-frame buildings?*¹

For mass timber building elements, the choice of construction type can have a significant impact on concealed space requirements. Because mass timber products such as cross-laminated timber (CLT) are prescriptively recognized for Type IV construction, there is a common misperception that exposed mass timber building elements cannot be used or exposed in

other construction types. This is not the case. In addition to Type IV buildings, structural mass timber elements—including CLT, glued-laminated timber (glulam), nail-laminated timber (NLT), structural composite lumber (SCL), and tongue-and-groove (T&G) decking—can be utilized and exposed in the following construction types, whether or not a fire-resistance rating is required:

- **Type III** – Floors, roofs and interior walls may be any material permitted by code, including mass timber; exterior walls are required to be noncombustible or fire retardant-treated wood.
- **Type V** – Floors, roofs, interior walls, and exterior walls (i.e., the entire structure) may be constructed of mass timber.
- **Types I and II** – Mass timber may be used in select circumstances such as roof construction—including the primary frame in the 2021 IBC—in Types I-B, II-A or II-B; exterior columns and arches when 20 feet or more of horizontal separation is provided; and balconies, canopies and similar projections.

INTRO, Cleveland | Cleveland, Ohio
Harbor Bay Real Estate Advisors
HPA Architecture

Rendering: Harbor Bay Real Estate Advisors, Image Fiction



Allowances and Requirements for Concealed Spaces

Low-Rise and Mid-Rise Structures

For low-rise and mid-rise buildings, mass timber is typically used in Type III, IV or V construction. Up to and including the 2018, Type IV buildings were not allowed to have concealed spaces:

Section 602.4 Type IV. *Type IV construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of solid wood, laminated wood, heavy timber (HT) or structural composite lumber (SCL) without concealed spaces.*

Although several Type IV buildings have received alternate methods approval for concealed spaces (e.g., the John W. Olver Design Building at the University of Massachusetts – Amherst²), the lack of prescriptive opportunity has steered some designers toward the use of Type III or V construction for their mass timber projects. Neither has a prescriptive limit on the use of concealed spaces; however, Type III and V buildings must still comply with the protection and compartmentalization requirements of IBC Section 718, and the applicable sprinkler standard (e.g., NFPA 13).

The 2021 IBC includes a number of mass timber-related changes. Among them, Type IV-HT (formerly Type IV) will now permit concealed spaces in roof/ceiling or floor/ceiling assemblies (other than previously permitted 1-hour interior walls or FRTW exterior wall assemblies) when one or more of the following conditions are met:

- The building is protected throughout with an NFPA 13 sprinkler system and sprinkler protection is provided in the concealed space
- The concealed space is filled completely with noncombustible insulation
- Surfaces in the concealed space are fully sheathed with 5/8-inch Type X gypsum

It is worth noting that, in the context of heavy timber structures, the code has permitted the use of stud partition walls within Type IV structures as long as they have a minimum 1-hour fire-resistance rating. To clarify this, the following language has been added to the 2021 IBC:

Section 602.4.4.3. *Concealed spaces within interior walls and partitions with a 1-hour or greater fire-resistance rating complying with Section 2304.11.2.2 shall not require additional protection.*

Taller Mass Timber Structures

The 2021 IBC also includes a number of changes specific to taller mass timber buildings. Within the Type IV category are three new sub-types that allow the use of mass timber or noncombustible materials—Type IV-A up to 18 stories; Type IV-B up to 12 stories, and Type IV-C up to 9 stories. Concealed spaces are permitted in all three of these types under certain conditions, as follows:

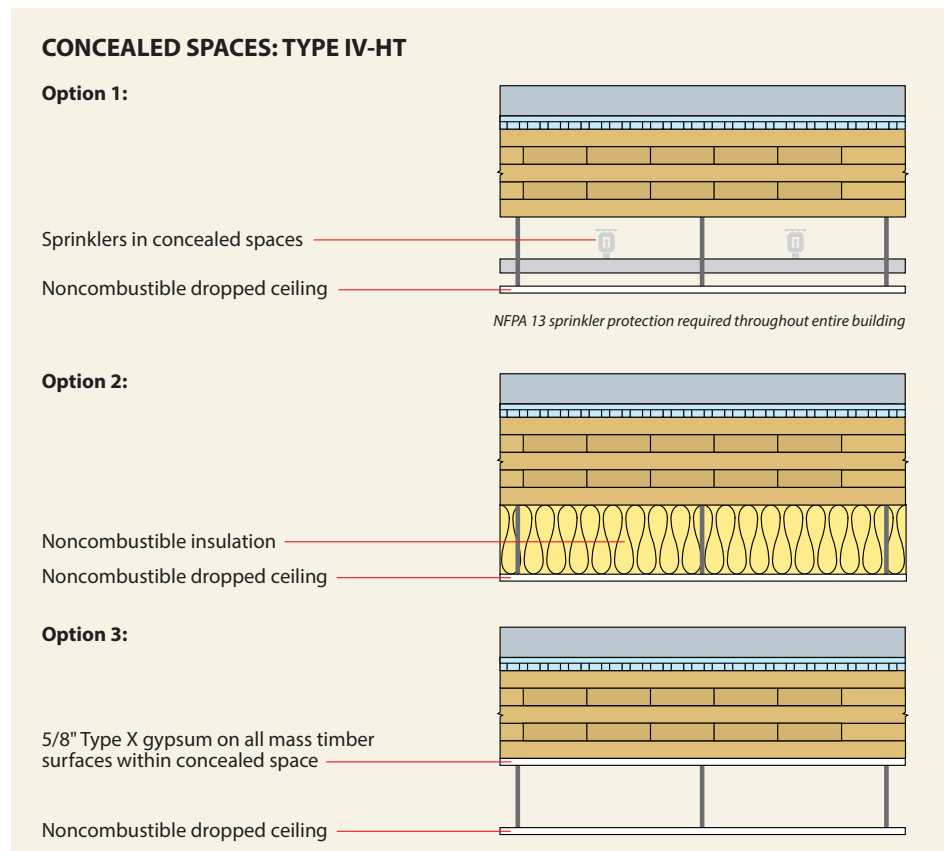
Section 602.4. *Type IV combustible concealed spaces are not permitted except as otherwise indicated in Sections 602.4.1 through 602.4.4. Combustible stud spaces within light-frame walls of Type IV-HT construction shall not be considered concealed spaces, but shall comply with Section 718.*

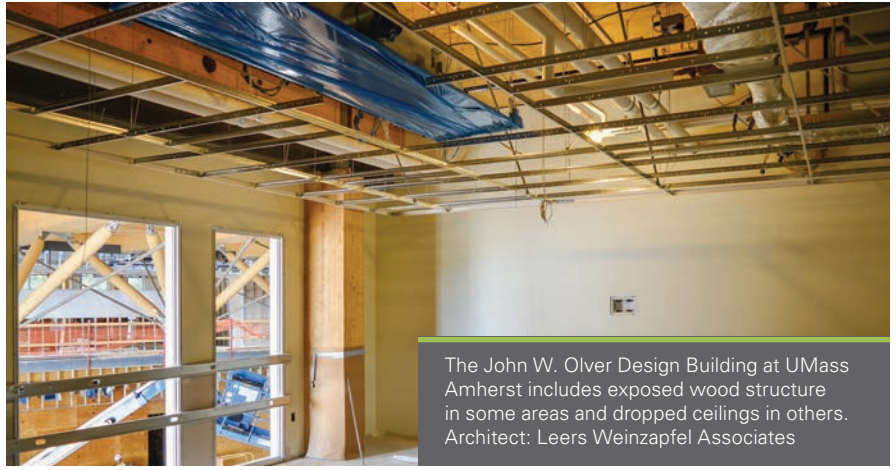
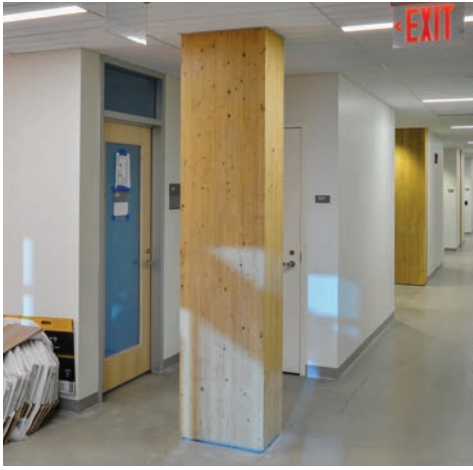
Type IV-A

Section 602.4.1.5 Concealed spaces. *Concealed spaces shall not contain combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the International Mechanical Code, and shall comply with all applicable provisions of Section 718. Combustible construction forming concealed spaces shall be protected in accordance with Sections 602.4.1.2.*

Type IV-B:

Section 602.4.2.5 Concealed spaces. *Concealed spaces shall not contain combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the International Mechanical Code, and shall comply with all applicable provisions of Section 718. Combustible construction forming concealed spaces shall be protected in accordance with Section 602.4.1.2.*





The John W. Olver Design Building at UMass Amherst includes exposed wood structure in some areas and dropped ceilings in others. Architect: Leers Weinzapfel Associates

Section 602.4.1.2 is the section requiring noncombustible protection of interior mass timber surfaces, typically two thirds of the required fire-resistance rating of the element but no less than 80 minutes. This can be achieved with 5/8-inch Type X gypsum providing 40 minutes per layer in accordance with IBC 722.7 or with other noncombustible materials in 2021 IBC Section 703.5 with time assigned in accordance with 2021 IBC Section 703.8.

Type IV-C:

Section 602.4.3.5 Concealed spaces. *Concealed spaces shall not contain combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the International Mechanical Code, and shall comply with all applicable provisions of Section 718. Combustible construction forming concealed spaces shall be protected with noncombustible protection with a minimum assigned time of 40 minutes as determined in Section 722.7.1.*

Note that concealed spaces formed with combustible construction in horizontal assemblies (e.g., the underside of a mass timber floor panel when there is a dropped ceiling below) must be protected in all situations. For Type IV-A and IV-B buildings, the minimum amount of noncombustible protection is a function of the required fire-resistance rating, as shown in IBC Table 722.7.1(1) but no less than 80 minutes.

Section 722.7.1 provides assigned protection times for noncombustible covering materials, with two prescriptive options: 1/2-inch Type X gypsum is assigned 25 minutes, and 5/8-inch Type X gypsum is assigned 40 minutes. Concealed spaces are perhaps most common in the form of dropped ceilings below floor panels. Floor construction in Type IV-A and IV-B buildings typically

FRR and Protection Requirements for Type IV-A and IV-B Buildings

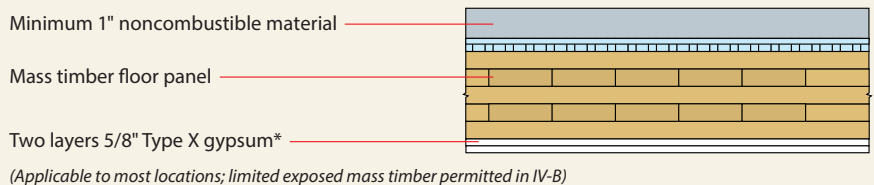
Required FRR of Building Element (hours)	Minimum Required Noncombustible Protection (minutes)
1	40
2	80
3 or more	120

Source: 2021 IBC Table 722.7.1(1)

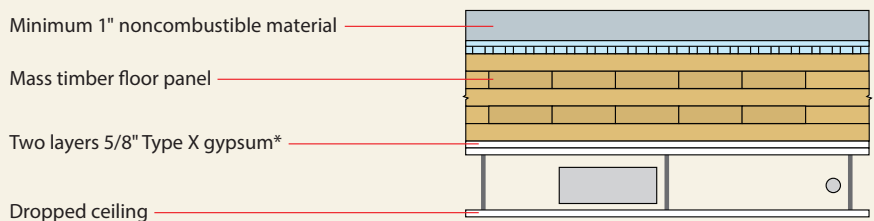
requires a 2-hour fire-resistance rating (which requires a minimum 80-minute contribution from noncombustible covering materials), indicating that a common scenario would involve two layers of 5/8-inch Type X gypsum directly applied to the underside of the mass timber floor panel. The remaining 40 minutes required to achieve the 2-hour-rated assembly would come from the mass timber floor panel, and the dropped ceiling below the mass timber panel would not be considered as contributing to the assembly's fire-resistance rating. Where mass timber bearing walls are utilized and exposed

CONCEALED SPACES: TYPE IV-A AND TYPE IV-B

Without Dropped Ceiling



With Dropped Ceiling



inside of similar floor ceiling concealed spaces, 3-hour fire resistance-rated bearing walls in Type IV-A construction require 120 minutes of noncombustible protection, and 2-hour fire resistance-rated bearing walls in Type IV-B construction require 80 minutes of noncombustible protection.

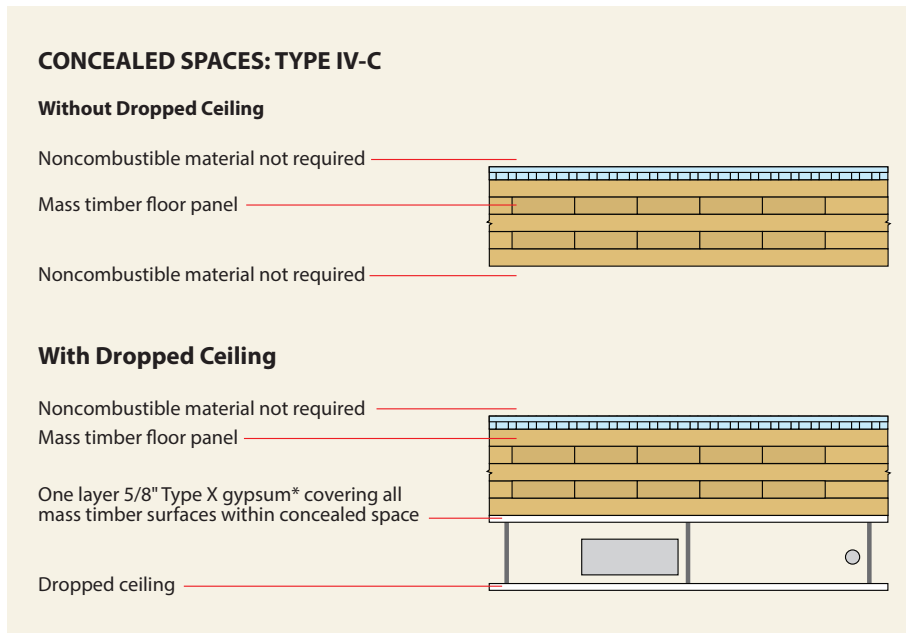
Bearing wall and floor assemblies in Type IV-C construction also require a 2-hour fire-resistance rating. The difference is that all of the wood can generally be exposed in this type of structure, except in concealed spaces. As noted above, Section 602.4.3.5 requires that, *Combustible construction forming concealed spaces shall be protected with noncombustible protection with a minimum assigned time of 40 minutes as determined in Section 722.7.1(a)*. One layer of 5/8-inch Type X gypsum would be the most common option for providing this 40-minute contribution;

however, mineral wool or stone wool materials added for sound attenuation may also be utilized as determined in 2021 IBC section 703.8 when tested and directly applied. Under a scenario with 40 minutes of noncombustible protection directly applied to the mass timber, the timber panel would provide the remaining 80 minutes of fire resistance (to obtain the full 2-hour fire-resistance rating) and the dropped ceiling below the mass timber panel would not be considered as a contributor to the FRR.

Mechanical Plenums in Mass Timber Buildings

In mass timber buildings where the structure is exposed, an important design consideration is whether or not the mechanical system will be exposed or concealed, and how it will run relative to the structural members. Mechanical plenums are one option for accommodating air supply. However, mechanical plenums

are concealed spaces, so when using them in a mass timber building, several code provisions must be followed. As noted in the code sections referenced above, concealed spaces must not contain *combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the International Mechanical Code*. Section 602 of this code requires that materials in plenums be either noncombustible or have a flame spread index of not more than 25 and a smoke developed index of not more than 50. (Other combustible exceptions exist for items such as wiring, pneumatic piping, etc., but not structural materials.) For this reason and the reasons noted above, all mass timber elements within mechanical plenums require noncombustible covering.



End notes:

¹ www.woodworks.org/experttip/are-sprinklers-required-in-concealed-spaces-such-as-floor-and-roof-cavities-in-multi-family-wood-frame-buildings/

² www.woodworks.org/wp-content/uploads/UMass-Amherst-Olver-Design-Building-WoodWorks-Case-Study.pdf

³ www.awc.org/codes-standards/publications/dca1

*Or other noncombustible protection with an equivalent contribution of noncombustible protection as determined in 2021 IBC Section 703.8

Contact WoodWorks for Free Project Support

For assistance with a project, visit www.woodworks.org/project-assistance or email help@woodworks.org. Visit our website at www.woodworks.org.

This document was produced in digital format only prior to publication of the 2021 IBC. Final code section numbers noted for the 2021 IBC are subject to change.

Disclaimer: The information in this publication, including, without limitation, references to information contained in other publications or made available by other sources (collectively “information”) should not be used or relied upon for any application without competent professional examination and verification of its accuracy, suitability, code compliance and applicability by a licensed engineer, architect or other professional. Neither the Wood Products Council nor its employees, consultants, nor any other individuals or entities who contributed to the information make any warranty, representative or guarantee, expressed or implied, that the information is suitable for any general or particular use, that it is compliant with applicable law, codes or ordinances, or that it is free from infringement of any patent(s), nor do they assume any legal liability or responsibility for the use, application of and/or reference to the information. Anyone making use of the information in any manner assumes all liability arising from such use.